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Yael Goverover *Editors*

Changes in the Brain

Impact on Daily Life

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Preface: Laying the Framework

Often, we meet clients in our practice who have had a brain injury or another type of neurological illness. When trying to explain the importance of the brain, we tell them that our brain directs everything our body does. Without the brain, or to be more realistic, without its functions, we would not be able to do most of the things we do on a daily basis, from the mundane to the rare. Our brain is a central processing unit that translates our thoughts, feelings, memories, and opinions into a complicated nerve cell firing process and chemical release. These processes are responsible for our behaviors, and these connections are complicated and difficult to explain. Recently, there has been a growing awareness of the functional implications caused by the injured brain. Traditionally, professionals have used neuropsychological batteries or impairment-based assessments to document the patients' symptoms. These traditional assessments, however, do not focus on learning how the symptoms interfere with daily activities, or why.

We were inspired to compile this book because in the past 20 years we have seen numerous clients through clinical practice and research that share the common characteristic of a central nervous system that functions less than optimally, accompanied with diminished engagement in activities of daily living and social activities. This could be due to injury, illness, or just advancing age. When practitioners and researchers discuss the symptoms experienced, they discuss the impairments that were caused by the damaged brain. These impairments could be cognitive or motor in nature, among others. Our clients, however, speak about how these impairments have impacted their life. They often mention the fact that they cannot go to work anymore, and that they no longer receive social invitations, or drive their car. However, for some patients this link is not linear, which makes this connection between the brain and the behaviors even more complicated. For example, one may see two people with memory impairment, one diagnosed with a preclinical dementia and the other having sustained a TBI. The person with the dementia does not leave his house anymore and does not attend any social events. The person with the TBI went back to work and manages an active life. Why the difference in behavior? The observation of differences in such behaviors across various patient populations, coupled with the challenges affected individuals and their families have in understanding these differences, triggered the writing of this book.

This book includes 13 chapters, all with a common theme—the link between diagnosis, brain, and behavior as it plays out in everyday activities. We also sought to explore different causes of distinct behaviors. Is the diagnosis the essential element, or is it the course of illness, or perhaps cultural factors? Or, is it a combination of such factors that leads to distinct difficulties in daily life activities? In each chapter that follows the diagnosis and its characteristics are described, followed by the relationship between the symptoms and disability. In addition, factors such as culture and society are discussed. In most chapters we sought to illustrate the dynamic link between impacted brain structures, impairment, and participation in everyday life performance. We hope that the reader of this book will be aware of both the complexity in the functioning of the brain and, more importantly, how brain function/dysfunction affects the performance of everyday life activities. The purpose of the book is to educate the reader in regard to the changes in everyday life that are encountered with various mechanisms of brain insult/brain changes. A discussion of the impact of such changes from the perspective of the patient is also included. The book was designed to be useful to the professional, but also of interest to those directly affected by brain injury, brain illness, or brain changes that come with normal aging.

In order to present the most accurate information about the different types of changes in brain function resulting from the different etiologies, each chapter was written by experts in the topic areas. Thus, one can read the entire book or just the chapter of particular interest. While each chapter is a standalone chapter, some chapters such as Chaps. 1 and 11 are general and relate to all types of disability. We are very grateful to the authors who took their time to contribute to our understanding of their area of expertise. We are also grateful to the patients who contributed their portrayal of how the injury or disease affected their life.

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Neuroanatomy: The Brain–Behavior Relationship

1

Glenn Wylie, Erica Weber, Daniela Sacchetti, Silvana Acosta, and Helen Genova

Introduction

This chapter is designed to serve as a reference for the mapping of some of the more important human functions and abilities (e.g., vision) to their respective brain areas (e.g., the occipital lobe). Vision, audition, touch, motoric output, emotion, memory and language abilities are discussed. In each section, some common deficits that result when the relevant brain area is damaged are also discussed. This provides a framework within which the other chapters of the book, which cover particular issues in greater detail, can be understood.

Vision and Visuospatial Functions

The visual system in your brain accomplishes something extraordinary every time you open your eyes: it allows you to perceive—to see—energy. The energy you can see is light, and the light we can see is energy of a particular wavelength. This

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section will explain how the visual system manages to change energy into neural impulses that your brain can use.

Vision begins in your eye. On the back of your eyeball, a sheet of cells called the retina transduce (or change) light energy into neural impulses. There are two types of cells in your retina, which are named after their shape: rods which are cylindrical, and cones which are cone-shaped. Rods need less light to work, but are sensitive to only a limited range of light at the blue end of the spectrum. Cones are sensitive to a far wider range of light, and thus allow us to see in color, but require far more light to work. This is why you do not see the world in rich colors at night, as you do during the day. At night, there is not enough light for your cones to work, and so only your rods are active—resulting in a world of dark blues. The most sensitive part of your retina is your fovea, and the fovea is densely, and exclusively, packed with cones. During the day, this allows you to see things that interest you in high definition and in full color.

The difference between rods and cones in the retina illustrates an important principle that is found throughout the visual system, and throughout the brain: information is broken up and different systems handle different types of information. Another general principle of brain organization is shown as the information moves from the retina to the visual cortex. As the information is transmitted along the optic nerve, it is divided such that information about the left half of space (the left visual field) is delivered to the right half of the brain (the right hemisphere) while information from the right visual field is delivered to the left hemisphere. This division of information is seen throughout the brain: the right side of the brain receives input from the left side of the body and vice versa. Moreover, the right side of the brain controls the left side of the body (and vice versa).

In the visual cortex, which is located in the "back" of the brain, just above the nape of your neck, the information from the eyes is broken down even further. Lines and edges are represented in one part of the visual cortex, colors in another, motion in yet another, and so forth. We know this because if these areas in the visual cortices are damaged (e.g., by a stroke), then the function that was supported by that area is also lost. For example, when the area responsible for representing color is damaged by a stroke, the stroke survivor will be unable to see colors. He/she will perceive the world as comprised of shades of grey. Furthermore, and somewhat surprisingly, he/she will also be unable to remember colors. This points to another important aspect of how the brain is organized and how it works: memories are represented by the same areas that represent the information when it is perceived. Therefore, when you "look back" at your childhood, you really are looking back inasmuch as your childhood memories are represented in your visual cortex. Visual memories are represented in visual cortices, auditory memories are represented in auditory cortices, somatosensory memories (memories of touch) are represented in somatosensory cortices, and so on.

While someone who has suffered damage to color processing areas will be unable to see colors, someone who has sustained damage to visual motion processing areas will be unable to see motion. These individuals see the world not as a dynamically changing scene, but more like a series of still photographs. This can be

very debilitating, because the series of still photographs does not update quickly enough to avoid accidents. For instance, when crossing the street, one might see an empty street, then a car turning onto the street, and then the car might strike the person before the scene is updated.

As the visual information moves through the visual system, it is gradually reassembled as the different aspects of the thing one is looking at (its color, its location, its luminance, its motion, its depth, etc.) are associated with one another. One area that is specially tuned to this kind of higher order visual information is the "fusiform face area," which is located on the bottom of the brain. This area is highly active when we look at faces, regardless of whether the face is someone we know or not. This area is also active when we look at face-like stimuli, such as cars where the two headlights look like eyes and the bumper looks like a mouth. Indeed, this area is probably analyzing all visual information all the time to see if it is a face, and is probably responsible for things that are not faces (e.g., cars) appearing to look like faces to us. It is likely that we have an area devoted to face processing because faces are so important to our survival. It is important to be able to recognize your parents when you are young, it is important to be able to distinguish friend from foe as you get older, and it is important to be able to recognize subtle changes in faces (e.g., the difference between a bored face and an angry face) at all times. Indeed, the ability to recognize faces is so central to our lives that the deficits resulting from losing this ability are surprising.

Disturbances in the reassembly of visual material can result in *agnosias* (Farah, 2004), a Greek term for "without knowledge." At a more fundamental level, *apperceptive agnosia* describes the difficulty in forming a mental representation of what is visually sensed, such that individual visual characteristics (e.g., light/dark, size, color) are perceived but cannot be integrated into a meaningful whole. This syndrome typically occurs after diffuse damage to the occipital lobe and surrounding neural regions. A higher-level deficit is seen with *associative agnosia*, in which individuals can perform the perceptual integration that is deficient in apperceptive agnosia, but cannot attach semantic meaning to the visual percept. For instance, they may be able to copy a picture of an object accurately, but would be unable to name it or draw it from memory, due to the lack of meaningful information attached to what they see. Beyond these two broad distinctions, visual agnosias may be limited to a specific category of object. For example, patients who have lost the ability to recognize faces from vision are said to have *prosopagnosia*. Because the rest of their visual system is generally intact, they are perfectly able to distinguish (and faithfully report) the features of a face. They can tell you the color of someone's eyes, the shape of his nose and chin, whether his teeth are straight or crooked. However, they are entirely unable to put all this information together into a single representation—that is, into the percept that you or I might call "John's face." They cannot recognize people they have known and loved for decades; they cannot recognize famous people; they cannot tell you whether two faces are from the same person or from different people except by laboriously cross checking each feature one by one. However, while they cannot recognize friends and family by sight, as soon as they hear the voice of one of these people they immediately recognize

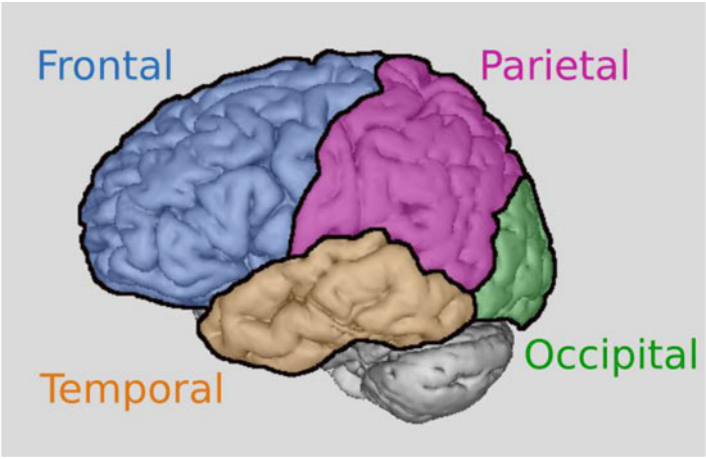

Fig. 1.1 The four primary brain regions, shown on the left hemisphere of the brain. The occipital lobe is shown in *green*, the parietal lobe is shown in *purple*, the temporal lobe is shown in *orange*, and the frontal lobe is shown in *blue*. The cerebellum is also shown in *grey*

them—thus showing that they have not forgotten these people, but rather that their facial recognition abilities have been damaged.

Much of the brain is devoted to vision. Indeed, the entire "occipital lobe" of the brain is given over to processing visual information. The occipital lobe is located at the back of the brain (see Fig. 1.1), and as we have seen, different aspects of visual information is processed by different parts of the occipital lobe. As the visual information is processed by the brain it moves from the back of the brain toward the front, and as this happens the information becomes increasingly complex. It follows two "streams" of processing: one stream results in representations about "what" we are seeing while the other results in representations about "where" the things are located in space. The "what" stream begins in occipital areas and ends in the temporal lobe, which is located under your ear and extends up to your temple (the face processing area is part of this stream). The "where" stream also begins in occipital areas, but extends up the back of your head into the parietal lobe, which is located between the back of your head and your crown. Visuospatial processing subserved by this "where" system describes a range of abilities, from basic (e.g., localization of points in space) to more complex (*constructional praxis*; Lezak, Howieson, Bigler, & Tranel, 2012). Fundamental parietal functions are critical in depth perception, orientation of lines, and perceiving motion—these represent many of the building blocks needed to perceive and interact with the spatial environment. More complex tasks include *constructional praxis*, which is the ability to manipulate objects based on spatial relationships. Examples of praxis include tasks like using your hand to turn a door knob and open a door, threading a needle, or copying a figure. Route-finding is another important use of visuospatial information that has great bearing on everyday functioning. These visuospatial abilities interact with other cognitive systems (e.g., attention) to produce more meaningful visual input

and directed output, such that seemingly visual disturbances may occur as a result of other cognitive deficits. One common example is that of *hemineglect*, an attention-based deficit typically caused by damage to the parietal lobe in which individuals essentially ignore one side of space.

Audition

There are some aspects of audition that are familiar. The keys toward the left of a piano's keyboard produce lower notes than those at the right. After being in a loud environment, our ears "ring" when we move to a quieter place. We are able to distinguish whether a sound is coming from the left or the right. When we are completely engrossed in an absorbing activity, we sometimes do not hear when people speak to us. This section will explain how these commonplace occurrences are achieved by the brain.

Sound enters the ear, and is transmitted—via the tympanic membrane—to a structure called the cochlea. The cochlea is shaped like a snail's shell, with an inner cavity that spirals in on itself getting smaller as it continues. This cavity is filled with fluid and the vibrations that sound produces on the tympanic membrane produce corresponding vibrations in this fluid. These are converted into neural signals by "hair cells" that are tiny, hair-like structures within the cochlea. Because of the way the cochlea is constructed, sounds of different frequencies cause vibrations in different parts of the cochlea; sounds of lower pitch cause vibrations near the one end of the cochlea (near the center of the spiral) and sounds of higher pitch cause vibrations at the other end. The neural signals produced by the hair cells are transmitted to the auditory cortex via the auditory nerve. Because sounds of different frequencies are registered by hair cells in different places in the cochlea, the brain is able to distinguish different sounds by where on the cochlea the information came from. If it came from the center of the cochlea's spiral, it was a low-pitched sound; if it came from near the outside of the cochlea, it was a high-pitched sound. In fact, the auditory cortex is "tonotopically mapped" such that higher pitched sounds are represented on one end of primary auditory cortex, low pitched sounds are represented at the other end, and intermediate pitches are represented in between—an organization reminiscent of a piano's keyboard. Thus brain deciphers the auditory world by converting the intangible world of sound into the far less difficult problem of where neural impulses come from on the cochlea (i.e., spatial location).

The hair cells on the cochlea are extremely delicate, and can be damaged by excessive vibration. Indeed, as we grow older, we gradually lose the ability to hear certain frequencies of sound, with the higher frequencies being the first to go. This is a particular problem for musicians, who not only need to hear the full range of sound, but also are constantly in environments that are full of sound. One possible consequence of hearing loss due to damaged hair cells is a condition called *Tinnitus*. This is a persistent "ringing" in the ears (though it can also be noises such as hissing, roaring, whistling, or clicking) that does not correspond to any external stimulation. As in disorders such as "*phantom limb*" (see sections on motor and

somatosensory cortices), *Tinnitus* may result from a loss of input to the brain. In the case of *Tinnitus*, it may be that the hair cells in a particular frequency range have been damaged sufficiently that primary auditory cortex no longer receives information about that frequency of sound from the external world. However, the cells representing that sound on the cortex continue to exist and continue to fire, and it may be that *Tinnitus* results from a continuous firing of these cells. The ringing in your ears after you have attended a loud concert is due to a related cause. In this case, there has also been damage done to the hair cells, but the damage is on a smaller scale and is not irreparable (taking about 24 hours to repair).

While our ability to locate sounds in space is not as good as that of other animals, such as a cat or a horse (because our ears are fixed on the sides of our head), it is nevertheless quite serviceable. We are able to tell where a sound comes from with sufficient precision to orient in the appropriate direction, at which point our eyes generally take over the task of identifying the source of the noise. The brain accomplishes this by comparing the time at which a given sound arrives at each ear. When a sound occurs on the left, it arrives at your left ear first and at your right ear an extremely short time later; when the sound comes from directly in front of you (or directly behind you), the sound reaches both of your ears at the same time; and when the sound comes from the right, it arrives at your right ear before your left. Although the difference in arrival time is minute, your brain is able to use this information to compute the origin of the sound (you can verify this by plugging one ear and trying to locate sounds). This fine-grained temporal analysis of auditory input is done in subcortical areas before the information reaches the primary auditory cortex, which is located on the top surface of the temporal lobe. Once the information reaches auditory areas, it appears that there is an auditory "what" system that extends down into the temporal lobe, and a "where" system that extends up into parietal areas (similar to the "what" and "where" systems in vision).

Unlike vision, where you can stop visual input into the brain by closing your eyes, your auditory cortex receives information continuously. You cannot close your ears in the same way you can close your eyes. However, we are able to stop auditory information from impinging on our thoughts through the use of auditory attention. At its most basic level, we can use auditory attention to simply inhibit all auditory input. You may do this when reading an absorbing book, for example. However, auditory attention also allows you to follow one conversation out of many in a crowded room (e.g., during a party). In this case, the environment is full of speech sounds, but only one stream of speech—coming from the person you are speaking with—is relevant, and you are able to selectively hear that person while the other conversations are ignored. While the information from other conversations is ignored, your auditory system is however still processing it. This is shown by the "cocktail party effect": when you are in a crowded room, carefully attending to one conversation out of many, you do not "hear" the other conversations at all. You are aware of noise, but not of any of the words spoken by the other people in the room. However, if someone calls your name, your attention is immediately attracted to that person. This could not happen if you had not been processing the auditory information from other speakers all the time.

Touch

Imagine you are baking cookies and absentmindedly touch the hot cookie sheet without an oven mitt. You pull your fingers back in pain. An important somatic sensory (touch) signal was just sent to your brain to relay information to help you determine your next move. We are always receiving such sensory information: the feel of your fingers on the keyboard, an itchy tag in your shirt, or a cold glass of water in your hand. Somatosensory information is responsible for the perception of different sensory signals: tactile signals (touch, vibration), where your limbs are in space (proprioception), pain, and temperature. These signals are conveyed along two different pathways in the spinal cord, both of which terminate in the thalamus (located deep in the center of the brain) before information is sent to the primary somatosensory cortex (a strip of cortex extending from the top of your head down towards each ear). These pathways are called the *dorsal column-medial leminiscal system* (DCML) and the *anterolateral system*.

Tactile Sensation and Limb Proprioception

The *dorsal column-medial leminiscal* (DCML) system is primarily responsible for perception of tactile sensation such as touch and vibration. The name of the pathway is derived from two structures along the pathway: the *posterior (dorsal) columns* of the spinal cord, and the *medial lemniscus* in the brain stem. From there, the pathway continues to the thalamus and thence to the primary and secondary somatosensory cortices (in the post-central gyrus) and posterior parietal cortex. This pathway is responsible for the localization and sensation of touch, and enables someone to determine not only what is being touched, but also which part of the body is doing the touching. This ability can be selectively lost. Indeed, in *astereognosis*, individuals cannot recognize an object in their hands (e.g., a comb) when relying on the sense of touch alone. However, when they are allowed to see the object, they are immediately able to identify it.

Limb proprioception is perceived via the same pathway (the DCML), and can be defined as the perception or awareness of your own limbs relative to the rest of your body. In everyday life, we are often unaware of proprioception except when we accidentally turn an ankle or have to quickly react to avoid colliding with someone else. However, there are certain clinical populations in which proprioception is negatively impacted including multiple sclerosis (MS). In populations such as MS, individuals may experience the sensation of walking "lop-sided" or feeling tipsy, which may increase the risk of falling. Thus, individuals may need to be more aware of the placement of their limbs to ensure balance and coordination.

Pain and Temperature

The *anterolateral system* plays a major role in the perception and processing of pain and temperature, and a minor role in tactile sensation and proprioception. There are three major pathways of the anterolateral system: spinothalamic, spinoreticular, and

spinomesencephalic. Noxious and temperature sensations are transmitted by the spinothalamic and spinoreticular tracts. The sense of pain is largely mediated by the spinomesencephalic pathway. Similar to the DCML pathway, the anterolateral pathway ultimately terminates in the primary and secondary somatosensory cortices and posterior parietal cortex.

In leprosy, a disease caused by a chronic bacterial infection, patients can lose the ability to feel pain due to the deterioration of the nerves of the somatosensory system. Limbs therefore can become subject to various injuries because the patient does not experience pain as he/she should. For example, when you get a blister on your finger after spending an afternoon raking leaves, you avoid using that finger for several days because the blistered area hurts when touched. This allows it to heal. If you were unable to feel pain from that finger, you would not favor it, and the damaged area would not be given the opportunity to heal. Eventually, this could lead to irrevocable damage. A similar disorder, which is genetic rather than infectious, is *hereditary sensory neuropathy type 2* (HSN2), in which the patient is unable to feel pain, or in some cases, any sensation of touch whatsoever. These patients are at risk for innumerable injuries: they burn themselves in the bathtub, break bones, suffer infections, without knowing or sensing that anything has occurred. On a daily basis, HSN2 affects their functioning in that they may have difficulty with tasks of every day living such as self-care or care of others. Damage to fingers or hands may make it so that it is difficult to dress oneself, brush one's hair or prepare food for one's self or family.

Sensory Homunculus

Primary somatosensory cortex is organized such that the parts of your body that are next to each other (e.g., your hand and your wrist) are represented in adjacent places on the cortex. That is, your primary somatosensory cortex is organized like a little person (an homunculus), with the head represented next to the neck, which is represented next to the chest, and so on. This is also true of primary motor cortex (see below). A neurosurgeon named Wilder Penfield conducted a series of experiments during operations on patients with epilepsy and other brain disorders (Penfield, 1950). Penfield stimulated the post central gyrus of patients (under local anesthesia) and asked where in the body they felt the stimulation. He found that during these stimulations, sensations of pressure, tingling and numbness were reported from different parts of the body in a pattern that he used to create a somatosensory map (or homunculus). This map revealed that the left side of the body was represented in the right hemisphere of the brain, and it also showed that the amount of cortical area devoted to different parts of the body are not equal, nor are they proportional to the size of the body part. For example, the amount of cortex devoted to the face is far greater than the area devoted to the back of the head.

Somatosensory Disorders

There are two major types of disorders of the somatosensory system. The first is *Primary Tactile disorder* in which damage occurs to the primary somatosensory cortex, the thalamus or subcortical regions of the somatosensory pathways. This damage results in loss of the ability to perceive basic aspects of somatosensory information, such as pressure sensitivity, perception of vibrations, two-point discrimination or deficits in proprioception. Primary tactile disorder can result in one type of impairment (lack of pressure sensitivity) while retaining other abilities (proprioceptive knowledge or temperature perception) (Corkin, 1978).

Higher order touch disorders involve damage to the secondary somatosensory cortex, the posterior parietal cortex or the insula. These disorders involve impairment of the ability to perform more higher order processing of touch including object recognition and feature discrimination. Individuals with *amorphognosia*, for example, have difficulty perceiving the size and shape of an object. *Ahylognosia* results in the inability to perceive the texture, weight, or temperature of an object (Delay, 1935; Denes, 1989). *Tactile agnosia* results in an inability to identify an object based on its somatosensory properties even though the patient has not lost his/her sense of touch (Caselli, 1991). A patient with this type of agnosia would be unable to identify an object in their hand if they were not allowed to see or smell it, for example.

Damage to the somatosensory system can cause disorders related to one's perception of their own body. Our perception of our body is based on somatosensory input, proprioception, and visual feedback. Many disorders involving body image and body awareness can occur, including *asomatognosia* whereby the patient is not aware of certain body parts, and feels that they are "missing." In *somatoparaphrenia*, the patient does not believe that he/she owns a part of their body that is paralyzed. In severe forms of these disorders *misoplegia* can occur, where the patient can abuse their own body part because they feel strong resentment or hatred of it. These types of disorders can occur after damage to premotor, parietal and posterior insular regions (Vallar & Ronchi, 2009). The experience of "phantom limb" refers to the situation in which an amputee patient has the sensation that a removed limb is still present (Ramachandran & Hirstein, 1998), discussed in further detail in the next section.

Movement

Movement is one of the key ways that we interact with our environment. We are constantly being exposed to objects and we must decide what to do with them. Making decisions about our actions are often based on intentions and goals. For example, if you are feeling tired you may decide that you want to have a cup of coffee, so you walk into your kitchen, reach for a mug, grab the coffee pot, and pour

yourself a cup. As you hold the mug in your hands and begin to take a sip you realize that the coffee is steaming and even though you may feel exhausted you decide to wait until the coffee cools off. Situations like the one just described may paint a clearer picture about how many actions we actually perform in a day, and this section will describe how these motor responses are produced.

The motor cortex is located in the frontal lobe and is comprised of three main cortical areas: the primary motor cortex, premotor cortex, and supplementary motor area. Each region is responsible for different functions but all play an integral role in motor control. The primary motor cortex is located in the precentral gryus, rostral to the central sulcus (extending from the top of your head down to your ears, just in front of the somatosensory cortex), and is responsible for the initiation of all voluntary body movements, with the exception of eye movements. (Voluntary eye movements are controlled by a region of the frontal lobe called the frontal eye fields.) The motor cortex is somatotoptically organized, meaning that it organized like a homunculus much like the somatosensory cortex, and activation in specific regions of the motor cortex cause the movement of specific parts of the body. As is the case with the somatosensory cortex, the cortical area devoted to each part of the body is not proportional to the size of that part of the body. The motor homunculus has very large hands, lips, and tongue compared to the trunk, arms, and legs. This distortion results from the fact that we require fine motor control of the hands, lips, and tongue to a far greater extent than for the arms, legs, and trunk. The phenomenon of *phantom limb* speaks volumes to the precise organization of the primary motor cortex and the power of the human mind. In almost all amputee cases (90–98 % of all patients), the patient has the sensation that a removed limb is still present (Ramachandran & Hirstein, 1998). Many individuals with this so-called "phantom limb" claim that they can generate voluntary movements with their amputated limb such as grabbing an object, waving good-bye, or moving their fingers. One explanation for this phenomenon lies in the topographic organization of the primary motor cortex (as well as somatosensory cortex). Neurons responsible for an amputated arm still exist in the brain and can be stimulated by neighboring neurons. For example, because the face and hands are mapped close to each other in the motor cortex, it is possible for facial stimulation to cause a sensation in an amputated hand. Unfortunately, pain is one of the most frequently reported symptoms of phantom limb, with approximately 70 % of amputees experiencing phantom pain for up to 25 years after the amputation. Individuals report shooting pains, burning sensations, and cramping sensations. One way researchers have tried to alleviate phantom pain related to cramping is by using a mirror box. For example, suppose an individual has undergone surgery for the amputation of his left arm and now he is left with the painful sensation that his hand is making a fist. By placing his right hand in a mirror box, the individual can see both his right hand as well as a mirror image of that hand—which looks much like his left hand would look if it were present. This illusion allows for the participant to open and close his right hand, but tricks the brain into thinking he is opening and closing both his left and right hands. This simple deception, which the patients are fully aware of (the purpose and function of the mirror box is fully explained to patients), alleviates the pain in a great many cases.

Contralaterality

As we have seen with other parts of the brain, the motor cortex works contralaterally. That is, motor areas in the right hemisphere of the brain control the left side of the body and vice versa. One time when this organization is clearly evident is when stroke patients present with "*hemiparesis*," in which individuals with right hemisphere damage experience left-sided weakness or paralysis.

Planning Movement

The ability to plan movements is a function of the premotor cortex and supplementary motor area and they execute these plans using connections with the primary motor cortex. Located directly in front of the primary motor cortex is the premotor cortex. The lateral (outer) premotor cortex is responsible for motor responses to objects in our environment such as reaching for a cup of water to take a drink. The medial (middle) premotor cortex, also referred to as the supplementary motor area, is responsible for motor skills that do not require strong attentional demands to our environment (e.g., knitting). The supplementary motor area also plays an important role in executing behavioral sequences where the completion of one response is the cue to perform the next. Located in the ventral (front) premotor cortex and the inferior (lower) parietal lobe are special cells called mirror neurons. Mirror neurons become active when people make particular movements or witness other people making that same movement. The next time you let out a big yawn and trigger a domino effect you can blame it on mirror neurons.

Other brain regions that perform motor functions include the basal ganglia and cerebellum, both of these areas have strong connections with the motor cortex. Evidence for the involvement of these regions in motor functions is seen in instances where they are damaged. The basal ganglia are a cluster of nuclei located in the forebrain and include the caudate nucleus, putamen, and globus pallidus. Damage to the basal ganglia may result in two different types of symptomatology: *hyperkinetic* and *hypokinetic* symptoms. Hyperkinetic symptoms display excessive involuntary movement as seen in disorders like Tourette's syndrome. Tourette's syndrome is characterized by the presence of motor and vocal ticks and is characterized by excessive and repetitive actions (e.g., head jerking). Tourette's syndrome is thought to be a result of improper functioning of the basal ganglia, which is involved in procedural learning. A problem arising in the basal ganglia may set up the possibility for individuals to get stuck performing the same action over and over again. Individuals with hypokinetic symptoms display a loss of motor activity as seen in Parkinson's disease. Parkinson's disease includes symptoms of slowness of movement (*bradykinesia*), lack of spontaneous movements (*akinesia*), and stationary tremors. The symptoms of Parkinson's disease are a result of the loss of neural connections between the basal ganglia and substantia nigra. The cerebellum or "little brain" is located at the back of the brain, just above the brain stem. Like the cortex, the cerebellum also has two hemispheres and contains about 50 billion neurons.

The cerebellum plays a large role in skilled motor movements like playing an instrument or kicking a soccer ball. Individuals with cerebellar damage present with movements that are erratic and uncoordinated. Damage to the cerebellum can result in *ataxia*, a disorder that is defined by uncoordinated voluntary movements. An individual with ataxic symptoms may not be able to coordinate balance, walking, speech, and even eye movements.

Emotion

The experience of emotion is mediated by a complex network of brain areas. It was once thought that the limbic system was primarily responsible for the feeling of emotion, but recent neuroimaging and lesion research now implicates a network involving not only limbic regions but cortical and paralimbic regions. People can experience a wide range of emotions (happiness, joy, disgust, fear, annoyance, anger, sadness, despair, surprise, shame), and the work of Paul Ekman and others have identified the presence of "universal emotions" experienced across cultures (Ekman & Friesen, 1971). In the following review of the neural basis of emotion, we will be examining the brain structures underlying these universal emotions: happiness, fear, anger, sadness, and disgust.

Fear

We have all experienced fear. Fear can be defined as "an adaptive but phasic (transient) state elicited through confrontation with a threatening stimulus" (Adolphs, 2013). Much of the research on the experience of fear has been based on deficits in patients who have sustained focal brain lesions, and on neuroimaging studies. This research has consistently shown that a region which is critical in fear processing is the amygdala. The amygdala is thought to be involved in the perception of fear, such as perceiving a look of fear on another's face (Adolphs, Tranel, Damasio, & Damasio, 1995), as well as when one feels fear (Halgren, Walter, Cherlow, & Crandall, 1978). Additionally, the amygdala is connected to both cortical regions (orbital and medial prefrontal cortex, and cingulate cortex) as well as hypothalamus, periaqueductal gray (PAG), and specific brainstem nuclei. These regions all appear to be involved in both the perception and experience of fear.

How do you react when you are afraid? If a loud, unexpected sound occurs very close to you a fear response is likely. If you were alone in your house and heard a sound coming from upstairs, think of how you would react. Would you freeze and listen harder? Would you run? Generally, when one perceives an imminent threat, one of two responses occurs: freezing or fleeing. Each of these responses is adaptive when used appropriately: if a predator or threat is close, and there is no way to escape harm, freezing to be unnoticed is more adaptive. If a threat is farther away, fleeing may increase the chances of survival. There is neuroimaging research to indicate that there are two separate pathways that underlie freezing or fleeing processes. Neuroimaging research indicates that the prefrontal cortex is more active

during perception of a distal threat (i.e., a threat farther away) whereas the PAG is more active in response to a proximal threat (i.e., a threat closer to hand). This is just one example of how the brain can react differently when we perceive danger.

There is a rare genetic disorder called Urbach-Wiethe disease, which is defined by progressive bilateral damage to the amygdalae. Although this disease is extremely rare, several studies have been performed on the patients with this disease. Consistently, these patients show very little response to fear stimuli of differing kinds. One study exposed a patient "SM" to tarantulas, haunted houses and scary movies, and consistently the patient reported not being scared of any of the experiences, leading researchers to further confirm the role of the amygdala in fear processing.

Happiness

Many things make us feel happy. Experiencing a pleasurable event, doing an enjoyable activity, looking at a pleasant scene or picture are all examples of situations in which the emotion of happiness can be present. Moreover, we are beginning to understand the neural mechanisms underlying happiness. Indeed, in a meta-analysis of the neural substrates of emotion, it was found that nearly 70 % of neuroimaging studies that induced happiness showed activation in the basal ganglia, indicating that this region is critical for the feeling of happiness.

Much of the research on the perception and experience of happiness has been performed in the area of drug addiction as well as the neural circuitry involved in reward processing (Schmidt et al., 2008). Although many individuals experience happiness without drug use or rewards, in an experiment, these are the stimuli that elicit a "pleasurable" response similar to the ones other people feel on a given day. Both lines of research have indicated that the basal ganglia play an essential role in obtaining a reward, regardless of reward type, whether it be an addictive drug, food, money, or sexual activity. The regions of the basal ganglia involved in reward processing include the nucleus accumbens (NA), ventral pallidum, and ventral tegmental area (VTA), and the dopaminergic projection from the VTA to the NA has been consistently shown to be a critical circuit in the reward system. It has been shown that in Parkinson's disease, where there is damage to the basal ganglia (specifically dopaminergic depletion), individuals often experience *anhedonia*, which is an inability to feel pleasure or happiness.

Disgust

Interestingly, the basal ganglia also appear to play an important role in disgust processing. Viewing faces with a disgusted emotional expression has been shown to activate basal ganglia (Phillips et al., 1997, 1998; Sprengelmeyer et al., 1998). Further, individuals with basal ganglia damage such as that seen in Huntington's disease and Parkinson's disease have deficits in identifying the facial expression of disgust compared to healthy controls (HCs) (Ille et al., 2011; Suzuki, Hoshino, Shigemasu, & Kawamura, 2006).

While the basal ganglia appears to be critical for recognizing the emotion of disgust in another's facial expression, there appears to be a related neural network involved in the feeling of disgust evoked by experiencing it oneself (by viewing disgust-provoking pictures). This network involves the insula. Much of the research on the experience of disgust has come from individuals with obsessive–compulsive disorder (OCD) who are highly sensitive to stimuli perceived to be "disgusting." Individuals with OCD show increased activation of the insula while viewing disgusting stimuli compared to controls (Stein, Arya, Pietrini, Rapoport, & Swedo, 2006).

Sadness

The feeling of sadness is common to everyone, and can be felt in varying degrees, in a wide range of situations. For example, sadness can be felt while watching a sad movie, but to a greater degree at the funeral of a loved one. Because of this complexity, sadness is a difficult emotion to study and multiple brain regions have been suggested to underlie its experience. These differences are likely due to the nature of how sadness is induced. Many researchers have studied sadness while showing subjects sad films. Studies of this nature have shown that the amygdala and prefrontal regions are active during the feeling of sadness (Goldin et al., 2005; Levesque et al., 2003), among others. Other studies have involved requiring subjects to recall a time in their life when they felt sad, and then used neuroimaging to examine what brain regions became active. These "recall" studies have indicated that although frontal regions of the brain are active during recalling times of sadness, the anterior insula is also active, suggesting a specific role for this region in internally induced sadness (Reiman et al., 1997). Although these studies provide insight into the brain regions involved in sadness, many person-specific factors may contribute to the neural networks underlying this emotion. For example, it has been shown that certain disorders, such as major depression (Surguladze et al., 2005) or obsessive–compulsive disorder (Fontenelle et al., 2012) may influence the brain's response to the feeling of sadness. Interestingly, we are now beginning to understand that treatment for these disorders, such as mindfulness to treat depression, can alter the brain's response to depression (Farb et al., 2010). For example, it was recently reported that individuals who had undergone mindfulness training showed greater recruitment of somatosensory regions during feelings of sadness compared to a control group, suggesting a recruitment of these brain regions as a result of the mindfulness treatment.

Cognitive Functioning

In 1953, at the age of 27, a man who would become known as HM received a life changing surgery. Since the age of ten, HM had experienced seizures that were attributed to a childhood bicycle accident. The seizures worsened as he grew older; from age 16 until he received surgery 11 years later, HM experienced about 10 absence seizures a day and 1 generalized seizure a week (Ogden, 2005). In an effort

to alleviate these seizures, HM underwent a successful operation to remove both anterior medial temporal lobes, and this did indeed reduce the frequency of his seizures. After the surgery HM only experienced about 5 absence seizures a month and less than one generalized seizure a year. Unfortunately no one at the time could have predicted the other consequences of the surgery.

Language

The temporal lobes are located on the sides of the brain and are separated from the frontal and parietal lobes by the lateral fissure (see Fig. 1.1). The temporal lobes contain the auditory cortex and auditory association areas, visual association areas, and language areas. The auditory cortex is responsible for processing sensory input from the ears (see above) and is located on the superior (very top) gyrus of the temporal lobe. Located behind the auditory cortex is an area known as Wernicke's area, which is a relatively small region responsible for language comprehension. Damage to this area results in "*Wernicke's aphasia*" in which the understanding of speech and writing is compromised. An individual with Wernicke's aphasia can produce speech with normal grammar but it is usually meaningless. Because the ability to produce speech is intact, Wernicke's aphasia is sometimes referred to as "fluent" aphasia.

While Wernicke's aphasia can be thought of as resulting from damage to the input of the language system, "*Broca's aphasia*" can be thought of as damage to the output of the language system. Broca's aphasia results from damage to an area of the frontal lobe immediately above the tip (or pole) of the temporal lobe, which is called Broca's area. If this area is damaged, individuals are able to understand speech, but have difficulty in producing speech. Indeed, the first patient with a documented case of this aphasia was called "Tan" because "tan" was the only word he could produce after his brain injury. Because the ability to produce speech is compromised, Broca's aphasia is sometimes referred to as "non-fluent aphasia."

In addition to Wernicke's and Broca's aphasias, there are also *transcortical sensory* and *transcortical motor aphasias*. Transcortical sensory aphasia is a type of fluent aphasia like Wernicke's aphasia, except that an individual with transcortical sensory aphasia has a strong tendency to repeat words or phrases. An individual with transcortical sensory aphasia is more likely to repeat a question than to produce an answer. There is a strong element of repetition in transcortical motor aphasia as well. Transcortical motor aphasia is a non-fluent aphasia like Broca's aphasia (i.e.,comprehension is intact), except that an individual with transcortical motor aphasia is able to repeat words and phrases. Therefore, difficulty while speech production is difficult,repetition is spared.

Memory

The medial temporal lobe is comprised of structures that are critical for long-term declarative memory (i.e., the system of memory that is responsible for integrating pieces of an individual's experience into their memory stores) including the

hippocampus and surrounding hippocampal areas. When HM received the surgery that would save him from constant seizures no one was prepared for what would happen to his memory: he was unable to remember or learn any new information (*anterograde amnesia*). Every day after his surgery was a new day, and HM was never able to remember new people, keep up with current events, or recall new life events like moving or the death of his own parents. HM also suffered from *retrograde amnesia*, meaning that he was unable to remember many events from the 11 years before his surgery. For HM time stopped around the time that he was a teenager. Although the story of HM is an unfortunate one, he has contributed a great deal to the field of learning and memory. Without HM we may have never known the importance of the temporal lobe in memory.

Overall, the memory process is often divided into three subprocesses: *encoding, consolidation,* and *retrieval.* First, memories must be formed, by learning information and *encoding* or inputting it into the neural networks it so that it can be later retrieved. Second, that information is *consolidated*, or strengthened and stored into a usable form. And lastly, the memory is later *retrieved*, or extracted from memory stores when needed. Throughout these processes, hippocampal function is paramount, although numerous other neural regions play significant roles in intact memory, including the frontal lobes, left parietal cortex, and amygdala. Also, it is important to note that dysfunction in just one of these processes can cause the entire memory system to fail. For example, if you were trying to study for a test while you were distracted, you may have difficulty remembering the material because you were not able to encode the information deeply enough to recall it later. In this example, it may be the case that your consolidation and retrieval systems are working fine, but because the information was not encoded in the first place, the memory system fails to retrieve the information.

Beyond the processes that occur when forming and retrieving memories, there are also important differences between types of memory. Within the category of long-term declarative memory, Endel Tulving (1972) made the distinction between *semantic memory*, which consists of knowledge stored for later recall without a specific context (e.g., knowing how many quarters are in a dollar), and *episodic memory*, or information from personally experienced events that are specific to a given time and place (e.g., remembering how you went to the bank for a roll of quarters last Saturday). Difficulty with declarative, particularly episodic, memory is a common complaint across many neurological conditions (e.g., Alzheimer's disease), medical disorders (e.g., HIV infection), and even normal and healthy aging. Unlike declarative memory, *procedural memory* (sometimes referred to as skill learning) refers to the knowledge necessary to perform tasks, like riding a bike. And just like riding a bike, procedural memory is difficult to lose without widespread and distributed neural dysfunction. Indeed, although HM was unable to recall the experiences he had while learning to perform specific tasks, he was able to perform them increasingly well over each practice session.

Attention

We are only aware of a small portion of all the stimuli presented to us moment to moment, and it is our attentional processes that are thought to select the information to be processed. Attention can be a top-down process (a voluntary and goal-oriented process, e.g., when we search for the word "attention" in this chapter) or bottom-up (a reflexive, stimulus-driven process, e.g., when the fire alarm sounds we automatically look in the direction of the noise).

Three independent anatomical and functional networks of attention have been identified (for a review see Posner & Rothbart, 2007; Raz, 2004; Raz & Buhle, 2006). The *alerting network*, responsible of achieving and maintaining a state of sensitivity to incoming stimuli, is associated with activation of the thalamic, frontal, and parietal regions of the cortex. The *orienting network* is associated with the functioning of posterior brain areas, including the superior parietal lobe, temporal parietal junction, frontal eye fields, and superior colliculus, and is associated with the selection of information from sensory inputs. The *executive attention network* is involved in complex operations such as monitoring the environment and resolving interference between stimuli or responses, and it has been linked to the anterior cingulate, lateral ventral, prefrontal, and basal ganglia functioning.

After a stroke affecting the parietal lobe (Riestra & Barrett, 2013), patients can suffer from *visual neglect*, an attention disorder characterized by the inability to attend to stimuli located on the side of space opposite the brain lesion (e.g., if the brain lesion was on the right, the left side of space would be neglected). In very severe cases of visual neglect, patients might fail to eat the food on the left side of their plate because they are not aware there is food there, eating only the food on the right side of the plate.

Information Processing Speed

Information processing speed (IPS) can be defined as "the amount of time an individual needs to execute a cognitive task or the amount of work an individual is able to perform within a unit of time" (DeLuca, 2007). Individuals who suffer from IPS deficits experience a general slowing of thinking: it takes more time to accomplish tasks. IPS is highly vulnerable to brain pathology and is commonly impaired in diseases such as multiple sclerosis (Chiaravalloti & DeLuca, 2008), dementias (Sliwinski & Buschke, 1997), Huntington's Disease (Maroof, Gross, & Brandt, 2011) and traumatic brain injury (Madigan, DeLuca, Diamond, Tramontano, & Averill, 2000); IPS also declines as a result of normal aging (Salthouse, 1996).

The neural substrates of IPS are still under examination; however it is accepted that there is not a single brain area associated with IPS, but rather a neural network involving complex interactions between multiple brain areas. IPS impairments have been associated with white matter damage (a component of the central nervous

system which consists of glial cells and myelinated axons), brain atrophy (brain shrinkage due to the loss of neurons, Kerchner et al., 2012; Penke et al., 2010; Salami, Eriksson, Nilsson, & Nyberg, 2012), or brain lesions (that can be caused by inflammatory processes or acquired trauma). One good example is in multiple sclerosis (MS), where inflammatory processes cause lesions throughout the central nervous system. In a functional magnetic resonance imaging study of IPS in MS, performance on a speeded task was associated with activation in the precentral gyrus and occipital cortex (Genova, Hillary, Wylie, Rypma, & Deluca, 2009). Moreover, the networks of brain regions in individuals with MS and in healthy individuals were quite different: while in the healthy group processing speed was related with activation at cerebellum, thalamus, frontal, and parietal regions; for individuals with multiple sclerosis processing speed was associated with activation at the insula, thalamus, and anterior cingulate (Genova, Hillary, Wylie, Rypma, & Deluca, 2009). These results are similar to studies that have investigated IPS in aging populations. This suggests that IPS not only relies on networks of brain areas, that are likely dependent upon the specific tasks employed, but also that the areas comprising these networks can change as a function of disease, or even as a function of normal aging. These aspects of IPS make it challenging to study.

Executive Functions

With the multitude of sensory, motor, and cognitive functions already described in this chapter, you might imagine that it would be overwhelming for the brain to be able to receive, interpret, filter, and react to these stimuli and processes without a way to organize them all; a higher order system is needed. This system exists under the umbrella term "executive functions," so named due to their hierarchical role in controlling the overall cognitive mission of the brain. Unlike many other cognitive abilities, executive functions are thought to represent a diverse group of cognitive processes, and do not represent one unitary construct. While numerous theories of executive functions exist, Lezak (2004) conceptualized executive functions as necessary for adapting to novel situations and having four distinct components: (1) volition, (2) planning, (3) purposive action, and (4) effective performance. Each of these larger components is also comprised of specific activity-related behaviors, including inhibition, task switching, concept formation, flexibility, self-monitoring and awareness, fluency, and initiation. This collection of higher order cognitive abilities are driven largely by neural processes in the dorsolateral prefrontal cortex (DLPFC—upper and outer regions of the frontal lobes), which projects to and from other cortical and subcortical regions in the brain for optimal coordination of input and output information (Damasio, 1985).

Beyond the DLPFC, the underside and internal regions of the frontal lobes (orbitofrontal and ventromedial PFC, respectively; see Fig. 1.2) are implicated in a host of behavioral, emotional, and social cognitive functions (Mendoza & Foundas, 2008). When damaged, individuals with these classic frontal lobe syndromes may experience disinhibition, irritability, emotional lability, poor insight, apathy, and diminished ability to effectively regulate their emotions. One often cited case of

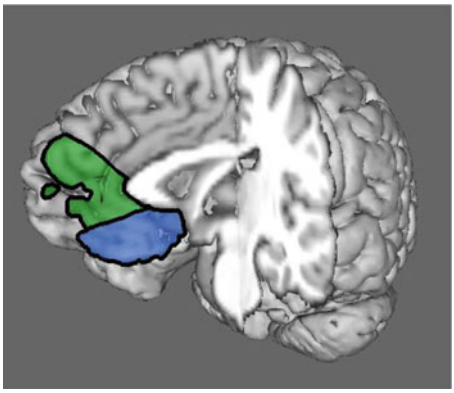

Fig. 1.2 A cutaway view of the brain showing the medial surface of the right frontal lobe. The area in *green* is the ventromedial PFC; the area in *blue* is the orbitofrontal PFC

behavioral consequences secondary to frontal lobe damage is the 1848 case of Phineas Gage, a railroad worker who survived a 3½ foot long tamping iron that had penetrated his skull (entering through his left cheek and exiting through the top of his head). Despite loss of vision in his left eye, many of his mental faculties remained intact, but as he recovered, it became clear to those who had known him prior to the accident that there had been a change from his premorbid level of functioning. Whereas he had previously been described at work as "the most efficient and capable foreman in their employ," his post-accident self was "fitful, irreverent, indulging at times in the grossest profanity (which was not previously his custom), manifesting but little deference for his fellows, impatient of restraint or advice when it conflicts with his desires…. In this regard, his mind was radically changed, so decidedly that his friends and acquaintances said he was 'no longer Gage'" (Harlow, 1868). With the case of Gage and other lesion studies to come, inquiries into the multidimensional and ubiquitous nature of frontal lobe functions have become abundant in the field of neuropsychology.

Summary

In this chapter, we have reviewed the brain regions responsible for vision, audition, touch, motoric output, emotion, and cognition, as well as common deficits that are experienced when these brain regions are damaged. A full treatment of these topics could easily fill several volumes, and we have therefore confined ourselves to providing a brief overview with the aim of providing a framework within which the other chapters of this book can be understood.

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The Aging Brain and Changes in Daily Function

2

Steven M. Albert

"Neurocognitive frailty" may be the biggest threat to successful aging (Park & Reuter-Lorenz, 2009). This frailty includes longstanding and in some cases subtle brain injury, declines in the number of dopaminergic receptors, volumetric shrinkage in many brain structures, lower white matter densities, increasing numbers of infarcts and lacunae, and spreading neurofibrillary plaques and tangles. The border between progressive neurodegenerative disease (such as Alzheimer's), normal age-related change, and compensatory neuronal remodeling in the face of such change is hard to draw.

Brain and behavior researchers now recognize that the "decline framework" for age-related change in neural activation is too simple. More productive is an "adaptive brain" approach, in which the brain responds to internal and external environmental change (Sugiura, 2016). Park and Reuter-Lorenz (2009) make a persuasive case for continuous functional reorganization and repair as the brain responds to neural insults. This reorganization is most clearly visible in increased frontal activation with age, which supports cognitive function in the presence of pervasive changes in brain integrity.

How these sorts of changes affect daily function is less clear than the more direct effects of brain injury or neurodegenerative disease. It is unclear how engagement in daily activity and social participation change in the setting of brain aging. It is important as well to examine ways to promote activity and engagement in the setting of brain aging. In this chapter, we take up these issues by examining high functioning cohorts of older people to determine change in daily function in people who do not meet criteria for cognitive impairment and disability.

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Investigating Brain Aging Apart from Brain Injury or Neurodegenerative Disease

The functional consequences of brain aging are not simply the result of depletion in brain capacity but rather reflect homeostatic processes. As Park and Reuter-Lorenz (2009) point out, "people generally function remarkably well even into advanced old age, and do so even in the presence of a great deal of pathology as discovered at autopsy." In their view, "the puzzle for cognitive neuroscientists is not so much in explaining age-related decline, but rather in understanding the high level of cognitive success that can be maintained by older adults in the face of such significant neurobiological change." This adaptation is ongoing across the lifespan and is independent of neurodegenerative disease. Park and Reuter-Lorenz's "scaffolding theory of cognitive aging" examines recruitment of new brain circuitry, evident in greater bilateral activation and increased activation of frontal areas, to meet the demands of cognitive tasks.

Just as brain aging is complex, so are its effects on daily function. In the absence of neurodegenerative disease, how does brain aging, and in particular, age-related reorganization of cognition, affect daily activities and social participation?

Cognitive changes with age are well documented. These include declines in processing speed, working memory, and long-term memory (which begin in young adulthood), but stability in verbal ability (which is more a measure of accrued knowledge than a cognitive mechanism). Behind these changes lie alterations in underlying functions, such as declines in perceptual speed, executive control (inhibitory dysfunction), and sensory acuity. Research examining the effect of these broad changes on daily function is less common than studies of daily function among people with neurodegenerative disease or frank brain injury.

To examine the effects of age-related changes in the brain on daily function in the setting of normal aging, this chapter examines cohorts of older adults from two studies that completed neuropsychological tests as well as detailed self-reports and performance assessments of daily function. We limited analyses to participants who were cognitively normal on full neuropsychological batteries or cognitive screening assessments. To rule out other sources of functional limitation, we limited analyses to participants who reported no disability in the activities of daily living (ADL). Thus, we define samples that are free of obvious neurodegenerative disease and also mostly high functioning. The latter allows us to rule out, to the extent possible, other sources of functional limitation.

In this way, we can get a first look at the effects of normal brain aging on daily function. Key contrasts include first, differences in function by age, and second differences in function associated with variation across the range of normal cognitive performance. Function outcomes include performance measures of efficiency and safety in performing household tasks; measured assessment of strength, speed, and motor skill; self-reports of difficulty with instrumental household tasks, such as light cleaning and shopping; and self-reports of social participation. Thus outcomes include a broad selection of measures covering impairment, activity, and participation.

Brain Aging in Older Adults with Normal Cognition and No Disability in the Activities of Daily Living: Effect of Age

The Sources of Independence in the Elderly (SITE) project was designed to investigate risk factors for disability, as well as factors associated with recovery from disability, in people aged 70 or older. We enrolled older people who resided in the community and who were likely to experience disability transitions. SITE respondents reported at least some difficulty with upper and lower extremity function, as indicated by reports of difficulty walking a quarter mile or carrying a bag of groceries. People who were living in assisted housing or receiving skilled nursing care were excluded. For this analysis, as mentioned earlier, we excluded people with mild cognitive impairment or dementia, as well as people reporting disability in the activities of daily living (as assessed by self-reported difficulty in eating, toileting, bathing, or dressing). Participants were categorized by age: 70–74, 75–79, 80–84, and 85+.

The exclusion of people with poorer cognition and ADL disability was effective in eliminating most age differences. The four age groups did not differ in number of chronic conditions, proportion with cluttered homes, or level of education.

Sampling and recruitment for SITE is described elsewhere (Albert et al., 2006). SITE participants were Medicare beneficiaries residing in Northern Manhattan, New York City in 2002–2004, with the last enrolled participants completing follow-up in 2006. The Columbia University Institutional Review Board approved the study protocol.

SITE participants completed a neuropsychological evaluation conducted by Spanish–English bilingual testers. Results from cognitive assessments were reviewed in a consensus conference, which was based on National Institute for Neurological Disease and Stroke-Alzheimer's Disease and Related Disorders Association criteria (NINDS-ADRDA). The assessment covered the domains of memory (Selective Reminding Test: total recall, delayed recall; and Benton Visual Retention Test recognition), language (Boston Naming Test and Boston Diagnostic Aphasia Examination: repetition and comprehension), and executive function (letter and category fluency). Test scores within each domain were converted to z-scores and summed to develop composite scores. Each composite was then converted to a T score using a regression procedure to adjust for age, gender, race–ethnicity, and education (Manly et al., 2005). We excluded all participants with scores 1 SD or below sample-based means in any domain.

Key outcomes for assessing daily function included the Assessment of Motor and Process Skills (AMPS), a gender-free, performance-based functional assessment that allows for the simultaneous evaluation of the quality of motor and processing abilities required for successful completion of complex and personal ADL tasks (Fisher, 2006). Motor skills are goal-directed actions a person undertakes to position one's body and task objects effectively, such as the ease or efficiency with which someone is able to sweep a kitchen floor. Process skills denote the person's ability to initiate and logically sequence the required actions for the execution of the task and draw upon cognitive abilities. Occupational therapists, who all completed the 5-day AMPS training program, conducted assessments.

Therapists rated observable motor (for example, body position, obtaining and holding objects, and moving self and task objects) and process (for example, sustaining and adapting performance) skills domains on the designated 4-point scale (competent, questionable, ineffective, deficit). AMPS software converts skill ratings into a logit score (range −3.0 to 4.0 for the underlying motor ability dimension, for example). Participants were observed performing 65 different IADL tasks. The most common tasks performed were cooking (making coffee or tea, preparing a sandwich, making a salad, preparing a beverage) and cleaning (sweeping and mopping) tasks.

For gait assessment, participants were asked to walk at their usual pace from a standing start on a 4-m course set up inside homes. Time to complete the walks was recorded by handheld stopwatch. The mean of two trials (seconds) was used to calculate speed.

Motor speed was assessed with the Grooved Pegboard and Moberg Pick-Up Tests. The pegboard test requires that people place 30 notched pegs into rows on the board so that the peg orientation aligns with the hole. The outcome is time in seconds required to place all 30 pegs. Because some participants were unable to place all pegs in the allotted time, we calculated a peg/s measure. The Moberg test was conducted with eyes open and involved moving a series of 15 small items (e.g., paperclip) across two compartments. We computed a similar object/s measure of speed.

Self-report measures included difficulty with instrumental activities (light housework, medications, light shopping) but also the Activity Card Sort (ACS) (Baum & Edwards, 2001). The ACS elicits functional status using photographs of older adults performing activities. Each photograph is labeled with the name of an activity. Thus, the photograph labeled "reading Bible" shows an older woman reading the Bible in her home. Activities range from such common tasks as "watch TV" to the more rare "playing a musical instrument." The original instrument contains 80 photographs of older adults performing activities in four broad domains: instrumental (e.g., grocery shopping and washing dishes), low-physical demand leisure (sewing and using a computer), high-physical demand leisure (swimming and gardening), and social (travel and dancing).

In our use of the ACS, respondents were asked to sort 39 photographs of high-frequency activities. From the larger set of photographs in the ACS, we excluded outdoor activities unlikely to be performed in an urban cohort, such as boating and hunting, as well as ADL tasks. We retained a few ACS tasks that appear in some IADL measures, including "do laundry," "managing investments," and "fixing things around the house." We administered the ACS using a Q-sort procedure. Respondents were given the full stack of labeled photographs and told to view each picture. They were then asked to divide the stack of photographs into two piles, a pile of activities they currently do not perform and a pile of activities they currently perform. Next, they were told to break up each pile into two separate piles. Respondents broke the pile of activities they reported they do not currently perform into a pile of "never performed" and a pile of "used to but no longer perform" activities. Respondents broke the pile of activities currently performed into a pile of "hard to do" and a pile of "easy to do" activities. The time frame was "today or the past 30 days." Respondents were allowed to move photos between piles before their ordering was recorded.

Table 2.1 Brain aging surrogates, by age: older adults with normal cognition and no disability in activities of daily living (ADL), *sources of independence in the elderly cohort*, $n=232$

	Age			
	70–74 ($n=73$)	75–79 ($n=73$)	80–84 ($n=50$)	85+ ($n=36$)
Performance tests				
AMPS Motor score** Process score	2.91 (1.1) 2.22 (0.8)	3.00 (1.0) 2.28 (0.7)	2.96 (1.1) 2.20 (1.0)	2.14 (1.4) 1.88 (0.8)
Grooved pegboard pegs/s**	6.30 (7.5)	6.31 (4.9)	7.34 (7.2)	11.0 (10.4)
Moberg pick-up item/s*	3.36 (1.4)	3.72 (2.5)	3.53 (1.4)	4.76 (4.2)
Grip strength, kg**	24.5 (8.6)	21.8 (7.7)	19.5 (6.7)	16.9 (5.7)
Gait, m/s***	0.88 (0.3)	0.81 (0.3)	0.79 (0.2)	0.64 (0.2)
Self-reports				
IADL difficulty, % Housework Medications Light shopping**	5.5 4.1 8.2	3.9 2.6 7.9	3.8 1.9 5.7	7.9 5.3 21.0
ACS, # tasks Tasks dropped+ Tasks difficult Tasks easy Adj function, %	10.0 (3.7) 2.1 (2.6) 19.9 (5.6) 61.9	10.0 (4.0) 2.2 (3.1) 19.3 6.4) 60.4	10.1 (3.6) 2.2 (2.3) 18.8 (4.9) 60.2	11.9 (3.8) 1.9 (1.9) 17.2 (5.3) 55.2

AMPS assessment of motor and process skills, ACS activity card sort
+ $p=0.052$, ** $p<0.01$, *** $p<0.001$ by one way ANOVA

As reported elsewhere (Albert, Bear-Lehman, & Burkhardt, 2009), we adjusted for lifestyle differences by computing an index that removes any activities respondents reported they never performed. "Adjusted daily function" in this sense can be defined as the proportion of activities people report they easily perform relative to the total number of activities they continue to perform. For example, a respondent who reported that she never performed 9 of the tasks and currently considers 15 of the remaining 30 tasks easy to perform would receive a lifestyle-adjusted function score of 0.50, 15/(39–9). This measure offers a number of advantages. It eliminates "never-did" activities and so adjusts for lifestyle differences; it includes activities no longer performed and so captures loss of activity; and it allows assessment of more complex activity profiles beyond the household and personal self-maintenance activities covered in standard IADL and ADL measures. It can thus be considered a measure of activity and social participation.

Results for this subset of high functioning participants in the SITE cohort are shown in Table 2.1. The four age groups of people with normal cognition and no ADL disability nevertheless differ in many of the functional outcomes. Performance declines with age across many functional domains, spanning both performance assessments and self-reports. The group aged 85+ stands out for poorer function relative to the other groups in both OT-rated performance and measures of motor speed. Other indicators, such as gait speed and grip strength, decline across the four age categories in more linear fashion.

Self-reports of declines in instrumental activities and daily participation are subtle and mostly do not differ across the age groups. Among instrumental activities, only difficulty shopping differed by age and only among those aged 85+. This is almost certainly due to greater prevalence of mobility disability. Activity Card Sort measures, such as adjusted function and number of easy and difficult tasks, by contrast, did not significantly differ across the age groups. Only the number of discontinued tasks differed, from 10 to about 12 in people aged 85+. While just about all self-report indicators showed greater disability with increasing age, differences were on the whole small.

This pattern of declining performance but mostly stable reported function among older adults with normal cognition and independence in ADL suggests compensation. It does not appear that older people in the cohort restricted activity or life space as a way of protecting function in the setting of declining performance. As the Activity Card Sort measure shows, activity and participation were mostly stable across age groups. Could compensation in this case reflect the adaptive brain discussed earlier? A productive hypothesis would suggest that older people without neurodegenerative disease show brain changes, such as remodeling of brain regions and increased activation, that blunt expected declines in function associated with declining speed, strength, and motor skill.

Brain Aging in Older Adults with Normal Cognition and No Disability in the Activities of Daily Living: Effect of Variation in Cognitive Performance

In 2010–2011 we enrolled a large group of seniors who completed Pennsylvania's Healthy Steps for Older Adults, a falls prevention program, and a comparator group of older adults from the same sites at the same time who did not complete the program. Both groups completed an in-person telephone baseline interview after providing informed consent, and all were followed up to a year in monthly telephone interviews to track falls and other indicators of function. The sample consisted of 1833 adults aged 50 years or older from senior centers across 19 Pennsylvania counties (Albert et al., 2014; Albert, Edelstein, et al. 2015).

Measures included self-reported medical conditions, measures of function and symptoms (adapted from the EQ-5D to assess disabilities in basic and instrumental activities of daily living, mobility, pain, and presence of symptoms of anxiety or depression; Kind, Dolan, Gudex, & Williams, 1998), assessments of physical performance (the Community Healthy Activities Model Program for Seniors [CHAMPS] physical activity measure; Stewart et al., 2001), falls in the preceding 12 months, self-rated balance, and memory performance.

To assess memory we used the Memory Impairment Screen-Telephone (MIS) (Buschke et al., 1999; Flatt et al., 2014; Lipton et al., 2003). The MIS involves registration of four unrelated words along with a semantic category cue. For example, respondents are asked to repeat "table" and "bingo." They are then asked, "Which is a kind of furniture?" "Which is a kind of game?" In this way, people associate a

semantic category with the word to help in later recall. Inability to remember the word in the presence of the semantic category cue may indicate a dementia rather than simply poor working memory. After 3–4 min of distraction with other questions, respondents are asked to recall the four words. Respondents receive 2 points for remembering the word without the cue, 1 point if they require the cue, and 0 if they cannot retrieve the word even with the cue. Thus scores range from 0 to 8.

We followed MIS test guidelines and considered anyone with a score less than 5 to have a possible dementia. These people, 5 % of the sample, were dropped from the sample. Similarly, we excluded people reporting any self-care difficulty in the EQ-5D measures, also about 5 % of the sample. In this way, the sample is comparable to the SITE cohort, described earlier, though somewhat younger (mean age 75) with less mobility disability and rural as well as urban residence.

The key outcome for assessing the effect of subtle differences in cognition in the Falls Free PA cohort was the CHAMPS questionnaire. It assesses weekly frequency and duration of 40 different activities typically undertaken by older adults. In our analyses, we dropped low frequency activities, defined as those with less than 10 % of the sample performing in the last 7 days, and examined only reported participation rather than frequency or duration. Twenty-three of 40 CHAMPS activities met this criterion. In this way, we used the CHAMPS simply to give an indication of activity and participation.

Given the geographic dispersion of the sample, all measures were obtained via telephone. A total of 1521 participants were available for analysis at baseline. We compared participants with a score of 5, 6, 7, and 8 on the Memory Impairment Screen to assess the effects of differences in cognitive performance in a non-demented sample with no reported ADL disability.

As Table 2.2 shows, memory performance in this high functioning sample was significantly associated with participation in six of the 23 CHAMPS activities. These include tasks involving physical exertion (brisk walking, light strength training exercise, light gardening) and high cognitive demands (using computer, volunteer work) but also instrumental activities (light housekeeping). Increases in participation were mostly linear across the range of MIS scores for these activities.

However, many of the activities were not related to memory performance, including social participation (visit friends and family, go to senior center, attend church, attend club, attend concert), cognitive tasks (arts and crafts, play cards, read), and physically demanding activities (walk uphill, walk to do errands, walk for pleasure, ride a bike, stretching exercises, aerobics, conditioning exercises).

In this high functioning sample, even subtle differences in memory performance matter for daily function but, importantly, not across the full set of CHAMPS activities. This too may speak to neural compensatory activity. A potentially productive hypothesis would examine whether neuroimaging reveals differences in brain activity among people with similar memory performance who differ in level of social participation. Do more active, engaged older adults show different patterns of brain activation or differences in brain architecture? More extensive research is warranted, with better characterization of cognitive function. For example, it is possible that some of the lower scoring participants in the Falls Free PA cohort (scores of 5 or 6 on the MIS) may meet criteria for mild cognitive impairment.

Table 2.2 Brain aging surrogates, by cognitive status: older adults with normal cognition and no disability in activities of daily living (ADL), *falls free PA cohort*, $n=1521$

	Memory impairment screen score			
CHAMPS, % reporting in last week	5 ($n=204$)	6 ($n=420$)	7 ($n=505$)	8 ($n=392$)
Visit friends/family	87.3	90.0	91.3	91.6
Go to the senior center	76.0	73.6	73.1	76.3
Do volunteer work*	34.8	38.8	43.3	46.9
Attend church or church activities	73.5	73.6	76.0	76.8
Attend club or group meetings	15.2	18.6	18.2	21.2
Use a computer***	37.3	39.4	47.4	54.7
Arts and crafts	26.0	27.6	30.5	34.2
Attend concert, movie, lecture, sporting event	20.6	18.3	22.4	19.7
Play cards, bingo, board games	47.5	50.4	52.1	50.0
Read	87.3	87.8	91.7	90.5
Heavy work around the house	8.3	8.9	10.7	11.7
Light work around the house*	85.8	88.3	92.4	91.3
Heavy gardening	8.3	12.9	10.7	11.7
Light gardening*	26.0	32.8	35.9	38.1
Walk or hike uphill	26.5	22.4	28.7	28.1
Walk fast or briskly***	21.1	23.2	30.3	37.9
Walk to do errands	34.8	33.9	36.1	36.8
Walk leisurely for exercise or pleasure	47.5	51.7	54.7	50.5
Ride a bike or stationary cycle	13.7	13.2	13.7	13.8
Do stretching or flexibility exercises	63.2	62.9	66.3	59.1
Do aerobics or aerobic dancing	12.3	10.3	13.3	14.3
Light strength training**	25.5	26.9	36.5	34.4
General conditioning exercises	22.1	30.0	32.3	30.9

CHAMPS, community healthy activities model program for seniors, limited to activities with greater than 10 % of the sample reporting participation
* $p<0.05$, ** $p<0.01$, *** $p<0.001$ by X^2

Improving Daily Function Despite Brain Aging

Increasing research evidence supports volunteering and exercise as ways to blunt the effects of brain aging on daily function. Evidence for the effects of direct cognitive remediation is more equivocal. Improving sleep health may also promote brain health.

Volunteering

Older adults commit more hours to volunteering than any other age group (although more recent birth cohorts are less likely to volunteer than earlier cohorts). An important area for future research is the extent to which volunteering or continued work beyond current retirement ages may promote brain health and in this way reduce the likelihood of decline in daily function.

Research suggests that volunteering is associated with positive outcomes across a number of domains. In the psychosocial domain, it is associated with a reduction in depressive symptoms and improvements in life satisfaction and social support. In the physical domain, volunteering is associated with better overall health, reduced functional limitations, and lower mortality risk. While less research is available on the effects of volunteering on cognitive function, a randomized controlled trial of the effect of group volunteering in elementary schools, Experience Corps, reported improvements in memory and executive function (Carlson et al., 2008) and increased cortical and hippocampal brain volumes (Carlson et al., 2015).

Experience Corps randomized older adults who sought volunteering opportunities either to a supervised teacher's aid program in public elementary schools or to usual volunteer opportunities (Fried et al., 2004, 2013). Participants in the treatment arm were assigned as groups to work with children in kindergarten through third grade as tutors and teacher aids. Each volunteer served about 15 h per week, usually over 3–4 days, throughout the school year. Volunteers (who received small stipends) worked with students to promote reading and arithmetic skills, as well as problem solving and conflict resolution. The program aimed to improve children's academic performance, for example, by boosting school attendance, graduation rates, and performance on standardized tests, but also to improve older adult outcomes by simultaneously enhancing psychosocial, physical, and cognitive function.

The mechanisms for the hypothesized benefit of Experience Corps include physical activity, social engagement, and cognitive stimulation. Volunteer effort in schools with children should improve physical function, such as greater lower extremity strength and balance, leading to improvements in mobility. Greater social support through volunteering should improve physiologic parameters, such as insulin resistance and blood pressure, as well as psychosocial factors, such as self-efficacy. Finally, cognitive stimulation through preparation of lesson plans and interaction with children in the school setting should promote cognitive skills and brain remodeling and activation.

Results from this important randomized controlled trial are still emerging, but evidence is emerging for benefit in executive function and brain remodeling, mentioned earlier, as well as physical activity, as indicated by accelerometer step counts (Varma et al., 2016). Psychosocial benefits have been reported as well (Gruenewald et al., 2015). All told, this model of volunteering suggests that at least some of the negative effects of brain aging can be blunted through a careful program of behavioral activation.

Exercise and Physical Activity

Emerging evidence from epidemiologic and, more recently, neuroimaging studies suggest a role for physical activity in preserving cognitive function in old age (Erickson et al., 2011). As one review summarizes the evidence, "an evaluation of the physical activity [PA]-cognition link across the life span provides modest support for the effect of PA on preserving and even enhancing cognitive vitality and the associated neural circuitry in older adults, with the majority of benefits seen for

tasks that are supported by the prefrontal cortex and the hippocampus" (Prakash, Voss, Erickson, & Kramer, 2015). Physical activity and exercise promote cardiorespiratory fitness, which in turn promotes larger hippocampal volumes and white matter integrity. Randomized exercise trials suggest that the volume of the hippocampus and prefrontal cortex remain pliable and respond to moderate intensity exercise over 6–12 months (Erickson, Leckie, & Weinstein, 2014). Still, caution is appropriate. A recent large randomized trial of exercise to promote walking speed, which demonstrated improvement in walking endurance, did not see benefits for cognitive performance (Sink et al., 2015). More research in this area is critical. One productive approach is evident in culturally tailored exercise interventions, such as the Rhythm Experience and Africana Culture trial (Lukach et al., 2016).

Cognitive Remediation

The effects of cognitive training on risk of dementia are controversial. Training improves tested abilities but may not transfer to other domains or enhance daily function. Commercial interests have a large stake in showing benefit, clouding research efforts. One early review reported the utility of cognitive training for reducing cognitive decline in normal aging (Hertzog et al., 2008), but evidence of the effectiveness of cognitive training in delaying difficulties in daily function has only recently emerged and results are equivocal. The largest and best conducted trial is ACTIVE, Advanced Cognitive Training for Independent and Vital Elderly, a large randomized controlled trial assessing the effects of three kinds of cognitive training (memory, reasoning, and speed-of-processing) on instrumental activities (IADL) (Ball et al., 2002). Ten years of follow-up are available (Rebok et al., 2014).

Results from ACTIVE suggest some benefit. At 10 years, 49.3 % of control participants reported the same or improved level of IADL difficulty as at baseline. Participants in all three cognitive training arms were more likely to report the same or improved IADL: memory arm, 61.6 %; reasoning arm, 60.2 %, speed of processing arm, 58.5 %. However, training did not lead to improvements in any of a series of performance-based measures of everyday function. The authors conclude, "the effects of cognitive training on daily function in this study were modest." Still, other studies using the ACTIVE trial have reported lower risk of auto accidents in the speed of processing treatment arm (Ball, Edwards, Ross, & McGwin, 2010; Edwards et al., 2009).

Sleep Health

Sleep disturbances may affect central nervous system restoration and in this way impair cognition and daily function (Cricco, Simonsick, & Foley, 2001). Indeed, sleep deprivation is often used as a model of dementia. However, recent reviews suggest that the association between normal sleep and cognition may be more complex because of the effects of multimorbidity, apnea, polypharmacy, variation in sleep architecture over the lifespan, and other factors (Scullin & Bliwise, 2015;

Yaffe, Falvey, & Hoang, 2014). It would be valuable to determine the sleep parameters with the greatest effect on cognition to target sleep health interventions and in this way improve cognitive function (Brewster, Varrasse, & Rowe, 2015). All in all, in older adults without extensive comorbidity, sleep does not change substantially with age and thus associations with cognition are less clear.

More complex trajectories linking sleep and impaired cognition have recently come to light. For example, the sleep-depression-dementia pathway suggests that depression is a brain insult, which, by affecting sleep, increases risk for cognitive decline (Cuijpers et al., 2015). If so, strategies to improve sleep may reduce the risk of depression and in this way maintain cognition and daily function.

Conclusion

In this chapter, we examined high functioning cohorts of older people to determine the extent of change in daily function with normal aging, that is, in people who do not meet criteria for cognitive impairment and disability. Older adults at greater ages and with subtle cognitive impairment show greater deficits in daily function but not uniformly. In many domains function is preserved. We conclude that this pattern of selective decline with preserved function overall reflects compensatory processes, which in turn suggest an adaptive brain. This is one more example of continual functional reorganization and repair as the brain responds to one particular set of neural insults, that is, aging.

We then turned to current research on efforts to blunt the effects of brain aging on daily function. Promising candidates include volunteering, physical activity and exercise, cognitive training, and improved sleep health. Each approach has some support for reducing the risk of cognitive decline and preserving daily function. However, in most cases effects are only small to moderate and in some cases remain equivocal. The safest conclusion at this point is a need to support cognition across the lifespan to preserve daily function in old age. This will require investment of resources for better early and mid-life educational, occupational, and neighborhood environments, as well as opportunities for continued cognitive engagement in late life.

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Alzheimer's Disease and Other Dementia Disorders

3

Sarah Seligman Rycroft and Tania Giovannetti

Pearl, a 70-year-old homemaker, is scheduled for her annual physical with her primary care physician. Despite a confirmation call from the physician's office the day before, Pearl missed the appointment. When the office called to reschedule, she was embarrassed and apologized for the error.

Henry, a 72-year-old truck driver, was on a new delivery route when he missed his highway exit. Having been a truck driver for 40 years, he was surprised when he felt lost and disoriented in a familiar city. When his employer called to inquire about the delivery, Henry complained that he must have received inaccurate directions for the trip.

Introduction

Alzheimer's disease (AD) and other dementia disorders are characterized by a decline in multiple cognitive abilities that interfere with work, daily functioning, or usual social activities (McKhann et al., 2011). Dementias may be classified based on their presumed etiology or neuropathology. AD is characterized by the buildup of beta-amyloid plaques and neurofibrillary tangles consisting of the protein tau, initially affecting the hippocampus and entorhinal cortex (Braak & Braak, 1991; see Chap. 1). Different forms of neuropathology characterize other dementia disorders. *Dementia with Lewy bodies* (*DLB*) involves cell loss and the presence of Lewy bodies, or abnormal protein aggregates that develop inside nerve cells throughout the limbic system and neocortex (Weintraub, Wicklund, & Salmon, 2012). *Frontotemporal dementia*

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(FTD) consists primarily of intraneuronal molecular abnormalities throughout frontal and temporal brain regions (Mackenzie et al., 2010). FTDs are also sub-classified according to the patient's cognitive/behavioral presentation (i.e., progressive nonfluent aphasia, semantic dementia, behavioral variant; Neary et al., 1998). *Vascular dementia* results from cerebrovascular disease involving multiple or specifically localized infarctions, ischemic events, or hemorrhage (Wetzel & Kramer, 2008). Although additional dementia subtypes have been described, AD is the leading dementia diagnosis in older adults (Weintraub et al., 2012) and features prominently in the scientific literature; therefore, AD will be the primary focus of this review.

AD and other dementias typically arise in older adulthood and follow a deteriorating course (Finkel, Costa e Silva, Cohen, Miller, & Sartorius, 1996). Dementia may begin with the subtle forgetfulness and confusion illustrated in the case examples of Pearl and Henry, described above. In dementia, these symptoms worsen over time and can lead to loss of independence (Krenz, Larson, Buchner, & Canfield, 1988) and severe caregiver burden (Ory, Hoffman, Yee, Tennstedt, & Schulz, 1999). According to the World Alzheimer Report, there are currently 36 million people living with dementia worldwide (World Alzheimer Report, 2009), and this estimate is expected to grow to 42 million by the year 2020 (Ferri et al., 2005). There are numerous important challenges currently facing dementia researchers and clinicians (e.g., early detection, pharmacologic interventions, etc.), but this chapter will focus largely on the impact of dementia on everyday functioning, including employment, social functioning, and activities of daily living. We will begin with a brief overview of the cognitive, neuropsychiatric, and physical symptoms of dementia that are associated with everyday functioning. The chapter closes with a brief discussion of cultural issues that are highly relevant to understanding dementia symptoms and functional outcomes.

Symptomatology

Two years after her initial symptoms, Pearl's friends tell her that she often repeats herself in conversation. Pearl is embarrassed by her memory difficulties, and she withdraws from social situations. Her physician tells her that she is in good general health, but she refers her to a neurologist and a neuropsychologist for further evaluation. The neuropsychological testing shows significant impairment in learning a word list and remembering figures that were presented during the examination. An MRI of the brain, which was ordered by the neurologist, shows generalized atrophy (i.e., shrinking).

Two years following his initial symptoms, Henry, who had retired from his job, was at a routine cardiology appointment when his wife complained to the cardiologist that Henry appeared more irritable and confused. At a recent family gathering, he made a few inappropriate comments that upset several people at the event. The cardiologist suggested that Henry see a neurologist and neuropsychologist. Cognitive testing showed intact learning of word lists and figures. However, Henry had trouble on tests requiring him to do two things at once or requiring him to alternate his attention from one activity to another. An MRI of his brain showed extensive white matter disease and multiple tiny strokes throughout his brain. Henry and his wife were unaware that he had ever had a stroke.

Cognitive Symptoms

Cognitive symptoms of dementia consist of progressive decline in various domains, including memory, executive function, judgment, language, comprehension, and visuospatial difficulties (Thune-Boyle, Iliffe, Cerga-Pashoja, Lowery, & Warner, 2012; Welsh-Bohmer & Warren, 2006). Episodic memory impairment is variable across dementia subtypes, but it is one of the hallmark features of AD (Geldmacher & Whitehouse, 1997). Episodic memory changes appear early in the disease and are generally attributed to difficulty consolidating or encoding *new* information (Hart, Kwentus, Taylor, & Harkins, 1987). Older memories, which were encoded prior to the onset of the dementia, are often well preserved. Thus, individuals with episodic memory impairment, such as Pearl in the case example above, may retain memories of events and people met prior to developing dementia, but may be unable to remember those occurring since the onset of illness (i.e., anterograde amnesia). Furthermore, because the episodic memory deficit disrupts new learning, and the memory was never encoded into the brain, the AD patient may receive little benefit from reminder cues in eliciting recall (Looi & Sachdev, 1999). Other forms of dementia spare the hippocampal formation (see Chap. 1); in these disorders information encoding may be preserved, but memory recall may be disrupted due to interference or poor retrieval of previously learned information.

Executive functioning refers to multiple cognitive processes that allow for the goal-directed control of attention, thinking, and behavior. Working memory refers to the ability to mentally maintain and manipulate information and is often associated with executive functioning. Impaired executive functions and working memory are observed following brain damage in many regions but they are typically associated with damage to the prefrontal cortex (PFC) and its related circuitry. They often manifest as disorganized behavior or difficulty planning and organizing one's activities and can interfere with recall of information stored in memory. These impairments related to executive functions and working memory also often present early in the course of AD, with some suggesting that they follow the initial symptoms of episodic memory decline (Perry & Hodges, 1999) due to the accumulation of neurofibrillary tangles in the PFC (Weintraub et al., 2012). In other dementias, such as FTD-behavioral variant, executive function deficits are the first cognitive symptoms to appear and are the primary feature of the dementia (Neary et al., 1998). This pattern also is observed in individuals with dementia associated with chronic vascular disease, who typically present with deficits in executive functioning and relative sparing of episodic memory encoding (Libon, Price, Garrett, & Giovannetti, 2004). The case example of Henry, described above, illustrates relative sparing of memory but the presence of executive function deficits associated with cerebrovascular disease.

Later symptoms of cognitive dysfunction in AD include language difficulties, with initial expressive deficits resulting in anomia (inability generating the names of words) and empty speech (Bayles, Boone, Tomoeda, Slauson, & Kaszniak, 1989) and receptive difficulties that affect oral comprehension manifesting later in the course of language decline (Welsh-Bohmer & Warren, 2006). Individuals may thus experience the "tip-of-the-tongue" phenomenon and eventually exhibit conversational difficulties due to impairment in both understanding others as well as

generating the names of words. Language and spatial deficits may be the initial and core cognitive symptom for some less common forms of dementia, including FTD-progressive nonfluent aphasia or semantic dementia (Neary et al., 1998).

Individuals with AD also experience visuospatial difficulties that result in problems with visual attention, or inability to attend to a portion of the visual field, visual memory and learning, reading, and perception of objects and faces (Benke, 1993; Jackson & Owsley, 2003). Object and face perception deficits may result in an inability to recognize items and people previously highly familiar to the individual. These deficits have been associated with damage to parieto-occiptal brain regions that prevents efficient use of visual information in guiding self-movement and maintaining spatial orientation (Tetewsky & Duffy, 1999). Individuals with these deficits may become more clumsy because of problems reaching to and grasping objects; they also may be more likely to experience difficulty finding their way back to a meeting spot and may become lost even in a familiar location.

The progression of cognitive decline, beginning with episodic memory and leading to executive function and language deficits, is the pattern often observed in people with suspected AD. However, there is great heterogeneity in the affected brain regions and neuropathology across individuals with dementia disorders (Weintraub & Mesulam, 2009). Therefore, it is not surprising that the extent of specific cognitive impairment is highly variable across dementia subtypes (Weintraub & Mesulam, 2009). A comprehensive neuropsychological evaluation is useful for characterizing the cognitive presentation of the disorder and educating patients and caregivers on the specific pattern of cognitive deficits and strengths.

Neuropsychiatric Symptoms

Individuals with dementia disorders also exhibit a range of neuropsychiatric symptoms. These symptoms include anxiety, apathy, depressed mood, hallucinations, and delusions, as well as behavioral manifestations such as aggression, restlessness, sleep disturbance, agitation, wandering, culturally inappropriate behaviors, sexual disinhibition, hoarding, cursing, and shadowing (Desai, Schwartz, & Grossberg, 2012; Finkel et al., 1996; Lyketsos et al., 2000). Although neuropsychiatric symptoms are not included in the diagnostic criteria for dementia, they are important with regards to the developmental trajectory of dementia, as risk of progression from mild cognitive impairment (MCI) to dementia has been associated with higher levels of neuropsychiatric symptoms. Specifically sleep disturbance, apathy, and anxiety have been shown to predict increased rates of progression to dementia (Somme, Fernandez-Martinez, Molano, & Zarranz, 2013). Further, increased presence of hallucinations, anxiety, and apathy have been found to be associated with greater global functional impairment (Wadsworth et al., 2012), highlighting the impact of these features on dementia severity. Interestingly, the course of specific emotional symptomatology has been shown to vary, with depression and anxiety decreasing and apathy increasing over the course of dementia progression (Wetzels, Zuidema, de Jonghe, Verhey, & Koopmans, 2010). The case example of Pearl described above illustrates how initial distress and anxiety concerning symptoms may lead to subsequent withdrawal

and apathy. Others, like Henry, may exhibit diminished insight, increased irritability, and socially inappropriate behaviors. These distinct emotional trajectories have important implications with regards to the developmental course of dementia disorders as well as relevant treatment approaches at different stages of illness.

Another important consideration in assessing the course of dementia disorders with regards to emotional symptoms is whether these mood factors constitute the cause of cognitive and functional decline rather than a byproduct of disease. Depression and other psychiatric symptoms can, themselves, lead to cognitive disorders that share a similar presentation to dementia or can co-occur with dementia and increase the extent of impairment (Welsh-Bohmer & Warren, 2006). Further, depressive symptoms in older age are common, with rates around 20% for individuals over the age of 65 (Blazer, Hughes, & George, 1987). It is therefore critical to understand and distinguish between emotional and cognitive factors involved in declining abilities, as their progression and response to treatment may be highly influenced by their etiology.

Psychotic symptoms are prevalent but variable across the dementia disorders, with hallucinations most common and observed earliest in the course of DLB (Borroni, Agosti, & Padovani, 2008; Johnson, Watts, Chapin, Anderson, & Burns, 2011), as opposed to the lower prevalence of these symptoms in some FTD subtypes (Rabinovici & Miller, 2010) and their later onset in AD (Lyketsos et al., 2000). When present in dementia disorders, psychotic symptoms tend to consist of relatively simple, non-bizarre delusions such as delusions of stealing, reference, infidelity, grandiosity, and persecutory delusions rather than hallucinations or implausible delusions, and they most commonly arise in the moderate-to-severe stages of the disorder (Bassiony & Lyketsos, 2003; Lyketsos et al., 2000). Conversely, older adults with initial psychotic symptoms have been shown to be at increased risk for progression to dementia (Kohler et al., 2012), further reinforcing the interactive process of underlying features of dementia and accompanying symptoms.

Physical Symptoms

Dementia is also associated with an array of physical symptoms that can pose health risks beyond the cognitive and psychiatric limitations of the disease. Some of these features may result from disorders that confer risk for dementia, including stroke or other cardiovascular risk factors, whereas others develop as dementia progresses, such as difficulty swallowing, which can lead to risk for pneumonia (Phelan, Borson, Grothaus, Balch, & Larson, 2012). Dementia has been shown to significantly predict increased risk for hospitalization, with admission rates for circulatory, genitourinary, infectious, neurological, and respiratory disorders occurring more often in older adults with dementia than those without (Phelan et al., 2012). A major physical feature that has been associated with cognitive decline is mobility impairment (Buchman, Boyle, Leurgans, Barnes, & Bennett, 2011). Although motor, sensory, and coordination deficits typically occur in late-stage AD (McKhann et al., 1984), it has been shown that balance impairments potentially related to early dysfunction of the vestibular and hippocampal systems arise as early as diagnosis of MCI, a precursor to dementia (Leandri et al., 2009).

Given mobility impairments, it is not surprising that a highly prevalent physical correlate of dementia disorders is increased risk of falling (Allan, Ballard, Rowan, & Kenny, 2009; van Doorn et al., 2003). Several risk factors for the incidence of falls include leg weakness, gait and balance impairments, functional impairment, visual impairment, hypotension, cognitive impairment, and medication use (Rubenstein, Josephson, & Robbins, 1994). These are common among the older population in general and may increase fall risk in individuals with and without dementia. However, several physical risk factors specific to falls in dementia have been identified and may aid in the distinction between healthy and pathological aging, including previous history of falls or recurrent falls, use of cardiac medications, autonomic symptoms, orthostatic hypotension, and limited physical activity (Allan et al., 2009), as well as deficits in executive functioning (Mirelman et al., 2012).

Symptomatology and Everyday Functioning

Predictably, this wide array of symptoms often leads to substantial functional impairment. In fact, functional impairment is a core diagnostic criterion of AD and dementia; this criterion is useful for distinguishing AD/dementia from normal cognitive aging and MCI, in which everyday functioning is unimpaired or only minimally disrupted. The extent and presentation of functional impairment in dementia is variable across individuals depending on the course of illness (Gure, Kabeto, Plassman, Piette, & Langa, 2010), functional expectations, and both protective factors and risk factors. Given that dementia is a disorder of older age, there is a lifelong opportunity for gradual development and interaction of these factors. This poses difficulty in distinguishing among factors that confer risk, those that delay illness, and those that emerge as correlates of dementia. However, increased understanding of relations between the complex factors involved in illness progression and functional deficits is important, as the resulting functional impairment can impede performance in domains critical to independent functioning in adulthood (Krenz et al., 1988). In the sections that follow, we will review the literature on everyday functioning in dementia with emphasis on employment, social functioning, and activities of daily living. The literature on functional outcomes in dementia is largest for activities of daily living, and this topic is the focus of our research laboratory; therefore, the review of activities of daily living will be more detailed and extensive.

Employment

The ability to secure and maintain employment is a societal expectation of adults that requires cognitive, physical, and functional competence, all of which may be compromised in dementia. It is therefore important to consider the impact of these symptoms on individuals with dementia as well as MCI, which typically precedes dementia and thus has a higher likelihood of onset prior to the age of retirement. However, relative to the literature on neurologic disorders that affect younger adults,

there has been very little research devoted to employment in dementia. Much of the research on employment has instead focused on caregivers and the extent to which caregiving demands reduce workforce participation and financial resources (van Vliet, de Vugt, Bakker, Koopmans, & Verhey, 2010). This focus on caregivers is likely due to the fact that many older adults who develop dementia disorders such as AD may have already retired from their professions or are close to retirement age. In the near future, however, as longevity and age of retirement steadily increase, we suspect that more research will be devoted to understanding employment outcomes in dementia.

Although research on employment in dementia is minimal, findings from previous studies have warranted exploration of the impact of certain features of dementia disorders on the ability to maintain employment. This literature suggests that employment may be influenced by a multitude of factors, including cognitive, behavioral, and psychiatric symptoms of dementia previously described. Cognitive symptoms in other illnesses (e.g., prospective memory impairment in HIV-infected individuals) have been shown to independently predict unemployment (Woods, Weber, Weisz, Twamley, & Grant, 2011). Thus, there is reason to expect that memory impairment and other cognitive symptoms of dementia may confer risk for difficulty maintaining employment in this population as well. Further, studies on employment in FTD have shown socially undesirable behaviors and psychiatric symptoms (e.g., depression, anxiety) to be associated with departure from employment or job loss (Morhardt, 2011; Mychack, Kramer, Boone, & Miller, 2001).

Interestingly, studies have shown that previous high work complexity can serve as a protective or delaying factor in the development and onset of dementia (Andel et al., 2005; Fratiglioni & Wang, 2007; Seidler et al., 2004; Smyth et al., 2004). It has not only been found that complexity of paid work predicted levels of intellectual functioning, but that this effect was greater for older (late 50s to early 80s) than younger (early 40s to early 50s) workers (Schooler, Mulatu, & Oates, 1999). A separate study showed that individuals with a history of consistent unemployment have been found to be at greater risk of developing dementia (Li et al., 1991), suggesting that a failure to be involved in work-related experiences may be detrimental to outcomes in later life. These studies support the notion that employment, particularly complex work activities, may delay or preclude the cognitive decline associated with MCI and dementia. The reasons employment may be protective against dementia are not entirely clear. Some have suggested that employment may increase one's cognitive reserve (Stern, 2002, 2012). Cognitive reserve is a concept that has been described as a store of cognitive "energy" or "power" that may be developed during one's lifetime through participation in diverse cognitive activities and challenges, such as education, employment, and leisure activities. Cognitive reserve is thought to be protective against the effects of brain damage or disease. For example, individuals with the same degree of brain damage may differ in their degree of cognitive impairment as a function of their cognitive reserve; the person with greater cognitive reserve will show fewer cognitive difficulties.

It is important to consider the potential for circularity in arguments for cognitive reserve. For example, the association between increased work complexity and preserved cognitive functioning in older adults may be explained by higher premorbid cognitive ability, specific associations between low education levels and vascular damage, or over-diagnosing dementia in individuals with low levels of education (Fratiglioni & Wang, 2007). An alternative explanation is that work may be enjoyable and prevent depressive symptoms and social isolation; however, Cohen-Mansfield and colleagues (2012) found that exposing individuals with dementia to task/work stimuli did not increase their experience of pleasure. The precise mechanism by which employment, particularly work that is complex in nature, enhances the aging process is unclear, and may involve some interaction of engagement in mental, physical, and interpersonal activities. Nonetheless, maintaining steady and challenging employment throughout the lifespan appears to benefit individuals as they age.

Conversely, there may be situations where high work complexity may be very stressful and consequently confer risk for dementia and other negative health outcomes. For most people, however, research indicates that work-related stress is unrelated to risk for dementia (Crowe, Andel, Pedersen, & Gatz, 2007), suggesting that this form of stress may not exacerbate cognitive deficits associated with dementia. Given the association between work complexity and decreased risk for dementia, it is alternatively possible that work-related stress does, in fact, confer some risk for decline, but that the protective impact of work complexity outweighs the impact of this risk. The notion that highly complex or stimulating activities may effectively counter harmful consequences of stress presents important implications regarding prevention and intervention practices for both younger and older adults.

Social Functioning and Participation in Society

The diagnostic criteria for dementia stipulate a significant decline in social or occupational functioning (McKhann et al., 2011). In contrast to task/work stimuli, social stimuli have been shown to increase pleasure or positive affect in individuals with dementia, potentially due to increased feelings of social isolation that accompany dementia disorders (Cohen-Mansfield, Marx, Thein, & Dakheel-Ali, 2011; Cohen-Mansfield et al., 2012). However, apathy, a previously discussed neuropsychiatric symptom of dementia disorders, is associated with low social engagement (Landes, Sperry, Strauss, & Geldmacher, 2001), suggesting that a decrease in emotionally driven social initiative may underlie social isolation associated with illness. It has also been suggested that individuals living at home with dementia may experience reduced social participation due to difficulties using the telephone (Nygard & Starkhammar, 2003) rather than reduced proactive social behavior. Although changes in social functioning and participation in society are common across dementia disorders, it appears likely that the mechanisms driving these changes vary greatly among different etiologies of disease, and potentially within these etiological subgroups as well.

Similarly to work complexity, a high level of social activity may serve as a protective factor in the progression of dementia disorders. It has been found that active participation in society predicts significantly later onset of dementia (Paillard-Borg, Fratiglioni, Xu, Winblad, & Wang, 2012), and degree of social participation has been shown to negatively correlate with risk for developing dementia (Paillard-Borg, Fratiglioni, Winblad, & Wang, 2009). Maintaining a high number of leisure activities in older age may provide stimulation in physical, mental, and social domains, yielding a cumulative advantage in the aging process (Karp et al., 2006). This combined effect is important given the lack of identification of a single modifiable lifestyle factor consistently related to decreased risk of AD (Daviglus et al., 2010) and inconsistent findings regarding the types of leisure activities that are beneficial to older adults (Wang, Xu, & Pei, 2012). Relatedly, a latent class analysis revealed a lifestyle pattern including abstinence from smoking, eating a healthy diet, exercising, and engaging in social activities that was associated with lower AD risk (Norton et al., 2012). Participation in society may thus be a multifaceted aspect of one's lifestyle that promotes healthy cognitive aging through multiple pathways.

Although the specific mechanisms by which social participation confers an advantage in the aging process are unclear, some research has suggested that, similar to employment findings, complexity of leisure activities in both middle and older age influences intellectual functioning (Schooler & Mulatu, 2001). Further, this relation was shown to be reciprocal, such that highly complex leisure activities supported, and were supported by, higher levels of intellectual functioning. These findings are not surprising given research showing that mental stimulation can serve to increase synaptogenesis in adulthood, resulting in enhanced brain function (Churchill et al., 2002). In line with this evidence, physical exercise, which may also increase with social participation, has positive effects on vasculature that can also counter risk factors in aging (Churchill et al., 2002). It is becoming increasingly clear that neurobiological and environmental mechanisms are highly interactive and that these interactions can have important effects on trajectories that determine outcomes in older age much earlier than the typical onset of dementia.

Activities of Daily Living

One day, Pearl invited her daughter to her house for lunch. When her daughter arrived, Pearl had prepared only drinks. She had not prepared any food items. When her daughter questioned her about it, Pearl apologized and admitted that she must have forgotten about the sandwiches that she had intended to prepare. Concerned about her mother's level of functioning, Pearl's daughter invited Pearl to move into her home.

Henry was preparing dinner while his wife was out for the day. When his wife retuned, she discovered several pots in the refrigerator and flour and baking soda on the set table in place of the salt and pepper. Henry, who was typically meticulous when he cooked, had made a mess in the kitchen. Since that day, Henry's wife took over the responsibility for dinners, but Henry still managed to prepare light meals when all of the objects were set out for him.

Consistent with declining social and occupational functioning, difficulty performing everyday activities, such as grooming and meal preparation, is a hallmark feature of dementia. A large literature shows that difficulties with everyday tasks are associated with a wide spectrum of negative outcomes, including decreased quality of life, frustration, depression (Espiritu et al., 2001; Hargrave, Reed, & Mungus, 2000), and institutionalization (Knopman et al., 1999; Smith, Kokmen, & O'Brien, 2000) as well as caregiver burden (DeBettignies, Mahurin, & Pirozzolo, 1990) and higher costs of care (Albert et al., 1999). In contrast to employment and other domains functioning, much of the outcome literature in dementia has focused on activities of daily living.

Assessment of Activities of Daily Living

The literature on everyday activities has used a range of methods. Most studies have relied on questionnaires that are completed by caregivers and designed to gauge a patient's need for assistance on a variety of everyday tasks (Lawton & Brody, 1969). Newer questionnaires have been designed to collect more detailed information regarding the breakdown of everyday tasks across various domains (e.g., memory, visuospatial tasks, etc.; Farias et al., 2006, 2008; Glosser et al., 2002; Jefferson et al., 2008). Some studies have used performance-based methods to address the drawbacks associated with questionnaire data, including the potential for unreliable reports (Arguelles, Loewenstein, Eisdorfer, & Arguelles, 2001; Zanetti et al., 1995; Zanetti, Geroldi, Frisoni, Bianchetti, & Trabucchi, 1999), variability in patients' daily routines, and the difficulty in meaningfully characterizing difficulties. Performance-based methods require patients to complete everyday tasks in the laboratory so that task accomplishment and errors may be scored and compared to normative data. These measures have the potential to be more objective than questionnaires, but they face the challenge of generalizability to real-world functioning. It is therefore important to develop coding schemes that may be used to relate performance on these measures to other constructs, including cognitive measures and caregiver- or self-report.

The methods used to code errors on performance-based tasks may differ across studies, but most researchers have generally used coding schemes that include omissions (failure to perform a task step), various types of commissions (inaccurate execution of a task step; e.g., sequence, perseveration, etc.), and action additions (performance of an extra, off-task step). Table 3.1 provides a list of error types, definitions, and examples of an error taxonomy that was developed by Schwartz and colleagues [(Buxbaum, Schwartz, & Montgomery, 1998; Schwartz, Reed, Montgomery, Palmer, & Mayer, 1991; Schwartz et al., 1995, 1998, 1999); see also Forde & Humphreys, 2002; Humphreys & Forde, 1998; Park et al., 2012; Ramsden, Kinsella, Ong, & Storey, 2008 for variants of this coding scheme]. Work from our group has shown that different error categories are associated with different cognitive difficulties, with higher rates of omission associated with episodic memory impairment and higher rates of commission associated with executive dysfunction (Giovannetti et al., 2008). Not all performance-based tasks incorporate this level of error analysis, possibly because it requires videotaped assessments and a great deal

Table 3.1 Comprehensive error score error categories

Error category	Definition	Examples
Omission	A step is not performed	Does not add sugar to coffee; does not add stamp to envelope
Commission		
Substitution	Similar, alternate object is used in place of target object	Spreads butter on toast with spoon instead of knife
Sequence	Anticipation of a step; steps or subtasks performed in reverse order	Butter on bread without toasting; applies jelly on bread then applies butter; dials telephone before lifting receiver
Perseveration	A step is performed more than once or for an excessive amount of time	Adds butter/jelly repeatedly to toast; adds multiple stamps on letter
Other	Correct object is used, but with an inappropriate gesture; the spatial relationship between objects is incorrect; a step is performed, but without the appropriate object	Grasps scissors like knife; cuts too small a piece of wrapping paper; rips wrapping paper (i.e., does not use scissors)
Action-addition	Performance of an action not readily interpreted as a task step	Puts toast in creamer; writes off-topic note on balance sheet

of time. Despite the resources and time required, detailed error coding offers the opportunity to characterize both overall level of impairment (i.e., total errors) as well as specific functional problems (i.e., distributions of error types).

Past studies have shown only modest correlations between caregiver/self-report questionnaires and direct observation of task performance (DeBettignies et al., 1990; Giovannetti et al., 2008; Giovannetti, Libon, & Hart, 2002; Kuriansky, Gurland, Fleiss, & Cowan, 1976). A study from our lab that used the detailed error analysis described above showed that caregiver ratings were associated only with omission errors on performance-based tasks in which participants completed goal-directed, everyday activities (e.g., make toast and coffee) in the lab (Giovannetti et al., 2008). This may suggest that caregivers do not notice other forms of error (e.g., commissions, action additions) or that omission errors are most disruptive to patients' independent functioning. More research is needed to understand the complex relations among various forms of everyday action assessment. Until these relations are understood, it is important to consider data from multiple sources and emphasize points of convergence across methods.

One consistent finding that has emerged from multiple methods is that everyday functioning is associated with cognitive impairment, such that individuals with greater cognitive impairment typically show greater functional disability (Barberger-Gateau & Fabrigoule, 1997; Lavery et al., 2005; Royall, Palmer, Chiodo, & Polk, 2004; Schmeidler, Mohs, & Aryan, 1998). Early in the course of the illness, individuals show difficulties with complex daily tasks, such as financial accounting and medication management (i.e., instrumental activities of daily living). These tasks

likely pose difficulties early in the course of the illness because they involve many steps that must be performed over a lengthy period of time and are less routinized than more basic activities. Basic activities of daily living, such as grooming and eating, tend to remain relatively preserved until later in the course of the illness as the individual experiences moderate to severe cognitive deficits (Barberger-Gateau & Fabrigoule, 1997). Problems in everyday activities, even complex tasks, were initially considered a distinguishing feature of dementia and uncharacteristic of MCI, but newer diagnostic criteria for MCI have been expanded to allow for "mild problems" on "complex" tasks as long as "independence" is maintained "with minimal aids or assistance" (Albert et al., 2011). Thus, the presence and level of functional impairment have enormous implications for the diagnosis of dementia and cognitive disorders in older adults.

Among individuals with MCI, frequent assessment of everyday functioning is important for tracking progression of symptoms. Investigators have shown that changes in functional abilities in people with MCI are highly predictive of conversion to dementia (Sikkes et al., 2011). In fact, a sharp decline in functional/cognitive ability in people with MCI more accurately predicted conversion to dementia than CSF markers and brain volumes (Gomar, Bobes-Bascaran, Conejero-Goldberg, Davies, & Goldberg, 2011). Thus, treatments designed specifically to improve everyday activities might not only serve to improve a wide ranges of outcomes in people with dementia but may be protective against conversion to dementia in people with MCI. Although there is insufficient evidence to recommend any specific interventions for improving everyday activities at this time, several studies on interventions have been published and are reviewed below.

Neuropsychiatric/Cognitive Symptoms and Activities of Daily Living

In addition to global cognitive status, neuropsychiatric symptoms are strongly associated with the ability to perform daily activities in dementia. Investigators have shown a relation between depression and daily functional status in dementia disorders (Ormel et al., 1998; Sarkisian et al., 2000), but some have suggested that this relation may be best explained by apathy, suggesting the importance of motivation loss in functional decline (Boyle et al., 2003; Tekin, Fairbanks, O'Connor, Rosenberg, & Cummings, 2001). As mentioned earlier, depressive and cognitive symptoms are tightly linked, making it difficult to determine whether it is possible or relevant to tease apart the relative influence of either factor on functional outcome. However, a large study of over 5,000 older adults showed that *both* depression and cognitive deficits contributed to functional decline in the early stages of a dementia disorder; later in the course of the disorder, only cognitive difficulties contributed to further functional decline (Mehta, Yaffe, & Covinsky, 2002). This study suggests that the influence of depression or other neuropsychiatric factors on functioning may change during the course of the illness. Relatively few studies have considered the interaction among depression, other neuropsychiatric symptoms, cognitive decline, and daily functioning, and even fewer have explored these relations using longitudinal study designs. Therefore, it is difficult to know the specific role of depression or other neuropsychiatric symptoms on functional abilities throughout the course of the illness.

As described earlier in the review of symptomatology, there is great heterogeneity in the pattern of cognitive deficits experienced by people with dementia. Some patients may show marked deficits in episodic memory and relative sparing of executive processes, whereas others may present with the opposite pattern of findings. This heterogeneity underscores the importance of determining which specific cognitive symptoms are most strongly associated with decline in everyday activities. To date, however, research on this question has yielded inconsistent results. Many studies show only modest relations between measures of daily functioning and measures of specific cognitive abilities (Royall et al., 2007). Studies that show positive results often highlight the role of executive functions in everyday activities (Cahn-Weiner et al., 2007; Pereira, Yassuda, Oliveira, & Forlenza, 2008). A recent study showed that executive function significantly predicted informant rating of instrumental activities of daily living, even after controlling for overall level of cognitive impairment, episodic memory abilities, and apathy (Marshall et al., 2011). Other studies emphasize episodic memory in addition to executive functions (Farias, Mungas, Reed, Haan, & Jagust, 2004; Farias et al., 2009; Goldstein, McCue, Rogers, & Nussbaum, 1992; Jefferson et al., 2008). These mixed results may be in part due to methodological difficulties in assessing functional ability such as potential report bias, emphasizing the importance of multiple sources of data and further refinement of functional measures.

Heterogeneity in Performance of Activities of Daily Living Across Diagnostic Groups

Although studies exploring relations between specific tests and degree of functioning have been mixed (i.e., variable-centered studies), research comparing individuals with different dementia diagnoses has reported relatively consistent findings of differing degrees of functional deficit across diagnostic groups. Gure and colleagues (2010) reported that individuals with AD showed less functional impairment on caregiver ratings than those diagnosed with vascular dementia or dementia due to other etiologies. This difference was significant even after controlling for dementia severity and other demographic factors. Using a combination of both caregiver ratings and performance-based measures, Mioshi et al. (2007) showed individuals with FTD-behavioral variant had greater functional impairment than individuals with AD or other forms of FTD (i.e., progressive nonfluent aphasia, semantic dementia). Other studies have shown the relation between global cognitive impairment and functional difficulties to differ across subgroups, with FTD-behavioral variant showing the strongest relation and primary progressive aphasia showing the weakest relation (Bouwens, van Heugten, & Verhey, 2009).

Recent studies have suggested that individuals with different dementia diagnoses may also exhibit different *types* of functional deficit. Work from our group has shown that individuals with subcortical ischemic vascular dementia (VaD) showed a different pattern of impairment than people with AD on a performance-based test of everyday activities. Specifically, individuals with VaD performed more poorly on performance-based variables associated with executive functioning—task accomplishment (i.e., omission errors, such as failing to turn on the toaster when instructed

to make a slice of toast) under conditions with distractor objects and errors reflecting inaccurate task performance (i.e., commission errors, such as applying jelly to a slice of bread and *then* putting the bread in the toaster). By contrast, people with AD performed worse on action variables associated with episodic memory—task accomplishment under conditions with multiple goals (e.g., make toast *and* coffee; Giovannetti, Schmidt, Sestito, Libon, & Gallo, 2006). Our group has shown similar differences between people with AD and people with dementia associated with Parkinson's disease (PDD), with AD participants showing a higher proportion of omission errors and PDD participants showing a higher proportion of commission errors on everyday tasks. Bangen et al. (2010) also recently reported significant differences between MCI subgroups on performance-based tests of functional abilities; participants with amnestic MCI demonstrated significantly worse performance on financial management, and participants with non-amnestic MCI performed significantly worse on health and safety tasks. These findings imply that the unique cognitive or neuropsychiatric symptoms associated with specific dementia or MCI syndromes may lead to qualitatively different patterns of functional impairment.

A Neurocognitive Model of Impairment in Activities of Daily Living

Along these lines, our research group has attempted to frame distinct functional impairment patterns within a neurocognitive model (hereafter Omission-Commission Model; Giovannetti et al., 2008; Giovannetti et al., 2012; Kessler, Giovannetti, & MacMullen, 2007; Seidel et al., 2011). Simply put, the model posits a link between specific neurocognitive deficits and specific functional deficits. As mentioned briefly earlier, failures in completing everyday task steps (omission errors) are associated with deficits in episodic memory and degraded task representations (semantic knowledge). By contrast, inaccuracies during the performance of everyday task steps (commission errors, such as incorrectly sequencing steps) are associated with executive control/working memory deficits (Giovannetti et al., 2008; Giovannetti et al., 2012; Giovannetti, Buxbaum, Biran, & Chatterjee, 2005). Several papers mentioned earlier that reported meaningfully different patterns of everyday action errors between groups of patients with different diagnoses provide support for this model (Giovannetti et al., 2006, 2012; Kessler et al., 2007). Further support for the Omission-Commission Model was reported in a study of 70 people with AD who completed a performance-based test of everyday functioning. The most frequent error categories—omission, sequence, perseveration, substitution, addition—were evaluated using a principal component analysis (PCA). Results yielded three distinct error components: omission, commission (sequence, perseveration, substitution), and addition (see Fig. 3.1). Furthermore, the three error components were associated with different neuropsychological processes. Commissions were related to measures of executive functioning and omissions were related to measures of overall cognitive impairment and episodic memory (Giovannetti et al., 2008).

The third error category reported in the PCA study, addition errors, includes behaviors that are tangential to the overall task goal(s) (i.e., putting a pencil in an envelope along with a folded letter). This error category was unrelated to any of the

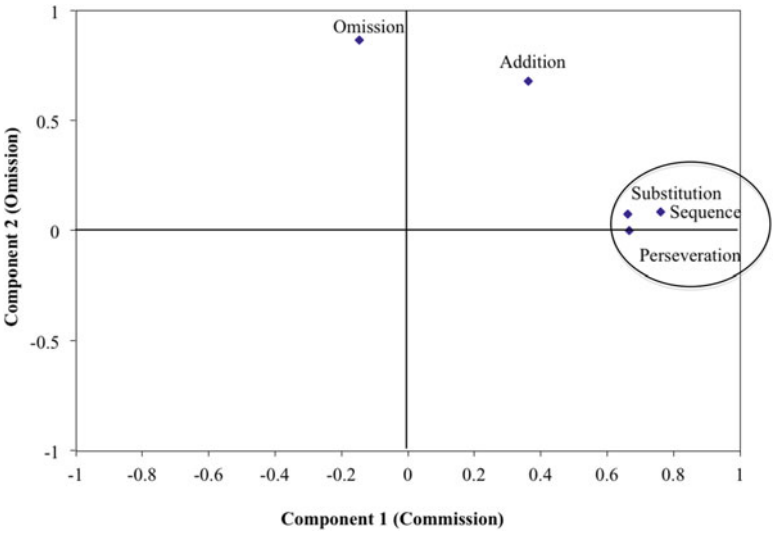

Fig. 3.1 Component loading plot from the rotated principal component analysis (PCA) of NAT error types from a sample of 70 participants with dementia. The *x*-axis shows loadings on component 1, which reflects commission errors. The variables that are circled (perseveration, sequence, and substitution errors) are closest to 1 on the *x*-axis indicating that they load most strongly on component 1-commissions. Consequently, these error variables are often grouped together to form a single commission error category. The omission error type loaded most strongly (i.e., closest to 1) on component 2-Omissions, which is represented on the *y*-axis. Addition errors fell between omission and commissions errors on the component plot. (Adapted from Giovannetti et al. 2008)

neuropsychological measures included in the study of 70 dementia participants, and it is not frequently observed in participants with AD. However, addition errors are quite common in people with executive function difficulties (e.g., schizophrenia; Kessler et al., 2007), and it is possible that these errors reflect reduced cognitive control over performance (e.g., utilization behavior) or multiple deficits (see Seidel et al., 2011).

Error Monitoring and Detection

Another important facet of everyday functioning in dementia is the extent to which patients are aware of and detect their errors. Some have argued that improving error monitoring might be a more effective approach to improving daily functioning than attempting to eliminate or reduce errors (Reason, 1990). For the purpose of understanding everyday error monitoring, performance-based measures have been fruitful in deconstructing the timing and process by which an individual detects, interprets, and successfully rectifies errors on an everyday task (Bettcher & Giovannetti, 2009; Bettcher, Giovannetti, Klobusicky, et al., 2011; Bettcher, Giovannetti, Libon, et al., 2011; Bettcher, Giovannetti, Macmullen, & Libon, 2008; Giovannetti et al., 2002; Hart, Giovannetti, Montgomery, & Schwarts, 1998). Using these paradigms, individuals with dementia show clear decrements in detecting

errors on everyday tasks when compared to older adults without dementia, even after controlling for differences in error rate (Bettcher & Giovannetti, 2009; Bettcher, Giovannetti, Klobusicky, et al., 2011; Bettcher, Giovannetti, Libon, et al., 2011; Bettcher et al., 2008; Giovannetti et al., 2002; Hart et al., 1998). Individuals with mild to moderate dementia detect approximately 20–30 % of errors compared to approximately 75 % of the errors detected by healthy older adults (Bettcher & Giovannetti, 2009; Bettcher, Giovannetti, Klobusicky, et al., 2011; Bettcher, Giovannetti, Libon, et al., 2011; Bettcher et al., 2008; Giovannetti et al., 2002).

Detailed analyses of everyday error monitoring have yielded more surprising findings, with results showing little relation between the number of errors one makes in a daily task and error detection or correction. The total number of everyday action errors was weakly and not significantly correlated with the proportion of errors detected in a study of people with various forms of dementia ($r = -0.25$, $n = 54$, $p = 0.07$; Giovannetti et al., 2002). Total errors and error detection/correction also have been associated with different cognitive processes (Bettcher, Giovannetti, Klobusicky, et al., 2011; Bettcher, Giovannetti, Libon, et al., 2011; Bettcher et al., 2008; Giovannetti et al., 2002), further supporting the distinction between overall error rates and detection/correction. Another notable finding is that even individuals with markedly low error detection are highly likely to correct errors that are detected. A majority (76 %) of detected errors are subsequently corrected by participants with dementia, suggesting that this population may experience relatively greater deficits in *recognizing* action errors than in acting to correct these errors once detected (Bettcher, Giovannetti, Klobusicky, et al., 2011; Bettcher, Giovannetti, Libon, et al., 2011; Bettcher et al., 2008; Giovannetti et al., 2002). These studies suggest that high rates of everyday action errors and deficient error detection may be the consequence of distinct neurocognitive deficits and that interventions focused on increasing error detection may improve error correction and in turn improve everyday functioning.

In summary, detailed analyses of performance-based assessments have shown that different error patterns may be observed across patients and populations, and that different error patterns may be reliably and meaningfully associated with distinct neuropsychological deficits (i.e., the Omission-Commission Model). This model may serve to help clarify the conceptualization and treatment of specific everyday action deficits across a range of tasks and contexts.

Treatment of Impairments in Activities of Daily Living

Despite the relatively large literature on everyday action impairment reviewed above, relatively few studies have evaluated interventions designed to improve everyday functioning. One highly cited randomized control trial (Ball et al., 2002) examining the effect of 5–6 weeks of cognitive training interventions on everyday functioning in healthy older adults showed no effects on daily activities, although the training did improve performance on cognitive tasks. The study authors suggested that the null effects, or lack of significant improvement in daily activities following training, might have been due to the fact that their healthy sample actually experienced very few difficulties with daily activities (i.e., ceiling effects). However, null findings also were reported in a review of nine randomized control studies of

cognitive training in dementia, where ceiling effects should not have interfered with results (Clare, Woods, Moniz Cook, Orrell, & Spector, 2008). Nevertheless, other methodological limitations, including the use of potentially insensitive functional outcome measures and small sample sizes, make it premature to draw firm conclusions regarding the efficacy of cognitive training interventions for people with dementia (Clare et al., 2008).

In contrast to studies on cognitive training, positive results have been reported for interventions that specifically target functional outcomes in dementia. Extensive training and repetition of everyday activities improve performance on the trained tasks, although training effects do not generalize to untrained tasks (e.g., *procedural memory stimulation*; Avila et al., 2004; Farina et al., 2002; Josephsson et al., 1993; Zanetti et al., 2001, 2009). Positive benefits also have been reported following a brief (approximately 15 min) pictorial and video review of task objects and the sequence of task steps just prior to performance of everyday tasks (Bettcher, Giovannetti, Libon, et al., 2011). This intervention showed reduced error rates and greater error detection on a performance-based task when evaluated in the laboratory; the results emphasized the importance of targeting degraded knowledge of everyday objects and tasks in interventions for dementia patients.

A wide variety of environmental adaptations also have been suggested for dementia patients (e.g., cue cards, sparse workspace), and some have shown positive effects even without extensive training or repetition (Brennan, Giovannetti, Libon, Bettcher, & Duey, 2009; Giovannetti et al., 2007). Gitlin, Corcoran, Winter, Boyce, and Hauck (2001) explored the effect of individualized home-based environmental adaptations among 171 dementia participants following *caregiver* training and showed improved functioning and reduced caregiver burden as assessed via caregiver ratings. Our group conducted a laboratory-based study to test the efficacy of arranging objects in the workspace in the order that they should be used in the task and a visual cue to remind participants to monitor performance. Participants did not perform the task repeatedly and did not undergo extensive training with explanation of the adaptations. The results showed significantly reduced error rates on performance-based tests (Giovannetti et al., 2007), but the adaptations had no effect on error detection or correction (Bettcher, Giovannetti, Klobusicky, et al., 2011).

In sum, environmental adaptations may be implemented by the caregiver and may benefit patients even if they are introduced without extensive training or practice. It is quite possible that combining environmental adaptations with repeated practice and patient training will yield even larger positive effects. Additionally, new technologies will allow for adaptations to be seamlessly introduced into the home environment (e.g., smart home; Cook, 2012). Further research using large samples, randomized control designs, and meaningful outcome variables is crucial to determine the effectiveness of interventions and adaptations for daily functioning. An important goal of this work also must be to determine whether and how patients may be matched to interventions that specifically target their unique functional deficit, as this approach may increase the benefit and reduce the cost of interventions/adaptations.

Cultural Considerations

Several epidemiological studies have shown significant differences in the prevalence and incidence of dementia across racial/ethnic groups, with higher rates of cognitive impairment in African-American and Hispanic individuals than Caucasian individuals (Tang et al., 2001). However, it is important to note that this pattern is not equivocally reported in the literature. There are large studies that show no meaningful differences in cognitive impairment across racial/ethnic groups (Fillenbaum et al., 1998; Fitzpatrick et al., 2004), although to our knowledge there are no studies showing better cognitive performance or outcomes in African-American or Hispanic participants as compared to Caucasian participants.

Innumerable environmental factors may explain the discrepancies in cognitive performance across ethnic/racial groups, including segregation, migration patterns, socioeconomic position, discrimination, educational and occupational opportunities, diet, and many others (Glymour & Manly, 2008). In a review paper, Glymour and Manly (2008) propose that these factors may be best understood through a multidimensional lifespan perspective. This perspective considers the complex interaction of risk and protective factors across the entire life course. For example, as reviewed earlier in this chapter, both social participation and high work complexity, which may be strongly affected by racial/ethnic group, may help to buffer against risk factors for development of dementia. Conversely, failure to participate in these activities in young adulthood may serve to exacerbate or maintain these risk factors, promoting a trajectory of decline. Importantly, the effect of risk factors related to social and work behaviors likely interact and accumulate over many years, placing individuals of certain ethnic/racial groups at increased risk for dementia from a very early age. Early experiences across domains may influence outcomes in adolescence, adulthood, and older adulthood, with interactions growing more complex over time. In fact, dementia research has suggested that interactions not only among lifestyle factors but also between lifestyle and pathobiological features of Alzheimer's disease (e.g., amyloid deposition) play a role in the clinical expression of the disorder (Lopez, Becker, & Kuller, 2012). Thus, the effects of these interactive processes can promote and deflect specific trajectories over the lifespan before emergence of the clinical features of illness.

In addition to cascading influences of experiences over time, there is also extensive evidence for multifinality—individuals with similar lifestyle patterns achieve very different outcomes. This makes isolating mechanisms of risk and resilience incredibly challenging. Among individuals who develop MCI, suggesting a shared transition from normal cognition to dementia, some go on to develop dementia, others remain stable in their mild impairment, and still others improve to a state of healthy aging (Winblad et al., 2004). Further, the association between dementia vulnerability and protective factors varies with age, as these factors have been shown to differentially influence risk for dementia in "younger older adults," under the age of 80, and "older older adults," over the age of 80 (Lopez et al., 2012). High variability in outcomes among seemingly similar risk groups and in the relative impact of risk factors further underscores the need for characterization of these dynamic processes in order to develop successful prevention and intervention strategies for individuals with dementia.

In addition to considering the development of risk and protective factors over the lifespan, it is important to consider whether the racial/ethnic differences in dementia reported in some studies reflect true disparities in cognitive abilities or simply differences on *tests* that are used to diagnose dementia. Cognitive tests are strongly influenced by education, which may bias tests to overestimate cognitive decline in African American and Hispanic individuals—groups with limited educational quality/opportunities/achievement (Manly, Jacobs, Touradji, Small, & Stern, 2002). In addition to education, many other factors associated with race and ethnicity may influence the *meaning* of low test scores across racial/ethnic groups (e.g., stereotype threat; Steele & Aronson, 1995). Investigators have suggested several solutions to reduce or eliminate test bias, including the use of racial/ethnic-specific norms and tests developed using Item-Response Theory (see Pedraza & Mungas, 2008). We suggest replacing traditional cognitive tests used to diagnose dementia and MCI with performance-based measures of everyday functioning, which have shown no significant relation to gender or education in many studies (Buxbaum et al., 1998; Giovannetti, Libon, Buxbaum, & Schwartz, 2002; Giovannetti et al., 2002, 2006; Schwartz et al., 1998, 1999; Schwartz, Buxbaum, Ferraro, Veramonti, & Segal, 2003; Schwartz, Segal, Veramonti, Ferraro, & Buxbaum, 2002; Sestito, Schmidt, Gallo, Giovannetti, & Libon, 2005).

Some investigators have argued that the differences between various racial and ethnic groups are greater than that which can be accounted for solely by test bias (see Glymour & Manly, 2008 for a review). In fact, test bias does not adequately explain the higher incidence of dementia in African-American compared to Caucasian individuals in longitudinal studies (Tang et al., 2001), as the influence of test bias would be expected to remain constant over the course of several years. Nevertheless, it is essential to understand the potential for any degree of racial/ethnic bias in measures used to diagnose dementia, as sensitive measures are crucial for early detection and adequately informed treatment recommendations.

Conclusions

As reviewed in this chapter, dementia is a degenerative disorder of older age that can lead to a wide range of impairments in cognitive, neuropsychiatric, and physical domains as well as everyday functional difficulties. Reduced participation in societal and work-related activities has been shown to constitute both an outcome and a risk factor for progression of the disorder, and difficulty performing everyday activities has been linked to a range of negative outcomes. A major goal of dementia research is to develop measures that accurately assess functional abilities, particularly given that interventions targeting functional deficits have been shown to be most effective in the literature to date. Performance-based measures have the potential to capture real-world functioning in the laboratory and to characterize functional deficits in dementia using error taxonomies that quantify task performance and can be related to measures of other constructs. These objective measures are also important in addressing differences in cognitive impairment reported across

racial and ethnic groups. A lifespan approach to dementia can help characterize socioeconomic, educational, and other lifestyle factors that interact with neurobiological components of risk and resilience. Increased understanding of these interactions is critical for the development of effective prevention and intervention strategies to maximize independence and successful outcomes in older age.

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Parkinson's Disease: Changes in Daily Life

4

Jacob I. Sage

Background: Pathology and Biochemistry

A neurologist who is confronted with a clinical problem always asks himself or herself the following question: Where is the lesion? The clinical syndrome that we call Parkinson's disease (PD) was described early in the nineteenth century but it was not until the mid-twentieth century that we began to understand where in the brain dysfunction was occurring. Beginning in the 1950s, neuropathologists realized that Parkinson's disease correlated with degeneration of neurons in an area of the midbrain called the Substantia Nigra. In addition, specific cellular inclusions, called Lewy bodies, which could easily be seen with the light microscope, were noted to occur in PD and became the hallmark of the pathologic diagnosis of Parkinson's disease. Within a relatively short period of time, it became clear that the substantia nigra produced dopamine and by the 1960s studies in patients with PD showed that it was possible to ameliorate the motor signs and symptoms of the disease by giving patients oral levodopa, a compound which was converted in the brain to the deficient transmitter-dopamine. Since the dopamine deficiency was also found in other neuronal systems and nuclei in the brain, Parkinson's disease was therefore thought of as a dopamine deficiency motor system disease. The cause or causes for this degeneration of dopamine neurons was then, and remains today, unknown.

The situation as we understand it now at the beginning of the twenty-first century is somewhat more complicated. Today, it is better to think of Parkinson's disease as a multi-system degenerative disease rather than as a simple degeneration of

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dopamine producing cells only (Mark & Sage, 2000; Mark et al., 1994; Mark, Sage, Dickson, Schwarz, & Duvoisin, 1992; Mark, Dickson, Sage, & Duvoisin, 1995; Mark, Sage, Walters, Duvoisin, & Miller, 1995; Sage, 1996, 2004a; Sage & Duvoisin, 1989; Sage, Miller, Golbe, Walters, & Duvoisin, 1990). Neurons in many brain nuclei that do not use dopamine as their transmitter also are being lost as the disease progresses. Major neuronal systems that use acetylcholine, serotonin, and norepinephrine are involved in the degenerative process. Furthermore, many if not most patients eventually have Lewy body disease that becomes widespread and includes pathologic degenerative changes in many areas of the cerebral cortex (Sage & Mark, 1993). Thus, our concept of Parkinson's disease has evolved over the last half century from that of a single system motor degenerative process to a more widespread brain disease involving many systems and causing dysfunction in many areas of the central nervous system and beyond.

What are the possible causes that get this degenerative process started and keep it going? Researchers over the past several decades have focused on two major areas, genetics and environment (Golbe, Mark, & Sage, 2007; Golbe et al., 1996, 2001; Lazzarini et al., 1994; Ricketts et al., 1998). At least five major gene mutations have been found and are considered susceptibility genes for Parkinson's disease. The first major gene abnormality causing Parkinson's disease was found by Roger Duvoisin and his coworkers and is a mutation in the gene that codes for a protein called alpha synuclein. This gene causes dominantly inherited diseases, meaning that if one has the mutation, there is virtually a 100 % chance that it will cause disease. Fortunately, this gene mutation has been found in only a handful of patients around the world and therefore is not a major cause of PD. The importance of this gene mutation, however, is that it has focused attention on the protein product, alpha synuclein. This protein has been found to be the major component of Lewy bodies, the hallmark of pathologic PD and therefore it must play a major role in the degenerative process. Unraveling the role of alpha synuclein in all patients with PD, even those that do not have the alpha synuclein gene mutation, hopefully will lead to a better understanding of the causes of the disease and eventually to better treatments that may slow the progression or halt the pathologic process. A mutation in another gene, called the Parkin gene, is found in approximately half of patients whose disease starts before the age of 40, young onset Parkinson's disease. However, since PD is mostly a disease of older individuals (average age of onset is 60 years), Parkin mutations do not account for large numbers of people. The incidence of other gene mutations in the Parkinson's disease population is unclear but together, the known gene mutations account for no more than 30–50 % of all patients.

The thought that environmental causes may play a role in the genesis of PD comes mostly from epidemiological studies. It has been known for many years that the incidence of cigarette smoking among patients with PD is much lower than in the general population. This fact has led to the idea that something in cigarette smoke may prevent or decrease the likelihood of the disease getting started. Based on such data, the Parkinson's research community in North America and Europe is about to start a study to test whether or not administration of nicotine via a dermal patch influences the rate of disease progression. There are, however, other explanations

for the lower incidence of smoking in PD patients, including premorbid personality traits caused by altered brain neurotransmitter levels that may inhibit the desire to smoke or the pleasure derived from cigarettes. It is unclear which is the cart and which is the horse. The data on caffeine use in PD patients are similar to that with cigarettes. Certainly, none of these data is compelling enough to suggest the preventive use of either nicotine or caffeine. A host of other environmental/nutritional factors have been looked at including vitamins E and D, Coenzyme Q 10, the antibiotic minocycline, the use of well water, rural living, and an ongoing study on the use of the dietary supplement creatine, just to name a few. So far, there is no proof to suggest that the lack of any of these agents or that the role of environment plays a role in causing PD or that giving one or more of these substances to patients slows the progression of PD.

At least one tantalizing environmental clue comes from work in the laboratory together with epidemiological data. Since there is no naturally occurring Parkinson's disease in any non-human animal, researchers have developed a number of models of PD in rodents and monkeys. One of these experimental models uses an insecticide, rotenone, to produce a progressive parkinsonism in rodents that somewhat resembles the disease in humans. The question, therefore, has been raised as to whether or not insecticide use in agriculture or the home and garden plays a role in the genesis of human Parkinson's disease. Preliminary epidemiological evidence suggests that insecticide use in the home and on suburban lawns in close proximity to human habitation but not in commercial agriculture might increase the likelihood of getting PD. More work on this issue needs to be done.

Regardless of whether or not the causes of PD turns out to be mostly genetic, environmental or due to other factors, the question remains about how these multiple causes go about producing the degeneration of neuronal systems that we see under the microscope (Chokroverty et al., 1985; Fahn et al., 2004; Investigators, 2006, 2007, 2008; Tilley et al., 2006). We have some clues about possible mechanisms. One mechanism that may contribute to cell death is a putative excess of free oxygen radicals in the brains of patients with PD. Free radicals are the result of many normal metabolic processes in cells. Nonetheless, they are destructive to cell membranes and therefore a number of mechanisms have evolved in biological systems to handle and dispose of free radicals. Free radical scavengers such as glutathione are present in cellular systems to reduce the free radical load produced by normal metabolic activity. It is known that these scavenging systems are less effective in the brains of patients with PD, thereby increasing the free radical load and promoting cell death by increasing the destruction of cellular membranes beyond their normal repair capabilities. Trying to reduce the brain's free radical load has been an aim of experimental therapies that so far have not been successful.

Another mechanism that accelerates cell death and degeneration in PD appears to be impaired apoptosis. Apoptosis is the cell death program that regulates the life cycle of all cells. Normally, it controls how long a given cell lives and when a cell dies. In PD brain cells, it seems to be working excessively. Neurons, therefore, are lost through programmed cell death at greater than normal rates and cannot be replaced effectively,

possibly causing the degeneration seen in PD. An important unanswered question is why the selectivity to some neuronal systems while other systems are spared in PD.

A third important mechanism that may accelerate cell death in PD patients relates to the efficiency with which these cells are able to produce energy for their survival. Brain cells in PD patients have an abnormality in complex I of the electron transport chain within the mitochondria. Mitochondrial electron transport is where most of cellular energy is most effectively produced. Abnormalities in this subcellular organelle, therefore, make it harder for cells to meet their energy requirements and thereby may make cells work harder and "wear" themselves out sooner. Future agents that help cells make energy more efficiently may slow the cellular degeneration in PD.

The causes of Parkinson's disease that we have been able to discuss in this short space only scratch the surface of what will be the actual situation. It is likely that what we call PD and what we consider to be a single disease today will have many different causes. The situation may be analogous to pneumonia. We may call it pneumonia no matter the cause but in reality, pneumonia is caused by agents as varied as bacteria, viruses, chemical agents, fungi, and more. Similarly, a variety of causes will likely turn out to be the case for Parkinson's disease.

Clinical Symptoms and Signs

As noted in the previous section, Parkinson's disease involves a number of different clinical areas: (1) Motor functions, (2) Sensory problems including pain, (3) Autonomic dysfunction, (4) Cognitive/psychiatric issues, and (5) Sleep disturbances (Duvoisin & Sage, 1996, 2001; Duvoisin, Golbe, Mark, Sage, & Walters, 1996; Sage & Mark, 1994, 1996).

We will begin with the motor aspects of the disease.

Motor System Symptoms and Signs

Alex, 55 years old, has been the owner of a laundromat for the past 20 years. He is married and has two adult daughters. He came to see the doctor, complaining about constant tremor in his right hand. He described that his tremor worsens while dealing with more stressful situations, such as lots of customers at the same time, or a lot of orders. However, when he does an activity such as folding laundry, or loading clothes into the washing machine, the tremors decrease. He also mentioned that when he lies in bed or goes to sleep, the tremors decrease significantly. His wife added and said that all of his life he tended to be depressed but lately it has gotten worse. In addition, she mentioned that he often sits on the couch and does not move or change position.

After initial examination of Alex, the doctor found rigidity affecting Alex's right side, and slowness of movements.

The majority of patients have a unilateral onset of clinical manifestations, also termed as hemiparkinsonism (Factor & Weiner, 2008). In most cases, the patient is brought to a physician by the spouse because of a change in posture or in the character of the gait. Sometimes signs of parkinsonism are noted during a visit to a

doctor for some other purpose. It is not unusual in these circumstances for the patient to deny any symptoms. Much of the early manifestations, notably minor postural aberrations and bradykinesia are outside conscious experience and are more obvious to another than to the patient.

PD patients often present with one or more of a small cluster of symptoms at the time of diagnosis. By far, the most common initial symptom at the time the diagnosis is resting tremor of one hand, although postural and action tremors are not rare (Rajaraman et al., 2000). Onset with tremor of the foot is decidedly less common. Other less common initial manifestations are slowness or shuffling or dragging one foot while walking, softness of voice, impaired finger dexterity or postural instability that may affect actions that require fine motor skills and bilateral coordination. Rarely, patients may present initially with a focal or segmental dystonia, which refers to muscle contractions that could cause twisting and repetitive movements or abnormal postures. An example of this is a foot cramp with various posturing of the foot and clawing of the toes.

Another common symptom seen during initial examination is cogwheel rigidity. Rigidity causes stiffness and inflexibility of the limbs, neck, and trunk. Patients with PD may have a tendency to posture the affected upper limb slightly abducted at the shoulder and flexed 45–50° at the elbow. When the patient walks, decreased or absent arm swing is usually seen on the affected side. Rigidity can be activated by having the patient do a repetitive task with the opposite hand such as opening and closing of the fist (Schettino et al., 2004). Bradykinesia is another symptom common in PD. Bradykinesia refers to decreased bodily movement. Symptoms of bradykinesia may include rapid decay in the amplitude and velocity of repetitive movements such as alternating pronation and supination of the forearm or tapping each finger successively. Thus, the classic triad of akinesia, rigidity, and tremor can be identified even in very early stages of PD with minimal hemiparkinsonism. General bradykinesia is manifested as a mild general slowness in all bodily movements. For example, loss of expressive gestures of the hands, loss of arm swing on walking, and a reduced frequency of normal movement of postural adjustment such as crossing and uncrossing the legs while sitting can be seen. An additional feature is difficulty doing two movements simultaneously. In addition to slowness, there is a decreased frequency and spontaneity of movement and action, hesitations in the initiation of movements and arrests of ongoing movements. Increased frequency of repetitive movements compensates partially for reduced speed. Automatic movements, or movements that occur without explicit planning, seem to be affected to a greater extent. Often, mild unilateral hypomimia and reduced eyeblink frequency is evident on examining PD patients with unilateral symptoms. Unilateral facial hypomania may simulate a facial paresis as a symptom of bradykinesia, such as decreased eye blink, a loss of facial expression.

Other symptoms that deserve mention include the characteristic Parkinsonian hand in which the metacarpophalangeal joints are flexed and the fingers are held straight. Occasionally, the interphalageal joint of the thumb is hyperextended. Slight edema of the hand and foot on the affected side may also be noted. Again, this dysfunctional posture of the hand can impact every activity that requires fine motor skills.

While sitting or standing, the hemiparkinson patient usually exhibits a slight thoracic scoliosis resulting in a contralateral tilt of the trunk to the affected side. This contrasts with the ipsilateral tilt seen in hemiparesis of corticospinal origin, a point which may be useful in differentiating the two conditions when other diagnostic signs such as tremor are lacking. Within 1–2 years, or sometimes after many years since the onset of the illness, the signs and symptoms become bilateral. Tremor often spreads from the hand to the foot of the same side, then to the opposite hand. Usually, by the time the manifestations become bilateral, the erect posture becomes slightly stooped. There is also gentle flexion at the knees and hips on standing or walking and the head is inclined forwards slightly.

Alex is now five years post diagnosis. He rarely goes to his laundromat and his wife hired a manager for the business. She mentioned that she often considers selling the business because it is hard for her to take care of both the business and her husband's needs. Five years post diagnosis, Alex uses few gestures and his writing is limited. It is very hard for him to walk and therefore he uses a wheelchair. However, he has an elevated extensor tone in the neck and trunk, which makes wheelchair positioning and transfers difficult and makes him unsafe to sit unsupported. He has rigidity in all limbs and demonstrates little spontaneous movement. Joint movement is limited and awkward due to tremor of the limbs; he also is slow to initiate muscular effort. Movements are slow and awkward. He fatigues easily, requiring several hours of bed rest during the day.

The Functional Result

The motor symptoms of PD result in impairment in everyday life that create barriers to normal daily life functioning. Most common are impairments of speech, gait, handwriting (micrographia), and vision.

Specifically in regard to *speech*, the voice tends to be soft in volume and as the patient utters a series of words, the volume decays further and speech may trail away into an inaudible whisper. The "song" of the speech becomes flat. Speech is also tachyphemic (characterized by a rapid speech that is difficult to understand, poor grammar, and use of words irrelevant to the sentence) and increasingly so as volume decays. There may be arrests in mid-sentence and a delay before speech can resume. Rarely the flow of speech is halted by repetitions of a syllable, a phenomenon called palilalia.

Akin to the problems of speech are changes in swallowing. The two, however, do not necessarily accompany one another. Swallowing is a complex act even though much of it is performed automatically. In Parkinson's disease, the complex sequential pattern of contraction and relaxation of the throat muscles necessary to propel food to the rear of the throat and into the esophagus may be slowed. The rate of swallowing is reduced. Consequently, eating may be slower and assume a deliberate quality. Foods seem to be held at the front of the mouth. Liquids and solids both are problematic. Attempts to hurry only make matters worse. Slowing of the normal automatic act of swallowing one's saliva results in a pooling of saliva in the mouth and throat. When a large amount is allowed to accumulate, it may spill forward and cause drooling.

Corresponding impairments of *gait* are observed. Most obvious is a reduced stride partially compensated by increased stepping frequency. Comparison of fast and slow walking reveals a loss of the range of walking speeds and types of gait available to the patient. The patients, for example, have difficulty varying the stride and speed of their gait and cannot saunter. Episodes of festination occur, characterized by very short steps which may culminate in a full arrest in which the patient's feet appear to be frozen to the floor. These may occur abruptly without apparent warning but often occur when a patient attempts to pass through a doorway, encounter other obstacles, or tries to make a sharp turn. Festination with freezing of gait typically occurs on changing directions. It may be strikingly episodic in occurrence. Long periods of normal or nearly normal gait can be suddenly interrupted by severe festination or an abrupt arrest due to freezing.

Problems with *eye motility* cause difficulty especially with reading or with other fine work that requires near vision (Messier et al., 2007; Schettino et al., 2006). One reason for difficulty reading is that the eyes do not move properly to scan a line of print. Eye movements are irregular and jerky. Having reached the end of a printed line, the patients has difficulty moving the eyes back to the left and down one line to find the beginning of the next line. There seems to be an analogy between the disturbances in walking and those in eye movement in Parkinson's disease. The eyes festinate, freeze, and travel slowly across the printed page. A nearly ubiquitous problem in patients with Parkinson's disease is the presence of convergence insufficiency. Convergence insufficiency refers to the situation in which the two eyes are unable to focus on a single target. Patients who cannot converge will see double with objects at close range. Prisms are not helpful in the majority of patients with this problem.

With generalization of the disease, the characteristic hypertonicity of the limbs is more noticeable. Hypertonicity from Parkinson's often presents as short, stiff leg movements and overall muscle weakness. It can be felt on passive manipulation and becomes gradually more marked. It is usually most marked in the neck muscles and less in the lower extremities. It usually remains more marked on the side initially affected. The Parkinson hand posture appears on the second side, but always remains more severe on the side first affected. Now the proximal interphalangeal joints become hyper-extended and the distal joints are flexed, such as in S*wan Neck Deformity of the Finger*

Falls and loss of balance represent another sign of disease progression. The development of impaired equilibrium marks an important threshold in the progress of the disease. It begins insidiously, usually as an occasional tendency to retropulsion. Retropulsion refers to episodes in which the patient steps backward involuntarily in certain situations, as when backing away from a closet or a sink. This may be complicated by propulsion, in which the patient leans forward farther and farther and may fall. Walking, like skiing, has been described as "controlled falling forward" and here the control has been lost.

One of the causes of loss of balance and falls is the loss of the "righting reflexes." Patients with PD often present with a loss of "righting reflexes." The patient fails to exhibit the normal reflex response to an imminent fall. This is not merely a

consequence of rigidity, bradykinesia or lack of coordination, but is a more complex motor defect. The base while walking may look normal, but is more often too narrowly based. The patient does not stagger or lurch as with cerebellar disease. A striking feature, not invariably present, is lack of awareness of an abnormal posture leading to a fall. For example, the patient may lean backward dangerously but fail to be aware of that.

Once the disease is fully developed, tremor and rigidity are more pronounced; seborrhea (i.e., skin problem, characterized by a red, itchy rash, and white scales) and diaphoresis (i.e., profuse sweating or perspiring) become prominent in many patients. Bradykinesia has become more marked. Most patients still retain sleep benefit, being improved for a short while upon arising in the morning. Gradually there is increased difficulty turning over in bed, with body movements such as dressing and handling utensils such as a knife and fork. Falls become more frequent due to increasing postural instability.

The most common treatment for symptoms of PD is levodopa. However, approximately 5 years following the initiation of therapy with levodopa, about half of patients begin to experience fluctuations in motor functioning. The smooth benefit from levodopa begins to wane (Block, Liss, Reines, Irr, & Nibbelink, 1997; Hempel, Wagner, Maaty, & Sage, 1998; Koller, Hutton, Tolosa, & Capilldeo, 1999; Sage & Mark, 2000; Syed, Murphy, Zimmerman, Mark, & Sage, 1998). At first they may notice that each dose is wearing off after 4 or 5 h. Symptoms such as tremor and bradykinesia emerge, only to be ameliorated for several more hours with each subsequent dose. Patients and especially family members may notice the onset of dyskinesias as the peak of each dose of levodopa takes effect. With time these motor fluctuations become seemingly erratic and unpredictable. The patient is required to take doses closer together as the benefit from each dose gets shorter.

Eventually after several decades or more, the patient may reach a stage of advanced motor disease confined to bed or chair, profoundly akinetic and rigid with minimal if any tremor. There is little voluntary movement. Joint contractures are common. The patient cannot stand without support. If supported, stepping movements may be elicited but these too soon disappear. Facial hypomimia is now complete with extremely rare eyeblink. Retraction of the upper eyelids exaggerates the staring facial expression. The mouth is constantly open. Rigidity of the chest muscles and reduced thoracic respiratory capacity render the patient susceptible to pulmonary infections.

Cognitive/Psychiatric Problems

In a periodic visit to the Doctor, Alex's wife mentioned the fact that it is very hard to have even a brief conversation with him. She said that he displays a "mask-like" facial expression, and it is sometimes hard for her to understand his feelings or the message he is trying to convey. In addition, she was very stressed about a new symptom that started recently in which Alex started to suspect that his wife and their Laundromat manager are stealing money from him and want to run away together. The doctor decided to check Alex's medication levels and ordered testing to examine Alex's cognitive and mental status.

Up to 50 % of patients with PD suffer mild or moderate depressive symptoms. Research suggests that the disease itself causes chemical changes in the brain that may lead to depression (Menza, Palermo, DiPaola, Sage, & Ricketts, 1999). This is not a reactive depression to chronic disease since it does not occur with nearly the same frequency as in other degenerative neurological diseases and there is no correlation with severity of other symptoms, such as motor and cognitive impairments. A significant percentage of patients provide a history of depressive illness or symptoms well before evidence of Parkinson's disease emerges, suggesting both a long prodromal phase of illness and pathophysiological association of the motor and other abnormalities and depression. For the most part, however, symptoms of depression in PD are no different from other depressed patients. Loss of initiative, sleeplessness, social withdrawal, fatigue, and weight loss are often early symptoms associated with depression. A major difficulty in differential diagnosis is that these symptoms can be present in non-depressed patients with Parkinson's disease as well. It is therefore crucial to ascertain whether or not more specific depressive symptoms such as crying, sadness, anxiety, or pessimism are present. Suicide is rare. Response to typical modern antidepressants such as SSRIs and to tricyclics is reasonably good.

Anxiety often accompanies depression but this need not be the case (Menza, Forman, Sage, & Golbe, 1993). Underlying anxiety can be constant but the most debilitating type occurs as an end of dose phenomenon in the form of a severe panic attack (Hillen & Sage, 1996). The panic occurs just as each dose of antiparkinson medication is wearing off and improves with the onset of action of the next dose. Nighttime can be the most debilitating since most patients do not usually take medication throughout the night.

Cognitive deficits, particularly those involving executive functioning are common even in early Parkinson's disease (Shohamy et al., 2004; Shohamy, Myers, Grossman, Sage, & Gluck, 2005; Shohamy, Myers, Geghman, Sage, & Gluck, 2006; Shohamy, Myers, Hopkins, Sage, & Gluck, 2009). For example, in a recent set of experiments, Shomamy and colleagues (Shohamy et al., 2004, 2005, 2006) asked healthy participants and patients with early and moderate Parkinson's disease to play a series of simple, but novel, computer games. These games were designed so that no possible strategy could successfully win the game. The researchers found that once healthy participants realized that the initial gaming strategy was not working, they quickly and often switched to new strategies. Patients with PD persisted in their initial unsuccessful strategy and were not able to shift and switch to a new strategy.

In about 15–20 % of patients, an initially mild impairment in cognition eventually progresses into dementia (Kosaka, Mark, & Sage, 1996). The first manifestation of clear-cut dementia in a Parkinson's disease patient is often the experience of confusion or hallucinations by dopaminergic or anticholinergic medications. As time passes, patients experience increasing confusion that may be episodic at first and then gradually worsens despite attempts to manage with decreasing daily amounts of anti-Parkinsonian medications. Visual spatial abnormalities are common and there is general loss of cognitive functions, such as memory and concentration. Language skills tend to be retained. Some patients become violent or exhibit verbally abusive behavior and agitation as the disease progresses.

As noted above, hallucinations can be an early sign of dementia but once started, take on a life of their own (Fahn et al., 2004; Jacob, Wagner, & Sage, 2003; Tilley et al., 2006). Visual hallucinations are most common. Patients may think that a speck of dirt on the floor is an insect or that a fire hydrant across the street is an animal. Patients often see children, family members who are long dead or strangers who are attempting to do something harmful. Paranoia often takes on a personal character with patients accusing their spouses of infidelity or of stealing money. The etiology for the dementia is varied. Diffuse cortical involvement with Lewy body degeneration is one likely cause as is co-existent Alzheimer's disease.

Sensory Problems

A variety of sensory symptoms occur in PD. The most common are myalgias. Myalgia refers to muscle ache and pain caused by muscle tension, stress, overuse; in PD myalgia may be ascribed to the changes in muscle tone. Myalgia may be misinterpreted as due to bursitis, carpal tunnel syndrome, angina, or lumbar disc disease. Low back pain heralding the clinical onset of PD is especially common and may lead to inappropriate surgery. As a result, later in the disease, chronic muscle aches and pains associated with the rigidity and posture are common. Headache due to increased tone of the nuchal musculature is also seen. The stooped posture becomes more permanent and causes back pain. The relationship between PD and these myalgic pain syndromes is confirmed when the pain disappears as the patients respond to dopaminergic therapy.

Muscle pain is also a feature of the altered muscle tone encountered in Parkinson's patients. Painful dystonic foot cramps are the most common. Although these are most frequently seen as a manifestation of end of dose, dystonic cramps of the shoulder and neck muscles may also occur, presenting as a painful shoulder or headache.

Bradykinesia, resulting in reduced shoulder mobility, can lead to painful frozen shoulders, requiring manipulation or medication for relief. Spasms of abdominal muscles or the diaphragm may erroneously suggest gastrointestinal or pulmonary disease.

A distressing but not uncommon symptom is burning pain in a limb, sometimes accompanied by sweating and rarely by erythema of the affected part. These thermal paresthesias are usually experienced as heat but can sometimes feel like coldness in the limb.

Additional areas of pain may include genital pain, trigeminal neuralgia-like pain, oral pain, proximal limb pain, and what has been called sensory dyspnea. Sensory dyspnea is a feeling in which patients feel as if they will be unable to take another breath. But spouses and other observers note nothing wrong with breathing, suggesting that this feeling is not caused by rigidity of the respiratory musculature. It may therefore be a sensation of dyspnea rather than actual difficulty breathing. In sum, many rare pain syndromes have been reported in the literature (Sage, 2002, 2004b, 2008; Sage, Kortis, & Sommer, 1990). Most of them occur as an end of dose phenomena in patients with a fluctuating response to levodopa.

Autonomic Dysfunction

Dysfunction of the autonomic nervous system is common in PD. The autonomic nervous system controls the unconscious or automatic functions of heart rate, digestion, breathing rate, perspiration, urination, and sexual arousal. Some of the symptoms related

to Autonomic Dysfunction in Parkinson's are low blood pressure after standing up (leading to lightheadedness or dizziness), constipation, difficulty swallowing, abnormal sweating, urinary leakage, and sexual dysfunction (abnormally decreased or increased interest in sex) (Hillen, Wagner, & Sage, 1996; Sage & Mark, 1995).

The impact of autonomic symptoms on daily life is significant, ranging from embarrassment when in social situations to difficulty maintaining intimate relationships consistent with levels enjoyed in the past. PD patients often greatly limit daily activities to maintain some level of comfort both physically and psychologically.

Sleep Disturbances

All human beings have a normal, if variable, cycle of sleeping and wakefulness during the 24-h day. In patients with Parkinson's disease, this normal sleep–wake cycle is often disturbed, with resulting insomnia (Sage, 2003). Inability to fall asleep can occur but is less common than inability to stay asleep. Patients therefore wake up frequently during the night. There are two major ways to categorize sleep disturbances. Some patients have vivid dreams and nightmares and may thrash about and yell during sleep. This is called rapid eye movement sleep behavior disorder. This sleep disorder can cause a person to act out their dreams, yell, scream, kick, or punch while sleeping. This often disturbs the partner more than the patient, but it may keep the patient awake as well. Kicking or jerking of the limbs may occur under these circumstances. Paranoid hallucinations may keep a patient from going to sleep. A second major mechanism causing reduced sleep is related to bradykinesia. All of us wake a number of times during the night, during which time we change position in bed either by moving from side to side or moving the limbs to a more comfortable position. Parkinson patients may be awake but are unable to move well enough to make these small adjustments in position. The discomfort from being unable to move the limbs or turn over quickly and easily prevents them from going back to sleep rapidly and leads to insomnia.

These nighttime sleep problems negatively impact daily life functioning through multiple mechanisms. Poor nighttime sleep commonly results in daytime sleepiness which prevents maximal functioning during the day across employment, social, and home settings. Depression may result from insufficient sleep, causing its own cascade of negative consequences. Insufficient sleep results in poor cognitive functioning such as reduced attention and memory. This is in addition to the independent effect of the disease on mood and cognition. Thus, sleep disturbances are important symptoms that result in a myriad of daily life challenges for affected individuals.

Employment Issues

The progression and symptoms of PD varies among different individuals. PD is chronic and slowly progressive, meaning that symptoms continue and worsen over a period of years in an unpredictable way. The effect of PD on employment can thus be highly variable. Loss of employment places a significant socioeconomic burden on young PD patients.

Challenges encountered at work have often been related to motor symptoms. For example, patients in executive positions may experience the classic PD tremor as a disability. Although usually not functionally disabling, tremor becomes a disability when the patient needs to deal with clients or customers. There is the justifiable fear that other people, not familiar with Parkinson's disease, may think that the tremor is related to alcoholism. Clients may perceive the tremor as a sign of nervousness or as an indication that the person with the tremor is lying. Tremors, of course, do get worse with anxiety and therefore any patient who needs to give a speech in public as part of his or her job or who needs to perform at a conference is at an immediate disadvantage. Since tremors, early on, are generally unilateral, putting the tremulous hand in one's pocket, could solve the problem initially.

Another example of difficulties at work are related to writing: Computers and writing are the life blood of most "desk jobs." Micrographia gets more pronounced the longer one is writing. That makes taking notes at a meeting very difficult. Even worse, micrographic handwriting may be so bad that it is illegible, even to the patient. The patient therefore may be unable to read his own noted later on. Handwriting, furthermore, slow and get even slower the more a patient tries to write notes quickly, worsening an already bad situation to the point where it may be impossible to write at all. Switching to a computer occasionally helps the situation, but typing on a keyboard may pose other difficulties for PD patients. Patients tend to depress the same key for too long, causing long strings of the same letter to be printed. Patients often hit the wrong key because of difficulties with fine finger coordination. This makes the accurate entry of number, especially, a big problem in programs such as spreadsheets.

Many people work at large corporations in huge building complexes. One of my patients found that his biggest problem was getting from place to place within the office building where he worked. His more involved leg began to drag to the point at which he could not easily make it to conferences at the other end of the building. He became fatigued and even out of breath by the time he arrived at another office for a meeting. This finally became such a problem that he had to retire. A large factory such as an automobile assembly plant would probably present similar difficulties to a Parkinson patient, even early on in the disease.

Factories and workshops present problems in which safety is a major issue. Several of my patients work at jobs in which they repair and maintain motorized or electrical equipment that can be reached only with ladders. Another patient worked in a chemical plant with vats of liquid. These work places present issues for patients who have a postural instability with a tendency to fall or have poor hand coordination and cannot easily operate power tools. Some companies are very helpful. One such firm provided my patient with special ladders with rails. In other companies, coworkers often begin to "cover" for the patient or sometimes trade for the dangerous places on the job site.

Eyesight needs to be good no matter if you work with machinery and tools or if you sit at a desk or computer reading all day. Convergence insufficiency is the most common motor eye defect seen in patients with Parkinson's disease. This makes it very hard to focus on near objects because it causes blurred vision or at worst diploplia. Eye strain from either of these problems produces headaches and fatigue further aggravating the daily difficulties of patients already having troubles coping with the workload.

With the progression of Parkinson's disease, cognitive issues begin to take their toll in the workplace. Patients with executive functioning problems and trouble shifting sets have difficulty multitasking, a necessity in most employment situations. Memory decline presents additional problems in keeping track of work needs and schedules. Following instructional or equipment repair and maintenance manuals becomes a difficult task. Decision making may become next to impossible. I have seen one company CEO whose firm was being run very efficiently by his secretary. Unfortunately, she did not get promoted to CEO upon his early retirement.

Finally, appearance becomes an issue in jobs where it is necessary to meet new people on a regular basis. The facial hypomimia of Parkinson's disease often makes patients look tired or even haggard. This facial expression can be interpreted by other as "looking angry." Difficulties with dressing such as knotting a tie or putting on makeup can make a patient look disheveled, a perception that is worsened by the frequent occurrence of facial seborrhea and dandruff that accompanies Parkinson's disease. Voice hypophonia makes communication an effort for all concerned, particularly if one is in a job position requiring public speaking in large rooms with poor acoustics. All of these problems are compounded for a patient who needs to look fit at a job interview.

With a progressive degenerative disease like PD, we have naturally focused on the negative impacts on work. I want to end this section, however, with two stories in which the onset of Parkinson's disease had a positive impact on some aspects of a patient's life.

> *One of our patients had a long career as a realistic painter when he developed PD. With the onset of tremor and bradykinesia, he was unable to execute the fine lines and small brush strokes necessary in realistic painting. He, therefore, switched his style to a more impressionistic approach. This new style met with outstanding critical acclaim. He was able to continue painting for the rest of his life and his works towards the end of his career were widely sought after by collectors and museums. Parkinson's disease had made him a better artist.*

The second story I want to note is the career of Michael J. Fox. I do not know Mr. Fox, personally, but I am a great admirer of his approach to adversity. When his PD advanced to the point at which Mr. Fox could not longer star in movies or on television, he changed careers and became a successful philanthropist and advocate for Parkinson's disease patients. I predict that the activities of his second career will do more good and bring people more happiness that did his first career as an actor.

Social Functioning/Participation in Society

Maintaining participation is a constant act of negotiation for adults with disabilities (Hammel et al., 2008). Participation is subject to change throughout the lifespan at the individual level. Having a chronic disease such as PD may influence activities and participation at an earlier phase of life.

Depression is the most frequent complication of Parkinson's disease that directly affects participation in social interactions. Many patients are simply not motivated to go out with friends, leave their home, talk on the telephone or even interact with close family members. Spouses often complain that a patient may sit around for hours or an entire day without speaking. Even when a patient is induced to meet with a group of friends, he often sits at the table without participating in the conversation, sometimes even falling asleep. This sort of behavior can be interpreted as rude or at best, a lack of interest in others. Friends and even family begin to avoid contact with such patients and the original problem is compounded. Patients become isolated from most of the interesting activity around them.

Anxiety and even panic attacks often, but not always, accompany depression. Patients often suffer from a chronic state of low-level anxiety that inhibits social interactions. They may be anxious about freezing in crowded spaces, their appearance, a lack of social graces such as being able to eat soup or drink with spilling or they may simply be anxious for no apparent reason. The most debilitating form of anxiety occurs as a panic attack just as a dose of antiparkinson medication is wearing off. This uncontrollable panic does not go away until the next dose kicks in and makes functioning at all during these periods virtually impossible. Panic attacks can be accompanied by a feeling of severe bradykinesia, necessitating the passive movement of a patient's limbs. This makes going out in public a particular ordeal.

Proper social functioning is disrupted by obsessive behavior in Parkinson patients. The disease can cause obsessions to the point of severe pathology, all of which can be worsened by the medications used to treat PD. Excessive gambling is the most frequently cited obsession. However, any obsession is possible. We have seen socially destructive obsessions that include eating too much, pornography, sex and prostitution, unnecessary buying, and others.

Paranoid ideations can strain family relationships. The most common paranoid ideas concern sexual infidelity or matters involving money (Ramírez-Ruiz, Junqué, Martí, Valldeoriola, & Tolosa, 2006).

> *One patient told me that her husband was having an affair with a young woman in the attic. In practically the same breath, she said, "but why would a pretty young girl want to have sex with an old geezer like him?"*

Accusing a spouse or other family member of stealing money causes friction that is difficult to control. Reasoning with patients who have these paranoid thoughts usually does not help for very long. Antipsychotic medications are often necessary to make family life bearable.

Embarrassment about the consequences of motor dysfunction causes patients to avoid social interactions and participation in public functions. Abnormal involuntary dyskinesias associated with levodopa intake for disease control or significant postural tremor causes problems with fine coordinated movements. The inevitable spills that occur with consequent dirtying of clothes can be distressing to otherwise neat and clean patients. Increased saliva with drooling is another motor issue with similar results. Furthermore, all the problems of advanced Parkinson's disease can

occur intermittently and without warning. Non-motor problems can be just as uncomfortable. Urinary frequency and urgency makes it hard for patients to go anywhere not in close proximity to a bathroom. This includes long car rides and even public transportation. Occasional incontinence just worsens the fear of social embarrassment. The unpredictable nature of these problems make it hard for patients to plan activities in advance and further inhibits the desire even to try to do things with other people.

Independence and Activities of Daily Living

One of the most ubiquitous detriments to the independence of Parkinson patients has to do with the way in which most of us live. In the United States, since World War II, most of the population does not live in organic neighborhoods. Many of our cities, towns, and suburbs are artificially segregated along zoning lines. It is a rarity for someone to live with the grocery store at the corner, the doctor in the next street and the pub across the block. Towns are divided into residential, commercial, and office districts. In many instances, these separate areas are far from each other. The situation may be getting worse rather than better. In central New Jersey, where I work and live, state regulators are allowing one hospital in the city of Trenton and another hospital in the town of Princeton to move to locations on major highways accessible only by car. When these moves are complete, these hospitals will undoubtedly strive to deserve the same respect from Parkinson's patients as does the cuisine at the fast food joints across the median divider. Furthermore, in most of our cities and suburbs, public transportation is rudimentary or non-existent. To top it all off, gated communities for the elderly, where many Parkinson patients live, are often placed in former farm fields in the middle of nowhere. The so-called retirement communities in my neck of the woods are 15 miles from the nearest emergency room and 5 miles from the supermarket or movie theater. All this makes driving a necessity, a task that becomes increasingly difficult with the advance of Parkinson's disease.

Parkinson's patients are subject to more automobile accidents than the general population (Pfeiffer, Wszolek, & Ebadi, 2012). The reasons for these automotive mishaps are varied. Generalized bradykinesia and slowed reflexes certainly play a part in a slow response in emergency situations on the road. Patients have trouble turning their heads fully and quickly to detect other vehicles coming from the side or in the next lane. Blurred or double vision can have a role, especially at night. By far, the most common warning that a patient is beginning to have trouble with driving occurs when spouses or other notice that the patient is drifting out of his own lane. Many times the patient drifts into oncoming traffic or has some minor fender-benders in which he sideswipes a parked car on the right. This tendency to go too far either to the right or to the left is mostly related to the asymmetry of Parkinson rigidity, bradykinesia, and motor function in many patients. The unaffected side tends to exert an unequal pull on the steering wheel and the car inadvertently goes off to one side, causing an accident. Visual-spatial abnormalities also lead to poor

judgment about oncoming traffic and parked cars. Usually, one or two accidents, however minor, results in loss of driving privileges and with it, independence. Not being able to drive brings the person to another level of dependency. The patient may become prisoners in their own suburban enclaves.

Once a patient cannot drive on his own, he often cannot even get around his own neighborhood, let alone go to the opera. This is because of another "architectural" feature of post war street design. Streets built within the past 60 years are built for the convenience of automobiles and not pedestrians. Most suburban streets are wide, many without sidewalks, with the street trees far from the street itself so as not to impair the view of drivers, and with houses set back a significant distance from the roadway. This results in the ability of cars to go fast but inhibits the ability of people who are slow to cross the street safely. It also makes even a residential street kind of a suburban highway. Patients do not get a safe feeling on a wide street not enclosed by street trees such as the stately elms of early twentieth century towns. Setbacks create a situation in which patients cannot easily be seen by other people from the front windows of their houses and the pedestrian cannot easily call for help should he or she get into trouble. All this makes walking unpleasant and unsafe especially for someone with a motor disability. Hence they become house bound well before it is necessary.

Another area of difficulty resulting from the inability to initiate movement together with bradykinesia relates to independent basic daily activities, such as dressing, eating, or showering. For example, Motor acts such as putting on the sleeves of a coat, repetitive movements required for brushing teeth, cutting a piece of meat, combing one's hair, or shaving become problematic and often require help. Especially difficult is getting out of a deep chair or couch. Patients may need help with toileting, writing letters to friends, or paying bills and writing checks. Dysphagia with the threat of aspiration necessitates eating slowly and taking small bites, all of which makes meals a time of even greater dependency than otherwise would be necessary especially if some one else needs to cut the food into small pieces. Getting up from the toilet without help often requires the use of bars in bathrooms. Slipping with falls in the shower necessitates the use of shower stools or the aide of another person for bathing. Patients need to have hard kitchen-type chairs with arms strategically placed around the house.

Progression of Parkinson's disease produces gait problems that include freezing, start hesitation, and postural instability. Freezing is the phenomenon in which a patient is walking along reasonably well, when his feet suddenly and without warning become glued or frozen to the floor. This tends to occur more often with turns, when walking through doorways or in crowds, but it can occur at any time in any place. The abrupt freeze can cause a fall. Start hesitation occurs when the patient is standing or sitting. As he gets up or tries to start walking, his feet are again glued to the floor. Trying to get going again may cause a fall. "Tricks" to help freezing and start hesitation sometimes help but require the assistance of another person or of mechanical aides. Visual cues such as having another person put an obstacle, such as his foot, in front of the patient's foot and having the patient step over the obstacle sometimes initiates walking. Another way to help a person start walking is by

shining a laser light in front of the patient's feet. These lasers usually are attached to walkers or canes. However, using a cane or a walker could inhibit mobility in other areas such as arm function and the ability to carry packages. Postural reflex impairment causes falls because patients are unable to right themselves and maintain their balance from small shifts in bodily position. Finally, orthostatic hypotension worsened by antiparkinson medications may cause fainting with subsequent falling. All of these problems necessitate the use of canes or walkers and finally result in needing the assistance of another person to prevent injurious falls when walking.

The most difficult and unremitting problem for independence is of course the onset of dementia. Patients begin with memory loss that makes incessant note making necessary. Keeping the checkbook balanced and paying bills must be delegated to a family member. With increasing cognitive dysfunction, buying food or doing daily house chores becomes impossible. Patients may get lost in their own neighborhoods and be unable to find their way home. As dementia worsens, sleep patterns are altered. The patient may be awake at night keeping the spouse from getting a good night of sleep. All of these issues alone or in combination finally can lead to nursing home placement and thereby complete loss of independence.

Quality of Life

Caregiver strain is one the biggest factors that affect quality of life. It is almost impossible to be on call and working 24 h a day, seven days a week, without rest of vacation. Yet, this is what many spouses must do when Parkinson patients begin to lose independent function. One source of such strain is lack of sleep. Patients tend to awaken many times during the night for a variety of reason; urinary frequency and urgency and inability to move and turn over in bed with subsequent discomfort keeps patients from sleeping. Such patients may need to be moved passively by the caregiver many times during the night. Night sweats associated with autonomic dysfunction can be a problem. These sweating episodes can be so severe that they require a change of night clothes and bed linens. Nightmares or hallucinations can awaken patients. Some patients have pain that tends to be worse or at least more noticeable at night. Many patients have excessive daytime sleepiness, either from disturbances of the sleep–wake rhythm or from medications, both of which may cause night-time insomnia. No matter what the cause and it only takes one, the caregiver gets an inadequate amount of sleep. Chronic loss of sleep creates physical and psychological exhaustion. Caregivers are then subject to more of their own medical problems and may be unable to go on. It is important, therefore, for physicians to try to insure that patients are not keeping their spouses up at night more than is absolutely necessary. Furthermore, caregivers need to get time off during the day, with other family members kicking in to help when possible, or by getting paid help to the extent that it is economically feasible.

Economic factors also affects quality of life. The impact of a reduced or nonexistent paycheck is obvious. Parkinson's disease patients need lots of costly medication. The use of generics moderates the price but when a patient is on four or five

different medications, the numbers begin to add up. Obsessions, as an adverse event of medications, can take a dreadful toll on family finances. We have seen patients run up large debts from excessive buying or gambling. Home health aids and nursing home care can quickly deplete family budgets and life savings.

In men, sexual dysfunction is a frequent complaint. Autonomic insufficiency makes erectile dysfunction common. At the same time, dopaminergic drugs can increase sexual desire. The combination of these two factors produces problems for both partners. Women find that their husbands have more desire but are unable to perform adequately, a situation that produces frustration for both of them. The usual medications aimed to help men maintain erections are expensive, causing a further strain on what may be an already tight budget. Sexual problems in women with Parkinson's disease are somewhat different from men. Women have the usual age-related issues with vaginal lubrication. The main direct result of PD on sexual function relates to the fluctuating response to levodopa. Women find that they cannot achieve the same pleasurable results if they are having intercourse during an off period, probably due to decreased mobility and increased rigidity. Counseling may be beneficial. Adjustment of the medication timing or the timing of sexual activity is helpful but may interfere with other important activities.

There are a number of factors, some great and some small, that affect a patient's desire and ability to go out or even to interact with friends in the home. Depression is probably the most common of these factors. Patients become unmotivated to do anything but sit in the chair at home. More distressing are the reactions of friends. Some people are uncomfortable with illness and disability and therefore become reluctant to continue to socialize with Parkinson patients. They may be embarrassed by drooling in restaurants, sloppy eating habits due to poor motor coordination, choking or coughing, or they simply may be unable to cope with a patient who is falling asleep at the table because of excessive daytime sleepiness. Many people interpret sleeping during dinner or conversation as being rude rather than being sick. The end result is that patients feel that they are being abandoned by their friends and even by their family. Other smaller indignities also take their toll. Constipation is a constant preoccupation for Parkinson patients, as is the fear of falling from either poor postural stability of orthostatic hypotension. For those patients with pain such as thermal paresthesias, the diminution of life's quality moments is clear. Having to wake one's spouse just to turn over or to go to the bathroom at night is troublesome and disruptive for the caregiver and the patient. Poor sleep at night increases daytime sleepiness. Finally, it goes without saying that nursing home placement, even when absolutely necessary, is not a pleasant thought.

Some Parkinson patients are able to make the most of an illness that is life changing and wring some good out of every moment. One of our patients had been an out of shape "couch potato" all of his life. When he developed Parkinson's disease, his doctor convinced him that exercise was beneficial and informed him that in rodent models of parkinsonism, exercise slowed the progression of the disease. This patient took all this to heart, lost many pounds, got himself into great shape and became a marathon runner. To date, he has completed both the New York City and Boston marathons. The story of Michael J. Fox needs no retelling.

Cultural Considerations

Two studies have addressed the influence of ethnicity on the long-term outcome of family care giving (Carter, Stewart, & Archbold, 2008). African American, Hispanic, and Asian patients were compared to the white majority. African American and Hispanic minorities provided more hours of care despite having fewer financial resources than did white caregivers. These two groups also had more informal support and more cognitive and emotion focused coping than whites. African Americans had better psychological health than any of the other groups, reporting less caregiver strain and less depression than did white caregivers. Hispanics and Asian Americans reported more depression than did white caregivers. At any rate, the minorities had poorer physical health despite better psychological health. It is hard to say what factors drive these statistics. Cultural beliefs of family responsibility, faith in a personal God, or the greater use of informal support systems such as extended family or church groups all may play a role in buffering the emotional impact of care giving.

Many Parkinson patients are reluctant to tell others that they have the disease. It is as if being sick is socially unacceptable. One clear-cut issue is the fear of being fired. This is despite the fact that most employers and fellow employees turn out to be understanding and helpful once they become aware of the situation. Whatever may be the case, many patients consider unemployment to be a stigma since many people in American society identify themselves mostly by the type of work they do. One of the first topics of conversation at any cocktail party is, "What do you do?", meaning what job do you have? Furthermore, our culture stresses individual self-reliance and losing a one's job therefore means that one will become an economic burden on others. An even more pernicious cultural attitude is that getting Parkinson's disease is somehow the patient's fault, meaning that the patient did something wrong. It sometimes is put into terms of moral deficiency, "What did I do that this happened to me?"

Many Parkinson patients, like many others of the elderly, perceive that they are better off in gated retirement communities. Advertisements for these housing projects stress how much fun life is after the age of 55 and our culture seems to be making this living arrangement the norm. In fact however these places produce lots of stresses that often go unnoticed by the young. We have already noted the distances many of these places are from essential services. That is easy to measure. Harder to measure is the stress of listening to ambulances arriving daily to take a neighbor to the hospital. Think also of the impoverishment of one's life without the sight and sound of children and without the stimulation of conversation that includes opinions and issues affecting all age groups. These communities often narrow the outlooks of their inhabitants to the point that they care only about themselves, a form of selfishness that extends to all of us, especially when it comes to voting for school budgets or government social and medical programs for the poor and disadvantaged.

Despite a relentlessly progressive disease, however, most patients continue to live in their own homes and continue to be generous and unselfish in their daily lives. In fact it is remarkable that so many Parkinson patients are so altruistic.

For example, many of our patients have enrolled in many research studies over the years, even when they were told explicitly that the study results would be of no personal benefit to them. Many are simply willing to help find a cure for future patients and give their time and effort willingly and without recompense. I have never heard a Parkinson patient say, "I don't want to be a guinea pig," as a reason for refusal to join a study. These positive cultural attitudes hopefully will help find a cure for Parkinson's disease.

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Stroke: Impact on Life and Daily Function

5

Cristin McKenna, Peii Chen, and A.M. Barrett

Background/Nature of Illness

Although there are many resources to help us understand stroke, the experience of having a stroke involves changes to many activities in social, leisure, and work life, and the way we interact with the world. The purpose of this chapter is to describe what happens to people who have experienced a stroke, and are living with a change in daily life circumstances. This serious medical event is the fifth leading cause of death in the United States, and an American dies of stroke every 4 min (Centers for Disease Control and Prevention, 2015). However, many more people in the US survive their stroke, but live with a persistent **mind-body problem** which affects movement, sensation, thinking, and emotional aspects of their lives, and limits their activity and participation at work, at play, in the family, and as members of society. A stroke is a health "wake up call": 25 % of people who have one stroke will have another stroke within the following 5 years (National Institute of Neurological

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Disorders and Stroke, 2015). However, even if stroke survivors remain healthy, their lives after stroke may be radically changed. We will approach the daily life impact of stroke by outlining the fundamental impact of stroke on our brains, bodies, and the **mind-body problems** caused by this condition.

Stroke's most characteristic effect is to disrupt the connection between what we intend to do and what we can do, separating the mind and the body. In healthy people, intentions and actions are perfectly coordinated, and performing the tasks we need in daily life seems effortless. However, with a stroke, the brain sustains damage as a result of interruption of the flow of oxygen and other nutrients to the brain. This interruption is caused by a disruption of blood flow, since it is blood that carries oxygen and nutrients to the brain tissue, and also carries away waste products. When brain cells die or are damaged as a result of this interruption in blood flow, the result is a stroke. The concept of blood flow is crucial to understanding what happens to the brain during a stroke event. An interruption of orderly blood flow can either be caused by blood bursting through the wall of a vessel (a hemorrhage), or blood vessel blockage, by a clot or piece of fatty tissue (ischemic stroke). The treatment for stroke can be viewed in three phases: health strategies to prevent stroke, emergency/immediate medical attention after stroke, and activities to improve the ability to function in daily tasks, work, and social roles after stroke, which continue indefinitely.

The concept of stroke as a mind-body disorder captures the essential nature of the interruption between the person's mind, which wants to act and interact with the world, and the body, which is suddenly limited. Communication signals between the mind and body are distorted and abnormal, and the mind's signals may get lost or go unanswered. Stroke survivors then may say that their memory, speech, or arm "is no longer doing what it is supposed to do."

There is an intricate and close relationship between the body's cardiovascular health (the integrity and well-being of the heart and blood vessels) and the health of the brain. Thus, there is overlap between positive actions we can do to prevent stroke, and those that help us to prevent heart attack and cancer. Making lifestyle changes to lower stroke risk can thus also lead to better general health. Excellent information can be found through the website of the American Stroke Association (www.stroke-association.org) and the American Heart Association (www.americanheart.org). Unfortunately, only about a third of stroke survivors make changes in their level of activity (exercising for health) or diet ("heart and brain healthy"; Teo et al., 2013). This study also indicated that although personal factors can limit the ability to make lifestyle changes (willingness to change, concern about risk), external factors like the financial resources available to the person, or even to public health in that country, can also limit access to exercise resources and food options. It is beyond the scope of this chapter to discuss in detail the medical health strategies to prevent a stroke, but it is worth mentioning the factors which can make it much more likely that one person has a stroke than another person. Some of these are beyond a person's control, such as being older than 55, or having a close blood relation who has had a stroke. However, we have the power to modify some aspects of our health and lifestyle that increase risk (risk factors). These include smoking (quitting lowers stroke risk), high

blood pressure and high cholesterol (taking medication and making other changes to lower these, reduces stroke risk), certain abnormal heart rhythms, diabetes, and artery disease (treatment lowers stroke risk), obesity (losing weight lowers stroke risk), and excessive use of alcohol and some street drugs such as cocaine (reducing use lowers stroke risk). Once a person has had a stroke, he or she also has a higher risk of having a second stroke. If a person has had the kind of stroke that results from a blockage of blood flow, it is particularly important for that person to be on a medication which helps to optimize blood flow or even thin the blood, to reduce the risk of another stroke. There are several appropriate choices of medication to achieve this goal (Furie et al., 2011).

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It is important to understand that health strategies have a direct impact on daily life, which may feel quite negative. Making lifestyle changes can be difficult for both stroke survivors and their families with respect to their available time and financial resources. One stroke survivor's husband told us that "Since the stroke, we have no evenings free for recreation—I take her straight to therapy or to her exercise classes after work, we eat a late dinner, and then we are so tired that we go straight to bed." Unfortunately, formal research on how the process of making lifestyle changes affects emotional stress, daily life and function is limited. Future studies are needed to specifically identify easier ways of incorporating lifestyle changes into the flow of daily life activities, reducing burden on the person with stroke and on caregivers.

The Experience: Mind-Body Problems

This section will consider and describe the symptoms, or specific impairments of body structure and function experienced as part of a stroke: the mind-body problems which people who have had a stroke deal with at the time of the event, and during recovery. These include mind-body movement problems such as paralysis, difficulty walking, stiffness which increases with movement (spasticity), phantom movement (the body perceives movement in a limb that is not actually moving), disruption in executing skilled purposeful movement (apraxia) and difficulty in accurately aiming one's movement in certain directions or into certain parts of space. We use the term "mind-body movement" problems because the mind sends a command to the body to move, but the body's response is altered. The body part no longer does what it is supposed to do. This is because the signals, electrical energy generated in the brain, which normally coordinate body movements with mental commands, are distorted and altered.

Mind-body problems can also affect the senses, and result in pain, and disruptions of one's sense of body position. For example, it can feel as if a part of the body is positioned in one way (as if one's legs are crossed), when, in reality, that

body part is positioned differently (legs are actually uncrossed). As strange as it sounds, one's feeling of familiarity with one's own body can actually change—it can feel like the stroke-affected arm, hand, foot or leg "belongs to someone else." Mind-body problems can also distort the way we put together complex information our senses relate about the environment around us, so that the world appears two-dimensional instead of three-dimensional, and the position of objects is altered. As odd as this may sound, our experience of the external environment may change—for example, people or events happening on the left side may seem unimportant, or may "disappear." Pain can also result from a mind-body mismatch, and after stroke, pain problems are associated with limitations on daily life activity and participation (Miller et al., 2013).

How do these kinds of mind-body problems affect daily life? Unfortunately, there is not much research directly examining how distorted body feelings affect daily activities. It is likely that they create unwanted emotional distance between the stroke survivor and family or professional caregivers, however. When the stroke survivor describes sensations that are not consistent with reality (commenting, "a cat is sitting on my arm!" when nothing is there), family caregivers can feel alienated from the stroke survivor, isolated and helpless. Other mind-body emotional problems after stroke also present challenges. These include depression, as well as abnormal awareness. Before the stroke, the stroke survivor, like all of us, has an alarm system that keeps a running record of how well he or she is performing at the challenges of everyday life. This alarm system lets us know when we make mistakes. After a stroke, however, the alarm system in the brain can stop functioning properly, because the alarm is itself supported by the proper function of brain cells. When this happens, the survivor may think he or she is able to do things that are actually dangerous or impossible. When a stroke survivor who has not been out of bed in weeks says "I'm able to walk," it may seem like s/he does not *want* to face the truth about the stroke. However, studies have shown that this unawareness is not a choice or an act of denial—survivors are telling the truth, and simply are not aware of the limitations because their brain alarm system is not functioning: it is not signaling them that anything is wrong. In the same way, mind-body problems after stroke can cause indifference to one's situation, and a disruption of socially appropriate interactions. This happens because the brain damage that occurred during a stroke can actually affect the parts of the brain that support emotional and social function.

The alarm-system problem with awareness that a person experiences after stroke is different from psychological denial, because we can see that different problems after stroke are affected differently by unawareness. Psychological denial would be expected to affect all of the disabilities a stroke survivor feels affect his or her self-esteem and competence, but in a recent study, we demonstrated (Barrett, Galletta, Zhang, Masmela, & Adler, 2014) that stroke survivors who were unaware of their very significant difficulties managing medications, and who underestimated the amount of help they needed in this area, nonetheless were able to report their mistakes when they attempted to name pictures, and were able to report weakness caused by the stroke, very accurately. This is consistent with a brain-related alarm system problem, because alarm systems

for a particular function are often maintained in brain areas closely connected to that function. Thus, a stroke survivor can have inaccurate awareness of some stroke-related problems, while being fully aware of others. In one study of people who had had a right brain stroke (affecting the left side of the body), the ability of a stroke survivor to identify his or her own errors was the most important factor predicting how well the survivor could do daily life tasks such as self-care (activities of daily living; Vossel, Weiss, Eschenbeck, & Fink, 2013).

In the following sections, we discuss the relationship between brain dysfunction resulting from stroke and its effect on (Sect. 5.2.1) movement, (Sect. 5.2.2) sensation, and (Sect. 5.2.3) emotion.

Mind-Body Problems in Movement and Mobility

Paralysis

It is commonly known that a stroke can affect the mind-body relationship governing arm and leg movements, causing paralysis. Stroke survivors may be partly or completely unable to move one arm, one leg, or both the arm and the leg, and the face may also be partly paralyzed. As stroke survivors endeavor to resume life as they once knew it, they find that the way their body carries out their mental commands has changed. Paralysis, loss of muscle and movement function in one part of the body, is a common stroke outcome. In a person who has had a stroke and who has paralysis after the stroke, the most common area of paralysis is on the side of the body opposite the stroke damage in the brain. The person's face, arm, or leg may be weak in isolation, or all of these areas may be affected together. The anatomic reason that the stroke affects the opposite side of the body is related to the way in which our body is controlled by the brain. When a person wants to move a part of the body, that desire is translated from the brain, through wiring in other areas such as the brain stem, spinal cord, peripheral nerves, and finally into the muscles, which execute the mind's commands via motion. Movement signals can be interrupted at any one of the points of transmission mentioned above, but after a stroke, the most common level of interruption is at the brain level. As a result, the mental command to move is not transmitted correctly, and the desired movements cannot be produced. The ability to use a paralyzed hand and arm, and to improve function in a paralyzed leg to stand, and to walk, is frequently a high priority to stroke survivors and their families. Recovery of paralysis can be viewed by some as the main benchmark for recovery. Rehabilitation specialists emphasize that what is critically important is the return of function (for example, driving), even if adaptations for limited movement are needed (for example, left-foot controls).

Two Methods of Rehabilitation

There are two main ways to approach the return of body movement. Both are legitimate and valuable approaches. The first approach involves an attempt to restore movement to the paralyzed part of the body by reinstating movement. This usually entails intensive practice of activities designed to maximize mobility of the paralyzed

limb. Think of a musician, practicing scales over and over: basic movements or tasks are practiced intensively, in order to build the ability to move effortlessly. A very different, but no less valid strategy is compensation. In this approach, the person focuses less on restoring the movement of a paralyzed limb, and more on learning strategies or using adaptations to "work around" the weakness, for example, by using assistive devices, or by using the unaffected, "good" limbs to do what the weak body part previously was able to do. These two approaches can be used together to produce maximum recovery of function. Stroke survivors and their families may not agree on when it is the right time to abandon efforts to restore or return function. This may become a source of conflict if one party is ready to accept limitation of movement and embark on using assistive devices, or the unaffected, "good" hand to compensate, and the other party feels that this is "giving up."

Continued work toward the return of movement is not an index of internal fortitude or a measure of character. Although the integration of personal strength and determination into illness recovery is invaluable, it is a medical fact that a profound interruption in the mind-body connection, such as the one that occurs after stroke, cannot be conquered by sheer force of will (Gillen, 2015). There is a better prospect of recovery of movement when some movement is already present: a small amount of movement can be strengthened and built through guided practice. Recovery of movement after stroke in both the arms and legs begins in the large muscle groups, closest to the center of the body. Therefore, ability to shrug the shoulders and move the arm at the shoulder joint typically occurs before recovery of hand movement. Return of hand or foot movement, when it does occur, typically follows the return of movement in the shoulder or knee.

Hand movement is a particularly prized milestone of recovery, as it is so integral to daily activities. When hand movement is a problem, it may even become more prized: Jack London describes the way problems with hand movement feel in "To Build a Fire" when the main character realizes his hands are not cooperating with the commands sent by his mind (in this case due to extreme cold, not stroke). "He discovered an appreciation of his own body which he had never felt before…It fascinated him, and he grew suddenly fond of this subtle flesh of his that worked so beautifully and smoothly and delicately (London, 2007)." Hand paralysis can create huge amounts of frustration, and it limits functional abilities: intensive therapies to improve movement in the hand and arm, in turn, are associated with reports of improved participation in spiritual and religious activities, crafts, reading, work, and activities with family and friends (social participation; Wolf et al., 2008). Problems with eating, dressing, and other self-care activities encountered by a person with a paralyzed hand are not usually caused by weakness in isolation. For example, daily life problems may result from frustration experienced by the stroke survivor, who can experience very negative feelings about the body that, in turn, adversely affect self-esteem (body image; Keppel & Crowe, 2000). It is good to discuss this, very normal, frustration with therapists and others: the more this normal becomes shared among the survivor, family and rehabilitation team, the less isolated any one person will be with these feelings.

Gait (Walking)

Difficulties in walking are common as a result of the mind-body disruption after stroke. "Gait"—the effortless pattern of movements of the arms, and especially the legs, in walking—can be significantly affected by stroke. Both arm and leg movement can be altered. Observation of most people with gait dysfunction after stroke reveals some common gait patterns. A person who walks after stroke may have difficulty in producing the desired movements that make walking effortless, and may also have difficulty in balance. The specific type of difficulty a person has in walking is determined largely by which area of the brain was affected by the stroke. The most common type of walking disturbance after stroke results in a pattern of walking movements in which the person's arm bends (flexes) more than usual at the shoulder, elbow, wrist, and fingers. At the same time, the person's leg extends more than usual during walking, so that the knee stays abnormally straight and the toe points down while walking. Clenching of the fist, bending at wrist and elbow, stiffening of the knee, and pointing down of the toe are exacerbated by walking quickly. This is a direct result of yet another mind-body disruption, namely *spasticity* (see below).

Balance problems and leg coordination are both definitely an obstacle to social participation in the community (Desrosiers et al., 2006; Hamzat & Kobiri, 2008), but stroke survivors may also feel embarrassed by the need for an assistive device such as a cane, brace, or walker. These devices can seem to be an impediment to normalcy or a marker of disability to stroke survivors, and this may inhibit their participation in formerly enjoyed activities. The experience of stigma that a stroke survivor experiences based on using a mobility device may differ depending on his or her cultural background: we discuss this in more detail at the end of the chapter.

Spasticity

As noted above, walking recovery may involve both physical therapy and also the use of assistive devices such as braces, walkers, and canes. From the perspective of the treatment team of physicians and therapists, these devices are akin to eyeglasses, in that they are external devices, and they allow a person to function in a way that would not otherwise be possible. It can be useful to make a comparison to eyeglasses in discussion, because eyeglasses are an artificial, obviously external device, usually viewed as allowing function in a non-intrusive manner. Further, most people think of eyeglasses as typical, and not particularly stigmatizing. The use of walkers, canes, and braces may be temporary for some stroke survivors, and may be permanent for others. Canes, walkers, and braces do not impair recovery and are important fall-prevention tools. Although they are frequently misperceived as "slowing down" recovery, they can prevent injury that would create a very serious setback. It is not true that a leg brace "slows down" return of foot movement.

Spasticity is a velocity-dependent change in tone (Malhotra, Pandyan, Day, Jones, & Hermens, 2009; O'Dell, Lin, & Harrison, 2009). This means that the faster a joint is moved, the more resistance is encountered: the stiffer it becomes. Spasticity contributes to the mind-body disruption after stroke by impeding the movement commands that are sent from the brain to the muscles. It increases with increasing speed of movement, and frequently creates increasing problems with walking as a person

recovers and walking speed increases. Spasticity can sometimes be briefly reduced by stretching the muscle, and sometimes can be treated by medications. Injection therapy can improve spasticity, but these injections need to be repeated regularly while the spasticity persists. Since spasticity is often persistent, injections may need to be scheduled every few months. It is very important that the stroke survivor undergo proper treatment of spasticity, as management can help prevent activity restriction. If a muscle is constantly contracted, the actual muscle length shortens and the limb can no longer be stretched back to a normal position, limiting walking, hand movement, bladder function, and can result in both decreased movement and pain for stroke survivors (Satkunam, 2003).

It is unfortunate that very little information is available about the emotional or personal experience of living with spasticity, and how it affects daily life. Our informal observations suggest that stroke survivors with spasticity can feel profoundly isolated, and ashamed. They may ask healthcare providers, "Have you ever seen a hand like this?" with evident self-disgust, or ask what they have done incorrectly, to cause this problem to develop. This suggests that they feel personally responsible for the symptom, which is not justified; there is no evidence suggesting that people who experience spasticity after stroke have not done the right things for themselves, or are in any way marginal compared to other stroke survivors.

Skilled, Learned, Purposeful Movement (Praxis)

Daily life is always affected when stroke causes a mind-body disturbance in executing learned, skilled, purposeful movement. People with this problem, known as ***limb apraxia*** (Barrett & Foundas, 2004), may have paralysis, but they may also have good strength and endurance. They have a specific problem with completing skilled movements that coordinate several joints and different motions over time, like those we make when we effortlessly scoop ice cream into a bowl. Limb apraxia is different from paralysis in the same way that the strength and speed of a movement is different from skill using a tool—no amount of strength or speed will make a person who has never used a paintbrush, able to create a beautiful portrait, as a trained artist can create. Losing our ability to use everyday tools, like a comb, a fork, or a baseball bat, creates challenges in daily life and in the activities we enjoy. There are subtypes of limb apraxia: slowed or clumsy movements can occur that disrupt the delicacy and accuracy of movements. There may also be difficulty in sequencing movement steps during tasks if a person has ***ideational apraxia***. For example, to brush one's teeth, one must complete several seemingly simple actions in the correct order. One must open the toothpaste, pick up the toothbrush, put toothpaste on the toothbrush, open one's mouth, and then proceed to brush each major surface of the teeth in turn, while refraining from biting down on the brush, retaining the toothpaste and saliva in the mouth, and without swallowing the toothpaste. A stroke survivor might lose this sequence, or unwanted steps could intrude: the stroke survivor might put the toothbrush in the mouth dry, bite down on it, and then let go of the toothbrush handle, retaining the brush in the mouth. Because learning skilled movements is associated with childhood, others sometimes assume the difficulties indicate a general problem with intelligence, or lost ability to make intellectual decisions. However, even a survivor with excellent

thinking and memory abilities can make this kind of error if he or she has ideational apraxia. Limb apraxia is not caused by a childish emotional state, loss of impulse control or personality changes: it is the brain's inability to plan the movement that is responsible than underlying weakness, or desire to do well. When people have this problem, scientists identify disturbed function and flow of movement information in the left brain (Mohr et al., 2011).

Because skilled learned movements are so important to daily life, limb apraxia is strongly and consistently associated with disability. After stroke, the presence of limb apraxia is associated with increased caregiver burden, poorer performance of activities of daily living, increased dependency in the home setting, and problems returning to work (Barrett & Foundas, 2004). Using tools, and making skilled sequences of movements, is central to our ability to function adaptively and competently in both new and familiar environments. Limb apraxia thus presents a major obstacle to function and freedom. Of even more concern, most people with limb apraxia are unaware that they are making errors, and cannot request help and support. We will further discuss problems with unawareness, and their impact on daily life, in the sections on Mind-Body Emotional Problems, below.

Mind-Body Problems Related to Moving in Our Three-Dimensional World

Our Bodies and Space

One of the most amazing aspects of our mind-body connection is the system that automatically manages information about where our body is, and where everything in the environment around us is located, so that all of our movements are adaptive and correctly directed. We can continuously and effortlessly adjust the way we move, as we navigate a crowded, moving train to find a seat; as we exit a huge theater with a crowd while looking for a loved one we are supposed to meet; as we play sports, drive, as we play with a fast-moving toddler, protecting her from falling as she climbs the monkey bars; as we hit a line drive in a weekend game with friends; as we drive to a niece's party in a town we have never visited before. The intricate ballet of coordinated perception, memories, and action is our spatial system: the mind-body problem that makes spatial function difficult is called **spatial neglect**. In this disorder, part of the three-dimensional world becomes useless to the stroke survivor. It is as if that part of the world does not even exist. Usually, there is an obvious difference between the way the stroke survivor understands the left and the right side of the world.

The stroke survivor may completely ignore someone speaking if that person is on the "bad" side—usually the left, because right brain injury is more often the cause of this problem. We will describe, below, two different forms of spatial neglect that affect different functions. When people have trouble with *spatial-motor aiming*, their movement system is tuned lopsidedly; like a grocery cart with a stuck wheel, they keep moving in one direction, even though they want to make movements in another direction. Usually, people with spatial-motor Aiming neglect are "stuck" moving too far rightward, but sometimes after stroke people may have trouble veering leftward, as well. We describe this mind-body problem below.

Spatial neglect may also affect visual-spatial perception of the environment, or knowledge of where important landmarks are located. Visual-perceptual *spatial Where neglect* is a mind-body sensory problem that affects awareness of one side of space. Again, spatial Where neglect usually affects the left side of the world, from the perspective of the stroke survivor. Visual-spatial Where neglect is described below, under (Sect. 5.2.2) Mind-Body Sensory Problems.

Spatial-Motor "Aiming": When stroke survivors make errors in spatial-motor "aiming," which is a form of spatial neglect (Na et al., 1998; Riestra & Barrett, 2013), they make errors because their ability to "map" and automatically compute the direction of our movements, and the "destination" to which they move the eyes, arms, legs, trunk, or whole body, is distorted. The internal gauge of the forces needed to move the body in one direction or another, can be out of balance. People with this problem may have weakness, but weakness after stroke does not cause this problem. Rather, the spatial system is giving the movement system incorrect "aiming" information, so that movements in one direction, or toward one part of space, are problematic. As we noted above, this problem is more common after a right brain stroke, which affects the left side of the body. When a stroke survivor has spatial-motor, "aiming" neglect, the survivor will have trouble turning his or her eyes and head to the left (to the side opposite the stroke). The survivor's posture will be lopsided, and s/he may lean too far to the right when sitting in a chair, work her/his way into a crooked position when lying in bed, with one foot or even leg off the bed. When that survivor moves parts of the body that are not paralyzed, like the neck or back or the unaffected, right arm, movements aimed to a particular point in space will fall too far to the right. Stroke survivors may try to put their eyeglasses on with the glasses positioned too far to the right, so that the left arm of the eyeglass frame hits the face, and when they attempt to dress or bathe, they may not move their good hand over to groom the left side of the body. The problem is not a visual input problem—aiming movements consistently swerve toward the "good" side, even with the eyes closed. Thus, when the survivor tries to stand, and is leaning too far to the right, he or she might realize that the body is not standing straight, but since he or she can only make rightward movements effectively, every attempt to correct posture is ineffective, moving the body in the wrong direction, and even eventually toppling the survivor over. These errors, which can appear clumsy or thoughtless, are the result of incorrectly aimed movements of the trunk, arm, leg, or hand. Even when people with stroke and spatial neglect can walk, they may not be able to walk straight—they may lean too far to one side even when corrected by a therapist—or they may collide with obstacles when moving in a wheelchair or while walking. This can be embarrassing for the stroke survivor and caregivers alike.

Like limb apraxia, spatial-motor "aiming" neglect is especially challenging for stroke survivors, who may be completely unaware of their movement errors. Because the body-space interaction controlling movement in our brain is designed to be effortless, our conscious minds are not easily able to monitor our spatial performance (Heilman, Watson, & Valenstein, 2011).

Social interactions also require the ability to make accurate movements in a room, behind a desk, at a dinner table, or in similar settings. If someone speaks on the left side, a stroke survivor with left-sided paralysis who has spatial-motor "aiming" neglect may turn the head and eyes in the wrong direction (toward the good side of the body). The survivor may repeatedly collide with environmental obstacles when walking or using a wheelchair; the survivor may veer or have trouble controlling steering when driving, and could lose the ability to drive safely. Family or care givers may find it very upsetting when stroke survivors fail to acknowledge they are making errors; they can feel quite isolated. Since schools and society do not emphasize non-verbal intelligence, and body-space skills, caregivers may find themselves needing to explain over and over why the stroke survivor behaves differently. Friends and family may not understand even after multiple explanations.

In fact, what the person with spatial neglect experiences may be very hard for a neurologically typical person to imagine. Again, because moving accurately and safely in the environment is something we learn to do very early in life, people around the stroke survivor may incorrectly think that the stroke survivor has lost the ability to think in an adult way, or may think that intellectual function is globally impaired.

At our rehabilitation center, we sometimes ask nurses in training, or family members of stroke survivors, to go through an exercise so that they can understand the experience of having a spatial problem. We give caregivers goggles that contain optical wedge prisms. These prisms displace and distort what they see, by displacing everything in the world to one side. We then ask them to maneuver a wheelchair or walk. When caregivers wear these prisms, they find themselves making incorrect movements; they may even feel off-balance. They can then more easily understand why people with visual-spatial problems are vulnerable to being overwhelmed by a spatially crowded environment—these survivors can have trouble seeing many things at once, or creating a visual "whole" out of "parts," even if the environment is well organized (Kimchi, 1992; Navon, 1977). Stroke survivors with spatial "aiming" neglect may make movements that seem bizarre or immature—for example, the stroke survivor with spatial neglect may reach out to touch something that is too far away. This can affect stroke survivors even when they are capable of very sophisticated thinking and have excellent memory—aiming spatial neglect causes a disruption in the mind-body systems that match the control of movements to our three-dimensional world.

People with spatial neglect after stroke always improve as the stroke improves, but its effects on life participation may be long-lasting. When a stroke survivor has had spatial neglect in the weeks after stroke, 6 months later that survivor will report moving around in a smaller area (reduced community mobility or smaller "life-space," (Oh-Park, Hung, Chen, & Barrett, 2014). This suggests that waiting for spatial-motor "aiming" symptoms to recover on their own, without specific treatment, is likely to put the stroke survivor at risk of social and community participation problems.

Mind-Body Problems in Perception and Sensation

Visual-Spatial, "Where" Neglect

Recovering from a stroke is rife with challenges. Just as the errors people make when they have spatial-motor "aiming" neglect can affect the way the stroke survivor moves to the left and right, spatial "where" neglect affects the ability to perceive the left and right side of the world we live in, and to be aware of new and relevant events. Spatial "where" neglect, unlike spatial-motor aiming, is especially noticeable in the way the stroke survivor deals with visual information. Spatial Where neglect is not vision loss—the survivor can usually see, hear and feel on the affected side of space at least a little, and the areas of the brain where the sensation comes in register the information, but the information is not processed normally. Like spatial-motor aiming neglect, visual-spatial where neglect is most common in stroke survivors who suffer a stroke on the right side of their brain, with left-sided paralysis. Unfortunately, most clinicians do not look for this hidden disability, and its assessment is frequently left out of the examination and clinical care documentation (Chen, McKenna, Kutlik, & Frisina, 2013). Hidden disabilities can definitely alter life social context, and others may confuse these mind-body problems with limited intelligence or motivation. Stroke survivors and their families may feel poorly prepared to deal with these reactions of others as they return to work and community (Stone, 2005).

People who have "where" neglect, even after a mild stroke, are in a sense experiencing a kind of blindness. However, people with this type of neglect can see objects; they can recognize them and identify colors, shapes and letters, even small ones, as they did before the stroke. The problems occur depending on *the location of the event in the space around the body*—people with "where" neglect do not notice important things on the side of their body opposite the stroke. So, for example, if a new person comes into the room from their left side, a person with visual-spatial "where" neglect may not see that person at all. Left-sided objects may be ignored: a stroke survivor might complain that there is nothing to drink with her meal, when a glass of water stands just to the left of her plate. This can be frustrating; caregivers can feel that the survivor is "demanding" or "careless" because further cues were needed: the caregiver might not realize that the water glass is simply not there, from the stroke survivor's perspective. Objects can also appear displaced to the right; people with "where" neglect might search over to the right side for objects, people, or landmarks that are actually on the left side. This can, again, look to other people as if the stroke survivor is confused, or distracted. We have observed "where" neglect to be very dangerous, because safety problems on the left side—a hot water tap left on, for example—may not be noticeable, and the stroke survivor could put his hand right under the stream of water, burning himself. Other common dangers include wheelchair, walking, or driving collisions with left-sided obstacles. Falls (more than six times more common in people with spatial neglect; Chen, Hreha, Kong, & Barrett, 2015), cooking-related injuries, oncoming traffic, and safety issues may occur in people with "where" neglect, because these stroke survivors may make errors when circumstances require rapid responses during childcare or work.

The visual problems of where spatial neglect affect visual information we keep in our minds for reference, as well as new, incoming visual information. These survivors might not be able to use spatial cues to remember the location of their personal belongings, or to interpret a map, and they may get lost easily even in their own house, driveway, or neighborhood. As we noted previously, survivors with spatial problems have a restricted "life space"—a smaller area outside the house and in the community where they move on a daily basis—compared with stroke survivors who have typical spatial function (Oh-Park et al., 2014). Stroke survivors may feel very discouraged by new limits on their community mobility, but may be too embarrassed to share their feelings with their caregivers or articulate the difficulty.

Some people with right brain stroke and spatial neglect may not be able to read, because they do not scan to the beginning of each line. Because they do not look far enough leftward, these stroke survivors do not see the left side, of a page or even of a word. The stroke survivor, looking at the word "backpack," might read "pack." One caregiver shared with us that since her husband's stroke, when they go out to dinner or are in a public building, she has to accompany him to the restroom. If he goes alone, he may misread the sign "WOMEN" as "MEN," and enter the wrong restroom—since he may only see and read the right side of the word. This need for assistance is difficult for both her and her husband to accept, since "being walked to the bathroom" is not consistent with their standard for personal autonomy and dignity.

Because visual-spatial function is normally automatic and effortless, and most people are not even aware of how and when they are exercising visual-spatial skills, spatial neglect is under-diagnosed and commonly misidentified as apathy, obstinacy or near-sightedness, which increases the burden of the mind-body disruption. Caregivers can find it very upsetting when the stroke survivor fails to greet them or respond to events in the "bad space," usually the left space, and when the stroke survivor does not notice gestures or emotional facial expressions that happen in the "bad side" of space, because the survivor has lost the ability to focus and concentrate on that part of the external world. As we stated above, stroke survivors may not notice the things they need to see when they are eating, getting dressed, or moving around at home, and they may appear lost, confused or careless, when actually their visual-spatial system is just not giving them access to the same reality the rest of us take for granted. People with spatial neglect after stroke simply do not have the right information needed to solve many everyday problems. The visual-spatial system is intended to work without any feedback or conscious control, and so stroke survivors are usually unable to recognize their own visual-spatial errors. Thus, stroke survivors with visual-spatial difficulties usually do not know why they are making mistakes, and they will not ask for help.

An emotional rift can grow between stroke survivors and their family and caregivers because of a lack of self-awareness (also called "anosognosia," or lack of knowledge of disease), because survivors may insist that they are functioning normally, while the family works hard to keep the environment and activities safe. Spatial "where" systems help us with information that come in through other senses, as well as visual information—the ability to hear noises on the left, and feel sensations on the left side

of the body (for example, feeling pain) can be distorted and abnormal. Everyone can become frustrated, and emotional tensions and misunderstandings can interfere further with relationships. If Where neglect is mistaken for a different problem (for example, an eye problem or a hearing problem), the stroke survivor might receive unnecessary testing, treatment, medication, and equipment. Spatial neglect is extremely costly. When spatial neglect goes undetected, survivors and their families may experience unexplained complications and setbacks during recovery. "Where" spatial disability increases the risk of acute and chronic complications associated with stroke, such as hip fractures, and can result in longer hospital stays.

Identifying either "where" or "aiming," spatial-motor neglect can be challenging. However, it is very important to identify them; otherwise, the survivor might receive treatment for memory problems, concentration, or some other problem that is not the real source of errors. If the wrong treatment is received, the stroke survivor is unlikely to improve and gain independence in daily life. Be wary of the following warning signs of a possible hidden disability of spatial function: (1) Bumping into one side of the body while walking through doorways (2) Staring off in one direction (particularly toward the unaffected side of the body), or poor eye contact (3) A driving accident since the stroke. Stroke survivors might report that they feel the car is running off the road when it is moving straight, either while driving or riding as a passenger, or the survivor may show a new tendency to veer to one side when steering. (4) Trouble finding things on one side or in one place (5) Incomplete self-dressing, especially if glasses miss the ear on the side affected by stroke. (6) The survivor's body or head is turned to one side most of the time (usually toward the unaffected side of the body).

Phantom Limb and Phantom Movement

In normal mind-body communication, messages move up from the skin through nerves, spinal cord, brainstem, and into the brain where the information is analyzed and a response strategy is sent to the limb. Sometimes, this pathway generates "phantom sensations," or false signals. Many people have heard about phantom sensations occurring in an arm or leg after amputation; this symptom can also occur after stroke, affecting a paralyzed limb. Under normal conditions, body awareness is continuously updated by all of our senses working together with the signals generated when we try to make a movement (Schwoebel & Coslett, 2005). A phantom movement can be felt, if the sensory and movement signals are poorly coordinated, or the movement signals are not properly controlled. Essentially, the stroke survivor can have the strong sensation that the paralyzed or affected limb is moving, when it is not (Melzack, 1990). The survivor may insist that he or she can move a paralyzed limb; even though caregivers and family might not see any movement, the stroke survivor might feel the "phantom" movement clearly, just as movements were felt before the stroke event. The perception of a phantom movement, or a phantom limb, replaces the perception of the actual limb. Even more strange to family and caregivers, some stroke survivors may feel that they have an "extra" limb—for example, they may feel that both a paralyzed arm, and an arm that can move, are attached to the same shoulder (Bakheit & Roundhill, 2005; McGonigle et al., 2002).

Body Ownership

Another mind-body problem that can happen after stroke is the aptly named "alien hand syndrome"—one hand seems to have a "will of its own" or is "not under my control." Persons with this experience have lost function in the part of the brain that allows perception of control over actions. This is different from paralysis, and the experience can be alarming or distressing. People with stroke can be reluctant to discuss the feeling of phantom movements, or a feeling of loss of limb control, because they may not realize that these problems are part of the mind-body disruptions in movement that can happen after stroke. Stroke survivors may worry that, if they report these sensations, other people will think they are hallucinating, or delirious. Of course, phantom movements are an experience something like a kind of hallucination, but these illusions usually do not affect judgment or understanding. When we discuss these problems with survivors, we mention that these sensations are like the sensations some people experience after limb amputation. Discussing these problems with physicians, loved ones or other health care providers can often relieve anxiety and could open a path for physical therapy, reassurance, and, validation that these experiences are part of their stroke recovery. Distortion of body ownership and phantom limb movement can be thought to be a psychiatric illness by stroke survivors and family members. Screening for these problems, and educating survivors and their families that they are caused by new patterns of activity in the brain after stroke, can be very reassuring.

Pain

Pain after stroke is common, especially shoulder pain, which provides a prism through which the mind-body disruption that results in pain after stroke may be viewed. Shoulder pain affects up to 84% of stroke survivors (Turner-Stokes & Jackson, 2002), yet it usually has a different cause than shoulder injuries due to muscle, bone and joint problems, and requires different treatments.

In the initial post-stroke period, the muscles on the side of the body affected by the stroke are loose and weak. Over time, the muscles on the side of the body affected by the stroke become tighter, and, as we discussed above, *spasticity* or abnormal tightness and contraction can occur. There are sources of pain in both of these states. Both flaccid (loose) and spastic muscle tone fails to do the muscle's job of holding the shoulder into its joint in a natural manner. The shoulder, a ball-in-socket joint, normally has a remarkable range of three hundred and sixty degrees of motion. After a stroke, the shoulder may have significantly reduced range of motion. This reduced range may become permanent if good therapy does not move the shoulder through a wide range frequently. Sticky places in the joint capsule—adhesions—will eventually restrict shoulder movement and cause pain. This condition, known as "frozen shoulder" (adhesive capsulitis) is treatable with a combination of therapy and medication, but can be prevented by therapy that moves the shoulder in a proper range.

Changes in muscle tone (both flaccid and spastic) may contribute to an incomplete dislocation (subluxation), of the upper arm bone (the humerus) from its socket in the scapula. There may be pain due to the alteration of bone position, and sensory nerve fibers translate this change in position as pain. Pain may also be due to a more

central origin that is a mind-body source. A solution that frequently seems to suggest itself to family and stroke survivors is to wear a sling. It might seem that wearing a sling would prevent or improve shoulder dislocation, but this is not supported by research studies (Page & Lockwood, 2003)—we do not recommend it. The sling might actually create harm by accelerating the process of adhesive capsulitis and impeding attempts to strengthen the arm, and sensory deprivation can result from reducing the input the arm sends to the brain when it is restrained in a sling.

Another cause of pain as a result of disruption in mind-body pain pathways after stroke is complex regional pain syndrome (CRPS; Chae, 2010) In CRPS, everyday sensations such as those of clothing or something in the environment lightly touching the affected limb, suddenly become intensely painful (dysesthesia). The distorted sensations can be unbearable. Wearing clothing, or having a blanket or sheet on the area, can become intolerable. Other changes in blood flow to the limb and eventually bone changes occur in CRPS. Since CRPS becomes more difficult to treat the longer it persists, early diagnosis and treatment by a pain management specialist is essential to prevent and reduce suffering.

Post-stroke pain syndromes can have a profound effect on daily life. For example, studies indicate that pain after stroke is strongly associated with mobility limitation (O'Donnell et al., 2013; Sommerfeld & Welmer, 2012), dependence, and cognitive decline (O'Donnell et al., 2013).

Mind-Body Problems in Mood and Emotion

Depression

Stroke produces profound mind-body disruptions. Although it is a part of stroke recovery to grieve for lost abilities and expectations, 30–40 % of stroke survivors experience serious and disabling mood changes. Depression is most evident within the first 2 years after stroke (Hackett, Yapa, Parag, & Anderson, 2005), and prompt treatment is associated with better recovery of everyday abilities (Mead et al., 2012) and faster improvement in strength and movement (Chollet et al., 2011). Early treatment of stroke-related depression was actually associated with better stroke survival in one study (Mortensen, Johnsen, Larsson, & Andersen, 2015). Well-known symptoms of depression include overwhelming feelings of hopelessness, emptiness, worthlessness, social isolation, and helplessness. This is distinct from emotions stemming from adjustment to disability. The change in brain chemistry is a medical condition, adversely affects the immune system and general health, and requires treatment. Less well-recognized but significant symptoms of depression include loss of interest in activities that were once enjoyable, disruption in sleep patterns (either insomnia or oversleeping), change in appetite with weight loss (or gain), and physical symptoms such as overwhelming fatigue, decrease in energy, irritability, or other physical concerns resistant to treatment (such as gastrointestinal difficulties, headache, or generalized aching), overwhelming sense of guilt for issues beyond one's control (such as feeling personally responsible for the state of world affairs). The structural damage that occurs in the brain after stroke seems to trigger depression as

a physical reaction to the stroke event, or as a reaction to neurochemical changes produced by the brain condition. More unfortunate, many stroke survivors with depression are unaware that their mood is abnormal, and even while depression is obviously limiting their ability to engage in life activities, they will deny that they are experiencing any emotional changes.

Depression after stroke results in feelings such as sadness, hopelessness, and helplessness (Brodaty, Withall, Altendorf, & Sachdev, 2007; Jaillard, Grand, Le Bas, & Hommel, 2010). Experiencing these feelings is clearly associated with worse health, social and economic problems and social isolation (Sienkiewicz-Jarosz et al., 2010). This is likely to happen because of a vicious cycle of life participation problems and adjustment issues. Depression impairs confidence, self-efficacy, and can reduce the survivors' willingness and ability to self-advocate and solve new problems creatively, accelerating losses. It can result in a reduced desire to participate in previously enjoyed social activities. Because being able to be independent, free and socially active is highly important in the US culture, loss of these abilities can further adversely affect self-esteem, adjustment, and recovery.

Initial adaptation to stroke can affect the risk of depressive symptoms that affect social participation chronically (Rochette, Bravo, Desrosiers, St-Cyr Tribble, & Bourget, 2007). Losing the ability to drive is an example of this phenomenon. Driving disability as a life problem may initially result from physical (e.g., hemiplegia) or cognitive problems (e.g., visual-spatial or concentration deficits). Many stroke survivors cannot return to driving (although some can). In people who cannot return safely to driving, disability may persist because changes in social role (dependency) and loss of initiation due to depression prevents the stroke survivor from pursuing rehabilitation, discussing return to driving with healthcare providers, or following through with driving assessment and adaptive driving recommendations. Depression, as well as the stroke itself, may directly impair cognitive functions required for safe driving including focused attention, normal processing speed, ability to plan routes, and ability to follow the plan to the destination (De las Cuevas & Sanz, 2008; Fisk, Owsley, & Mennemeier, 2002).

Survivors who cannot drive because of stroke-related impairments are dependent on others for daily errands, community gatherings, and leisure travel. This increases their risk of adjustment disorders with depressed mood. Chronically, some survivors experiencing depressed mood unfortunately choose to reduce their social activities, becoming grounded and isolated. Stroke-related problems that limit driving ability can thus become mood problems, or social participation problems.

Apathy and Motivation Problems

Living with a stroke survivor can place a strain on family, friends, and coworkers. Stroke survivors may be unaware that they have disorders such as spatial neglect, or depression, and therefore are not able to acknowledge what the family has lost, or express concern for their caregivers. In particular, a stroke affecting the right brain (left body) can make it hard to express emotion in the face and voices, and can cause a stroke survivor to lose the ability to respond automatically to others' emotions, which could make them appear insensitive or uncaring. Apathy (decreased expressed

concern or self-generated reaction to people or events) and motivation problems (decreased urgency, energy or drive devoted to task completion) can occur after any kind of stroke, and may be frustrating for family members who are trying to help loved ones in the battle to recover. When the person who has suffered the stroke does not seem to want to put the best effort into rehabilitation, or continually fails to participate in the process of rehabilitation, family members can feel alienated from him or her, and immensely unhappy, resentful, and angry. Stroke survivors who have apathy or loss of motivation may also stop going to therapy or taking appropriate medications, actions that adversely affect their well-being. At times, apathy and motivation problems co-occur with problems with self-awareness. Survivors may be ***unaware*** of their problems, may appear indifferent to their illness, and may even express that they do not think they are disabled or limited (Adair & Barrett, 2011). This unawareness, or anosognosia, as we discussed above, may even cause survivors to question whether they have had a stroke or whether they have been ill. This unawareness is part of the change in their thinking and brain function caused by stroke. One of the ways that it is distinct from psychological denial is that it almost always gets better, rather than worse, as time passes and survivors are more confronted with the impact of their stroke on their life in the outside world. When a survivor has unawareness, confronting the stroke survivor with the facts he or she seems not to understand can be confusing to the stroke survivor and is probably not productive.

Many stroke survivors will not be able to participate in a conversation about whether their beliefs are logical or reasonable; a profound mind-body disconnection is responsible for their distorted self-awareness, and discussion cannot usually alter this process. Family members and caregivers do not need to pretend to accept the stroke survivor's beliefs. In a neutral way, family members can simply continue with necessary activities and routine. For example, when the caregiver says "We're going to the physical therapy gym," and the survivor responds, "I don't need physical therapy," it may be helpful if the caregiver does not specifically respond to the statement, but simply helps the survivor put on her jacket, while describing the trip, how they will get there, and what will happen afterward: "We'll get some lunch after therapy at the deli: they will probably have the chicken soup you like." It is possible that the survivor will then be able to join and participate.

As previously noted, unawareness definitely affects daily life: survivors with unawareness do less for themselves, and recover more slowly, increasing the burden of their care (Gialanella, Monguzzi, Santoro, & Rocchi, 2005; Vossel et al., 2013). Even if stroke survivors with unawareness report that they are satisfied with their lives, they may have more falls and may be at high risk of accidents because of balance problems (Dai et al., 2014).

Emotional Lability

Emotional lability refers to rapid fluctuation to emotional extremes such as laughing or crying but with little provocation (Morris, 2009). This can happen after stroke affecting either side of the brain, but may be more common after right brain (left body) events. Affected stroke survivors have a mind-body dissociation that disrupts the expressions of emotion (such as laughing or crying) from their internal

state. This is called pseudobulbar affect, or sometimes may be labeled "emotional incontinence." A sudden, surprising burst of emotional expression (laughter, bursting into tears) may happen when the stroke survivor does not feel particularly emotional. It can sometimes happen after a minimal stimulus, such as hearing the word "mother," or seeing a Hallmark commercial, and can be quite embarrassing to the stroke survivor, and to loved ones. Medications can address this problem, and can be quite effective, but frequently stroke survivors and their families do not ask healthcare providers about this.

Social Interaction and Personality Changes

Stroke can change the way the survivor interacts with others. Our personality and individual style influences the way we assess and respond to others emotionally, and in communication, negotiation, and interaction. Stroke can change these behaviors and even create problems with accurately assessing and responding to the emotions of others. In that way, it can disrupt communication, because emotional exchange is an important part of human interaction. Stroke can also affect how much the survivor discloses: how private, or open, he or she becomes in expressing negative feelings such as anger, and expressing private thoughts or feelings, especially sexual, or physically intimate information. After stroke, about a third of stroke survivors may have difficulty censoring anger (Kim, Choi, Kwon, & Seo, 2002)—the parts of the brain that help us to "filter" what we say to others may be damaged, and this can adversely affect social participation. Personality changes after stroke are associated with reduced independence, and with caregiver depression (Stone et al., 2004). The stroke survivor who has experienced social behavior change may find it difficult to navigate working relationships of many kinds, and may experience conflicts limiting return to work and other aspects of social independence (Gehl & Paulsen, 2012).

At times, stroke survivors may touch themselves or others in a manner that is not socially acceptable. This problem may be more common after the right frontal region of the brain is damaged. For these individuals, an individualized approach led by a physician, nurse, or rehabilitation professional experienced with this problem can be very helpful (see reference (Joller et al., 2013) for a review); both behavioral learning and medication interventions are useful to re-establish boundaries on appropriate behavior. Psychological counseling for the family and caregivers may also assist in adjustment and open communication about challenges during recovery.

This section described common issues facing stroke survivors by reviewing mind-body problems affecting movement, sensation, pain, and emotional and social function. Frequently, family members, friends, coworkers, and caregivers misinterpret these changes as being the result of changes in the individual's values, intelligence, or desire to recover, instead of recognizing them as the result of damage to the brain. This misperception adversely affects the daily life of stroke survivors, who can become isolated from their loved ones. Spatial systems in the brain assist us in "thinking with our bodies" as we perceive the environment, and move around in it; spatial Where and Aiming abilities can be profoundly abnormal after stroke, limiting the survivor's adaptive capacity. Spatial disorders can cause stroke survivors to encounter safety risks during the simplest

aspects of mobility and self-care, and experience limited community mobility. Emotional changes, and apparent personality changes can also result from specific injury to parts of the brain that control these functions.

Other Issues in Life Participation

Physical as well as cognitive consequences of stroke may alter the survivor's ability to accomplish daily activities and fulfill social roles valued by the person or socio-cultural environment. Above, we discussed stroke-related issues that are frequent after moderate–severe stroke, but even when a stroke is mild, mind-body changes can create persistent limitations in life participation (Rochette, Desrosiers, Bravo, St-Cyr-Tribble, & Bourget, 2007).

A universal problem after stroke is in managing expectations and communicating about gradual progress. During the course of stroke recovery, the brain can re-connect with the body and with the world by re-forming its idea of relationships, as when we are children we learn to understand the relationship between the right hand and left shoulder, between our feet and the floor, between what we see and what others see. Stroke survivors may encounter similar learning situations. For the stroke survivor, the re-learning experience can be stressful or frustrating because they may expect themselves to adjust immediately. They may be profoundly disappointed about the time and effort that returning to an independent life and regaining social roles requires. Learning new movement patterns is not guaranteed, even when stroke survivors exert their best efforts and receive the most intensive rehabilitation. The amount of brain affected by the stroke, the areas of the brain affected, and other medical problems may affect how survivors recover. Every stroke survivor starts with a different set of physical resources in the brain, and it is important to recognize these organic differences, so that stroke survivors do not compare themselves inappropriately to other people who also have a stroke.

Hidden disabilities, as we discussed under mind-body problems, can affect thinking and emotion after stroke. In this section, we will discuss further the impact on meaningful life activities in how the stroke survivor is able to concentrate and remember. We will also discuss the stroke survivor's speech and language; and how fatigue after stroke affects daily life.

Life Problems Related to Concentration and Memory Deficits

Concentration and memory problems are very common after stroke. In one study, 90 % of a group of stroke survivors with good recovery reported that they had thinking and memory problems, including fatigue, cognitive slowing, memory difficulties, and poor concentration (Lamb, Anderson, Saling, & Dewey, 2013). Many stroke survivors express that they feel tired easily even though they are less active physically or mentally after stroke. This feeling can be related to a reduced capacity to concentrate in order to perform daily tasks such as remembering an appointment or following a conversation. Concentration is necessary for the broader definition of

memory that includes not simply storing past events or knowledge, but also picking out the specific information to be learned, paying attention to its details, retaining the information, and retrieving it when it is needed. Stroke survivors may not have difficulty remembering their own personal history in general. However, when they are retrieving details of a past event, which requires focused attention to sort through the memory, they may find this effortful, or they may not be accurate.

Learning new, detailed information, keeping it in mind for a few minutes, and calling learned information up at the moment it is needed, can be difficult after a stroke. Holding information in mind is needed for many daily tasks: for example, the survivor may have trouble making a call immediately after reading a 7-digit telephone number, and may need to recite the number several times or dial it one number at a time, as he or she reads the number over and over again. Manipulating information while holding it in mind, for example while calculating change in a store, may take longer or fail. The ability to keep a to-do list in mind may also be impaired; for example, the intention to go to the post office before going home may be easily forgotten. Stroke survivors may miss doctors' appointments, forget new friends' names, or fail to concentrate on difficult tasks. They may also have trouble tracking whether they have taken their medications, leading to double or missed medication doses (Barrett et al., 2014). Most stroke survivors recognize their attention or memory problems. Because memory problems are associated in our culture with the loss of competence, autonomy, and dignity, survivors may find these problems very stressful, frustrating, and embarrassing. Even if they are able to do what they need to do in daily life, stroke survivors may find their errors embarrassing and lose confidence and self-esteem. This may be why survivors of a mild stroke, with good recovery, report less life satisfaction if they have problems with mental organization skills (Edwards, Hahn, Baum, & Dromerick, 2006). When stroke survivors do not ask for help from healthcare providers, changes in their memory performance can be associated with problems in their jobs and social roles (Vestling, Tufvesson, & Iwarsson, 2003). Coworkers, supervisors, and even friends and family members may conclude that their thinking is "slow" or not as attentive as before, and their jobs or social roles may be threatened. Stroke survivors may feel that they themselves are defective, not their memory performance, and might feel guilty or ask for forgiveness. Even when stroke survivors are studied who lack severe cognitive issues, cognitive functional problems are associated with a poorer sense of well-being and less purpose in life after stroke (Clarke, Marshall, Black, & Colantonio, 2002).

Life Problems Related to Communication Deficits: Aphasia

Problems with communication using oral or written language is common after stroke. Usually, this is the result of a stroke that damages areas devoted to language comprehension, production or language meaning in the left side of the brain, but some people have problems understanding and using both written and spoken language after a stroke affecting the *right* side of the brain (crossed aphasia), or they may have trouble with communication after having a "mini-stroke" with little effect on other abilities.

Aphasia is a **mind-body problem** in that the language apparatus can be damaged, without affecting the intelligence, will, capability, or feelings of the person. In the same way that the internet connection for a computer can be broken, preventing someone from communicating by email, the language apparatus can malfunction, causing problems understanding or distinguishing words, whether written or spoken. In this situation the computer itself is intact, but cut off from channels customarily used for expression and connection. Sometimes, it is easier for the person with aphasia to understand written words than spoken words. It is always easier for the person with aphasia to understand if the words are presented in written form at the same time as they are heard, so that information comes in from more than one channel. It is also helpful if other information (clues) are also available—a gesture, a picture, a facial expression, or even a little drawing the communication partner might make on the spot! (Galletta & Barrett, 2014).

In real life, aphasia causes many difficulties. Communication disorders after stroke are very strongly associated with community participation problems (Ostir, Smith, Smith, & Ottenbacher, 2005). We feel that this gives rise to the worst problem in daily life that is associated with aphasia, social isolation (Dalemans, de Witte, Wade, & van den Heuvel, 2010). People may not speak directly to the person with aphasia—even though the person is standing right there. It is devastating to the self-esteem of the person with aphasia when someone they wish to communicate with, turns away and speaks to the caregiver. If you are a caregiver being asked to "translate" or "speak for" the person with aphasia, it is appropriate to encourage people to talk to the stroke survivor directly. If they speak slowly, use gestures, written words, pictures, or other aids, and check frequently to make sure everyone understands, they will show respect for the maturity and autonomy of the person with aphasia. People with aphasia want to be engaged and involved, and it may take time to find the right environment, where others are willing to make the right communication efforts. Contributing meaningfully in one activity may address social isolation more effectively than a range of activities in which they feel stigmatized or assigned a "less than" status (Dalemans et al., 2010; Sarno, 1981).

Remember that the ability to speak and communicate effortlessly is often interpreted in our society as a sign of intelligence. As a result, a person with aphasia who can still carry out his or her job well might be interpreted as being less competent; many people with aphasia report problems with working cooperatively with their employers to adjust work conditions and accommodate their needs. Reading a menu in a restaurant, reading road signs when driving, communicating with people about needs at a store, when lost, or in a public building such as a hospital, post office, or bank can be difficult. At times, others may assume that the person with aphasia is under the influence of drugs or alcohol, or has a developmental disability, and this can be very embarrassing. The National Aphasia Association (National Aphasia Association, 2014) provides palm cards and other materials that can be helpful in advising strangers that the barrier is a communication problem, so that they will not assume that the stroke survivor is intoxicated, or has a problem with intelligence. A counselor in vocational rehabilitation, a speech-language pathologist, a psychologist or neuropsychologist experienced with stroke

survivor self-advocacy and life adjustment issues, or a case manager or social worker with experience with communication disorders can be extremely helpful to the stroke survivor and his or her family in working out the best strategies for communication within the family, and also with the external world.

Fatigue

This, particularly frustrating, mind-body problem refers to the stroke survivor feeling chronically tired. It is described by stroke survivors as both a physical and a mental lack of energy. It is distinguished from a problem with endurance, because it can affect performance at the beginning of a task or immediately upon waking, just as much as it may affect performance at the end of a day.

It is not clear why some stroke survivors feel chronically tired, but the problem is common, affecting 10–30 % of stroke survivors (Glader, Stegmayr, & Asplund, 2002; Radman et al., 2012). Fatigue is an independent predictor of dependence, and predicts moving to an institutional setting after stroke (Glader et al., 2002). Of particular concern, fatigue does not resolve spontaneously over the first year after stroke, and in fact some stroke survivors report it as a new problem as late as 6 months after stroke or later, when they try to return to work. One study of stroke survivors with fatigue reported that half of them had to reduce work activities because of this symptom, and 23 % reported fatigue was the "worst" symptom of their stroke (Radman et al., 2012).

Many stroke survivors assume they need to deal with fatigue independently; in fact, occupational, or physical therapy, or speech-language pathology professionals, health psychologists, or rehabilitation physicians (physiatrist or neurologist) may be able to offer medication, cognitive-behavioral interventions, or compensatory strategies.

In summary, hidden disabilities such as concentration and memory problems, communication disorders (aphasia), and fatigue may affect the daily lives of stroke survivors just as much as visible disabilities (for example, paralysis). When stroke survivors have these problems, it may be helpful to understand that they are common, and that rehabilitation professionals have a toolbox of specific interventions and compensatory strategies.

Steps in Returning to the Community

Employment After Stroke

Returning to work obviously helps families financially, especially when the stroke survivor is younger, but returning to work may also aid re-integration into social role and general well-being; it is associated with better long-term outcomes (Daniel, Wolfe, Busch, & McKevitt, 2009). Most stroke survivors experience limitation on their ability to work due to stroke-related problems, based on comprehensive reviews of US and Canadian research (Graham, Pereira, & Teasell, 2011; Wolfenden & Grace,

2009). A very important factor in recovery is taking advantage of services that are available after the initial period of hospitalization (post-acute rehabilitation). These include vocational interventions. It is also important to use adaptive strategies, meaning specific changes in communication style, or equipment to assist in function, or other means of "working around" stroke-related problems. Lastly, a stable, secure work environment that engages the survivor as a partner is also helpful for successful work return (Wolfenden & Grace, 2009). We feel strongly that vocational rehabilitation services are underused by stroke survivors, as compared with working-age people with psychiatric issues or traumatic brain injury, and there is research to support this contention (Hofgren, Esbjornsson, & Sunnerhagen, 2010).

Even if stroke survivors return to work, they may need to change their hours or find a new job (Wolfenden & Grace, 2009). Only about 20–40 % of stroke survivors return to work (Graham et al., 2011; Hofgren et al., 2010; Wolfenden & Grace, 2009), and those who are younger, do not have communication disorders (Graham et al., 2011) and more independent (Hackett, Glozier, Jan, & Lindley, 2012) may find it easier to work. Changes in thinking, concentration, and memory (cognition) may also play an important role in return to work (Hofgren et al., 2010; Kauranen et al., 2013). Having trouble with several areas of thinking makes it more difficult to return to work successfully than having one or two areas of decreased thinking abilities (Kauranen et al., 2013).

Returning to Social Participation

As the survivor's success in recovery builds on itself, step by step, new areas of challenge will emerge. Universally, stroke survivors can have difficulty resuming family relationships, sexual life, and leisure activities because of new daily life limitations of function. Marital separation and divorce can be a direct result of the event, but a review of 78 studies on social consequences of stroke (Daniel et al., 2009) reported that 38–54 % of couples report they experience conflict (38–54 %). Up to three-fourths of stroke survivors report new, unwanted limits on their ability to take part in a sexual relationship. We know that school-age children of stroke survivor require support, but it may be very difficult for families to find resources and services that support them in explaining what has happened. Lastly, participating in leisure activities, such as sports, religious participation, volunteerism, clubs and other social groups, is very commonly limited after stroke: in 79 % of stroke survivors according to a review of 78 studies. Stroke survivors and their families can seek family counseling, peer support, resources through advocacy organizations, and resources available through organizations focused on aging and brain injury. Exercise, alone or in combination with other interventions, may also improve social participation (Obembe & Eng, 2016). Many communities are building health and wellness centers that offer support, counseling and resources for mental health and resilience through life transitions and in relationships. We encourage stroke survivors and their families to take advantage of these resources so that organizers will be motivated to keep them stroke-relevant and -accessible.

Cultural Issues

People with different racial and ethnic backgrounds can have different inherited medical conditions that affect stroke and its recovery (Sacco, Kargman, Gu, & Zamanillo, 1995). Socioeconomically disadvantaged groups differ demographically from those that are more privileged; these healthcare disparities may lead to differences in stroke outcomes (Kleindorfer et al., 2012).

Differences in functional recovery may also be the result of cultural and ethnic practices (McNaughton et al., 2011). In medicine, we strive to improve the *cultural competence* of providers, so that doctors, nurses, and others can present information to people in a way that makes the most sense to their racial, ethnic, religious, and other cultural beliefs and practices. Some conventional beliefs and practices might help to support better stroke recovery in the community; other practices might diminish independence. Healthcare providers need to discuss this information with stroke survivors so that the survivors and their families can choose how to balance their cultural and recovery priorities. Our scientific understanding of how cultural factors interact with the impact of stroke on daily life is still actively growing. For example, people from racial or ethnic minority backgrounds report that they may be more hesitant about using mobility aids like a cane, walker, or wheelchair than their Caucasian counterparts (Resnik, Allen, Isenstadt, Wasserman, & Iezzoni, 2009). This means that they may be at a disadvantage in obtaining and using these devices optimally; visual aesthetics of the device, and physician recommendations, can improve the likelihood African-American or Hispanic stroke survivors will view mobility devices positively. Cultural, racial, and religious beliefs can also affect how caregivers view professional support and adjust to changes in the marital and sexual relationship (Lurbe-Puerto, Leandro, & Baumann, 2012). It is important for stroke survivors and their families to educate their health provider team about their cultural beliefs and how they affect the recovery process; if the team knows more about the family's priorities, they can more effectively advocate for them. Stroke survivors and families may prefer to discuss cultural, ethnic, or religious issues with a social worker or case manager, rather than discussing them with the healthcare providers. Many cultural, racial, and religious support groups are also good at helping their members interact with healthcare teams.

In summary, stroke recovery continues beyond physical aspects of self-care; as stroke survivors look to return to work, social activities, and relationships with marriage partners, children, and others in the community through participating in meaningful activities outside the home, they may encounter challenges. It is important to realize that support from professional and community organizations, as well as rehabilitation-based resources like vocational assistance, may not be offered automatically. Stroke survivors and their caregivers can approach advocacy organizations, hospitals, and even university departments of rehabilitation sciences, where inexpensive and helpful services may be available. Organizations primarily serving other disorders (for example, organizations specialized to assist people with Alzheimer's Disease, and their families, if memory problems are a challenge to return to work), may be able to make useful referrals, or help the stroke survivor and

family plan next steps with specialized services. Because it is very common that cultural and ethnic practices affect the stroke recovery process, we hope that stroke survivors and their families will speak to their healthcare providers about these issues and their specific needs.

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Traumatic Brain Injury (TBI) and the Impact on Daily Life

6

Joan Toglia and Kathleen Golisz

Traumatic Brain Injury

Each year, an average of 1.7 million people sustain a traumatic brain injury (TBI) in the United States as a result of falls, motor vehicle accidents, sports injuries, assaults, blows to the head, or other injuries (Center for Disease Control and Prevention [CDC], 2015). Of this number, an estimated 43.3 % of Americans have residual disability 1 year after injury (Corrigan, Selassie, & (Langlois) Orman, 2010). The CDC (2015) estimates that 3.2–5.3 million Americans currently have a long-term or lifelong need for help to perform activities of daily living as a result of a TBI. Direct medical costs and indirect costs such as lost productivity of TBI totaled an estimated $76.5 billion in the United States in 2010 (CDC, 2016). TBI can be classified as mild, moderate, and severe.

Mild TBI

Approximately 80 % of TBIs are mild. A person with a mild TBI or concussion may remain conscious but appear confused. In some cases, there is a brief loss of consciousness for a few seconds or minutes. Brain scans such as an MRI or CT scan may be normal. Common signs and symptoms of a mild TBI include headache, dizziness, nausea, fatigue, irritability, sensitivity to noise, light, or busy environments and difficulties in concentration and thinking. In most persons, these symptoms are expected to resolve within 3 months but it is estimated that approximately 7–33 % of persons continue to experience significant symptoms

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that persist and significantly disrupt daily functioning (Shenton et al., 2012). Mild TBI can easily be overlooked or go unrecognized until the person experiences difficulty doing their everyday activities.

Tim was hit by a car while riding his bicycle. He was confused and dazed after the accident but witnesses state that he did not lose consciousness. He suffered a fractured elbow and ankle as a result of the accident and required orthopedic surgery. The first couple of months focused on his physical recovery and rehabilitation. After 10 weeks he returned to his job as an accountant but found he could not function. He was unable to prioritize, and mixed up client names and conversations. His co-workers wondered if he was having a nervous breakdown. They saw drastic changes in his work performance but there were no visible signs that anything was wrong. He did not immediately connect his difficulties to the accident. Co-workers didn't understand why he asked the same question over and over or why he always seemed like he was in a fog. He gradually became more and more withdrawn, isolated and depressed. He received a poor performance evaluation, was put on probation at work and was on the verge of getting fired. He didn't understand what was wrong.

This scenario is typical of persons experiencing mild brain injury. Symptoms may not appear until weeks following the injury or may even be missed as people may look fine even though they may be experiencing hidden cognitive difficulties in thinking, concentration, memory, reasoning, and emotional control. The word "mild" is deceiving as it leads one to believe that the problems are inconsequential when in reality, the problems resulting from a mild brain injury can have significant and far reaching effects.

Moderate–Severe TBI and Early Stages of Recovery

Persons with moderate to severe TBI, often lose consciousness for an extended period of time, lasting hours or weeks after an injury. Sometimes a person is quickly placed into a medically induced coma to reduce brain swelling. While a person is in a coma, appropriate positioning and range of motion of limbs is important to prevent later complications due to changes in muscles and ligament elasticity. Joints in the person's limbs can become stiff and contracted. As a person emerges from a coma they often progress through several stages during the recovery process. For example, immediately following a coma, disorientation, agitation, and confusion are frequently observed. The person may try to remove restraints, tubes, or get out of bed without a goal or purpose. Verbalizations may be inappropriate or incoherent and the person may not recognize family or friends or realize that they are in a hospital. Attention may be limited to less than a minute and objects are often used inappropriately. As agitation begins to subside, the person may be able to participate in familiar routine activities, although performance may be limited by confusion and decreased attention as well as physical or sensory difficulties.

Suggested Strategies for the Acute Phase

To facilitate attention and maximize performance during the phase of confusion and limited attention, the following suggestions may be helpful. See Table 6.1 for additional management strategies for cognitive behavioral problems.

1. Personal and familiar items can be brought to the hospital to stimulate past memories and help orient the person to place and time. Examples include favorite music, labeled photos, and recorded messages from family members.
2. Goal-directed, familiar, and purposeful functional tasks that are simple, rote, and repetitive can stimulate attention. Simple tasks such as combing hair, pouring water into a cup, eating, washing face with a washcloth, or drinking from a cup, should be encouraged.
3. Gentle physical guidance could be used during simple tasks (combing hair) to assist the person in performing the activity. Gradually, guidance is withdrawn, until the person performs the motion themselves.
4. Limiting the number of items placed in front of the person at one time will facilitate attention. For example, during eating, it may be best to have only 1 type of food on a plate. All other food, utensils, cups, etc. should be removed from the food tray. Too many items presented at once can create confusion, because the person does not know where to focus.
5. A quiet, structured environment is often needed to enhance performance. Thus, the number of visitors at any one time may need to be limited and distractions in the environment may need to be removed.
6. Short and concrete instructions with emphasis on key words will enhance communication and performance.

Difficulties in routine daily activities (feeding, grooming, and dressing) may be less observable after the period of confusion subsides and attention improves. The person may learn to function independently within the structured hospital setting but may continue to experience significant cognitive, physical, and emotional difficulties as described later in this chapter. Different types of problems can gradually emerge as the person returns home and tries to resume previous levels of function. In the early stages of recovery, the person has stopped working and family members and friends are often there to assist. In addition, a hospital setting provides a structured environment where others are there to provide cues and support, therefore the full extent of cognitive difficulties can be masked. It is not until a person tries to fully resume former roles and complex activities that difficulties in these areas may begin to become apparent.

A TBI, whether mild or severe, can result in physical, sensory, language, emotional, or cognitive problems that limit participation in everyday life. The next section reviews these different problems and their impact on daily functioning in greater depth. Since cognitive symptoms are the most frequent and disabling symptoms, greater emphasis will be given to this area.

Table 6.1 Management strategies for cognitive-behavioral problems

Problem areas	Problem observations *person may …*	Management strategies *caregivers and staff should …*
Confusion and disorientation	• Misinterpret information or be fearful in the environment • Be confused about time, day, present location • Yell out of fear or frustration	• Use familiar and functional tasks that are simple, routine, and repetitive such as washing face, combing hair, etc. • Provide wall calendars, clocks, and written reminders to orient to time and place • Limit the number of visitors and distractions (e.g., radios, TVs, etc.) • Simplify tasks by providing step-by-step instructions and only objects needed to complete each step
Reduced initiation	• Fail to carry out verbalized plans • Lack spontaneity or drive • Show limited interest in engaging in activities • Appear passive • Have difficulty generating ideas	• Use gentle physical guidance to help the person get started on a task • Provide structured directions • Establish a fixed routine • Use technology aids such as text messages, vibrating cell phones or pocket alarms to cue person to initiate tasks
Filtering information	• Appear not to listen • Have difficulty filtering information • Be unable to "multitask" • Miss details • Have difficulty prioritizing • Forget what people have said • Have difficulty concentrating • Be only able to cope with one thing at a time • Be easily sidetracked or distracted • Change the subject often • Not complete what they say or be "long winded" • Become easily bored	• Use short, simple sentences • Keep activities short • Ensure the person writes down important information • Assist the person to monitor and check work for errors • Encourage the person to engage in and complete one activity at a time • Reduce external distractions (noise, people) • Limit the number of items in tasks and/or only provide objects needed for next task step • Bring the person's focus back to task • Change activities to maintain interest

Pacing speed of response	• Take longer to complete tasks OR rush to complete tasks and make numerous errors • Take longer to gather thoughts and respond • Appear impulsive or disinhibited • Be unable to keep track of lengthy conversations or multiple step instructions	• Give the person extra time to respond or complete tasks • Speak clearly and at an even pace • Present only one thing or directional step at a time • Try not to interrupt the person • Re-direct the person to the task or conversation • Use touch to cue the person to slow down or speed up
Inflexibility or "getting stuck"	• Be unable to accommodate for, or adapt to change • Become "stuck" repeating actions or tasks • Be unable to shift to new tasks • Persist with incorrect methods despite feedback	• Assist the person to identify signs of frustration and stop what they are doing • Provide alternative ways of completing a task so a choice is available • Direct the person to another activity if they are continually making errors • If they are talking off topic, direct the person back to task by asking specific questions
Visual perception	• Misidentify, omit, fail to locate, align or position objects accurately • Skip over letters or words or misread letters when reading • Misuse objects that look similar • Have difficulty in functional tasks that require spatial placement such as dressing or object assembly • Pay unequal attention to both sides of the environment and neglect objects on one side (typically the left)	• Place a bright object or the person's arm on the neglected side of the task • Use bright tape to outline or surround key portions of task or object • Present information in a limited and organized structure • Keep visual space uncluttered • Use a small paper or plastic guide to assist scanning during reading • Place objects or clothing in the spatial orientation needed to complete task

(continued)

Table 6.1 (continued)

Problem areas	Problem observations *person may …*	Management strategies *caregivers and staff should …*
Loosing track of information[a]	• Have difficulty following instructions or conversations • Lose track of what they are thinking, doing, or saying • Get information mixed up or become confused • Repeat errors or steps	• Keep activities and instructions short and uncomplicated • Ask specific or direct questions • Provide reminders and checklists to the next step in a task
Remembering information over time[a]	• Forget conversations, names, appointments • Have difficulty learning new things • Lose or misplace things • Have difficulty recalling what they learned	• Repeat information as necessary • Provide cues and reminders to help recall • Encourage rehearsal of new information • Encourage use of external memory aids; diaries, calendars, time tables • Use electronic devices such as cell phones, PDAs, and computers to cue memory and hold information • Maintain designated places to organize objects
Planning and organizing[a]	• Have difficulty preparing for a task • Take a haphazard approach to tasks • Be unable to work out the steps or sequence involved in a task • Lose track of the task goal and become side-tracked • Not consider the consequences of their actions • Have problems organizing their own thoughts and explaining things to others	• Encourage the person to consider what they are about to do before commencing an activity • Provide a written structure or guideline outlining the steps in order • Give prompts or steps • Help develop a timetable (weekly, daily) to establish a routine of activities • Keep the environment organized so items are always kept in the same place • Encourage the person to take time to think about what they want to say

Problem solving[a]	• Have difficulty working out solutions to problems • Be unable to generate new or alternative ideas • Have a disordered approach to problem solving	• Help identify an achievable outcome for the task, ensure there is a purpose • Avoid giving open-ended tasks • Help the person to approach tasks in a more systematic manner • Assist the person to break a task down into smaller components • Reduce the demands made upon the person (one thing at a time, start simple)
Reasoning[a]	• Have a rigid and concrete thinking style • Take statements literally • Fail to "put themselves in another's shoes" • Be resistant to change • Have a simplistic understanding of emotions • Show poor judgment and poor decision making skills	• Use simple and direct language and avoid talking in abstract terms • Explain changes in routine in advance, giving reasons • Try not to get into arguments with the person • Avoid using emotional undertones • Provide real life examples (preferably the person's) when offering explanations
Mental fatigue[a]	• Tire quickly during mental effort • Have reduced tolerance and ability to cope • Easily become irritable, anxious, or agitated • Be overwhelmed and become "frozen" or "shut down" • Have their other problems exacerbated	• Encourage the person to take rest breaks • Schedule more demanding or essential tasks when the person is at their best (often morning) • Arrange activities to be shorter where there is an achievable goal

(continued)

Table 6.1 (continued)

Problem areas	Problem observations *person may …*	Management strategies *caregivers and staff should …*
Self-monitoring[a]	• Show poor adherence to rules • Not realize they have made errors because they have not checked their work • Monopolize conversations • Be verbose and keep talking when others are no longer interested	• Reinforce specific requirements of an activity • Encourage the person to check over their work • Provide checklists to structure monitoring • Immediately indicate, or provide feedback, when errors occur or when the person talks too much • Use signals, which have been agreed to in advance, to let them know they are talking too much • Encourage turn taking in conversations
Awareness[a]	• Be unaware of cognitive and physical limitations • Recognize mismatch between task demands and skills only when problems are encountered • Set unrealistic goals, plans, and expectations • Be resistant to the effort of caregivers/staff	• Ask person to state task goal and possible problems prior to beginning task • Provide explanation why proposed action (not the person's own plan) is useful, and reason through the steps (small steps, start gradually etc.) • Help to identify realistic goals—these may be smaller components of a lager plan, but more achievable
Language	• Have difficulty speaking, reading, or writing • Have difficulty understanding spoken or written words	• Simplify sentences • Use gestures, point, or touch to help • Allow increased time • Use alternate communication methods such as pictures or technological aids • Consult with the speech-language pathologist for additional suggestions

[a]Sections adapted with permission from *Working with People with Traumatic Brain Injury*. Developed by the Brain Injury Rehabilitation Directorate, South Western & Southern Sydney Area Health Service Training. http://www.tbistafftraining.info/SelfStudy/Module_4/4.0.htm

Specific Symptoms

Physical and sensory changes: TBI can cause a wide variety of changes in sensation, movement, balance, or coordination, depending on the area of the brain that is affected. Sensory changes can include decreased sense of touch, smell, or taste. There may be a ringing sensation in the ears, blurriness of vision, double vision, and loss of depth perception. In some cases, peripheral vision to one side may be diminished or lost.

Physically, paralysis, incoordination, or weakness on one or both sides of the body can occur. Balance may be affected and the person may need to use an assistive device such as a cane or walker to walk safely. Manipulating small objects, picking up coins, buttoning, or zippering can be extremely effortful. Some people make an excellent physical recovery after a brain injury, which can mean there are few observable signs that an injury has occurred. There are often physical problems present that are not always so apparent, but can have a real impact on daily life. Those that appear to have made a good physical recovery may find it difficult to engage in physical activities because of fatigue, dizziness, headaches, or distorted perceptions. For example, depth perception may be disturbed and the person may feel less secure in their surroundings. The person may misjudge the space around them. Objects that appear to be distant may be close and the person may bump into objects, misjudge the height of a step, or appear clumsy. Crowded environments may be difficult to navigate. The person may be at greater risk of losing balance or falling when there are a lot of distractions in the environment or when they need to quickly change direction of movement.

These physical changes can result in disruption of roles and routines. The person may not be able to manage everyday household chores such as emptying the dishwasher, taking out the garbage, shopping, and cleaning. A parent may no longer be able to engage in sports or bicycle riding with their children. Subtle changes in physical skills can also impact the ability to work, depending on the physical requirements of the person's job. The inability to resume former roles and responsibilities can result in depression, anxiety, and a lost sense of self. If physical changes are accompanied by cognitive changes, it further compounds difficulties as well as the recovery process. For example, it may be difficult to learn important physical exercises and do them independently. Physical and occupational therapists can help survivors and their families in addressing the physical and sensory changes that can occur after an injury.

Changes in language abilities: Difficulties that affect the ability to speak and understand others are observed with injury to areas of the brain responsible for language. This is termed "aphasia." Some people with aphasia have difficulty finding or using the right words in sentences (i.e., expressive aphasia). Persons with TBI may say words in the wrong order, substitute words with different meanings, use profanity unintentionally, use a single word repetitively, or say a word that does not make sense. Speech is described as nonfluent as it is often limited to halting single words. The person may understand everything that they hear or read but cannot express themselves verbally or in writing. Other persons with aphasia have less difficulty speaking and more difficulty understanding what they hear or read (receptive

aphasia). They may misinterpret words, require extra time to process what they hear, or need pictures or gestures to supplement spoken language. In some cases, there may be difficulty with both speaking and understanding (global aphasia).

Aphasia may be mild or severe. For example, mild aphasia may only be apparent in group settings, when rate of communication is increased or when sentences are long or grammatically complex. In addition to aphasia, poor articulation or difficulty in coordinating speech mechanisms may also be observed and speech may be slurred and difficult to understand (dysarthria). Language difficulties can significantly impact communication and social relationships. Family members and friends may need to learn different types of communication strategies—how to simplify sentences, use gestures, allow increased time, provide communication cues or communicating using alternate means such as touch, pictures, gestures, or technological and communication aids. See Table 6.1 for additional management strategies for language problems. A speech-language pathologist can work collaboratively with families and other health care team members to address a person's communication needs.

Changes in emotional control: Sometimes, the area of the brain that controls and regulates emotions is affected by the injury and the person experiences emotional fluctuations. Frequently, the person's emotional reaction does not match the actual situation. For example, the person may laugh when something is not funny or cry inappropriately. Emotions can appear very quickly and intensely, but they often do not last long. It is important to recognize that the person's emotions may not actually match what the person feels. In other words, they may not be able to stop crying even though they are not feeling sad. These sudden changes in emotion can be confusing to others, but it is important to keep in mind that these changes can occur without any apparent reason.

Anger and frustration may also erupt easily and without warning. The person may be extremely irritable with a quick temper. They may yell, shout profanities, throw or bang objects, or threaten to hurt others over insignificant events or when they become frustrated.

Family members can help by remaining calm, and by redirecting the person's attention or taking them to a quiet area so that they can regain emotional control. Sometimes self-calming strategies (such as closing eyes and visualizing a calm ocean) or relaxation techniques can be taught. In some instances, a behavior management program may be required. A psychiatrist or psychologist should be consulted when there are emotional or behavioral issues. Medications may be prescribed by physicians to help stabilize emotions or decrease their intensity.

The Effects of Post-TBI Symptoms on Daily Life

A person living with brain injury is faced with multiple challenges in everyday daily life activities that were previously taken for granted. The person may struggle with morning routines, shopping, managing finances, crossing the street, planning daily schedules, or using everyday technologies. Simple activities may now be effortful,

fatiguing, and overwhelming. While physical symptoms such as weakness, spasticity, or uncoordinated movements pose obvious challenges with navigating one's environment, driving, walking distances, etc., the other symptoms commonly documented post-TBI exert their own impact.

Cognitive deficits post TBI present significant daily life challenges. Difficulties in attending, perceiving, or thinking are not always readily apparent immediately following injury because cognitive perceptual symptoms can be easily misinterpreted. Cognitive perceptual symptoms manifest differently with the demands of the situation or activity at hand. In many situations, the person may function quite well, yet at other times, the person may have difficulty with seemingly simple tasks. For example, a person may have no difficulty keeping track of a conversation with one other person within a quiet home environment; however at a dinner table with 6 other people, the same person may be unable to focus or keep track of what was just said. There may be days that the person has no difficulty getting ready in the morning or shopping and other days when everything falls apart. The degree of distractions, the level of familiarity and predictability, the amount of things that are going on simultaneously, and the degree of structure are examples of external factors that can significantly impact the brain's ability to process, organize, or interpret information. In addition, internal factors such as level of fatigue, anxiety, stress, pain, or depression can also affect cognitive and functional performance.

Linda had her own apartment and was generally independent in routine activities. As she was getting ready for a therapy appointment 1 day, she became distracted after breakfast and began emptying the dishwasher. She lost track of time and then panicked when she realized she only had 20 min to get ready. Her anxiety increased as she quickly washed up, got dressed and flew out of the house. When she was a block away, she realized she forgot to comb her hair. She also realized her pants were unzipped and the buttons on her blouse were mismatched. She also discovered she was wearing two different shoes.

Cognitive lapses such as forgetting to do something, loosing track of something that was just done, or doing task steps in the wrong order are more likely to emerge when a person is anxious or stressed. The person may be generally independent in dressing but under some situations, they may be more likely to make errors. Similarly, slight differences in instructions can impact performance.

John was told to make a ham and cheese sandwich for lunch and he had no difficulty. However, when John was asked to see what was available in the kitchen and make himself something for lunch, he became confused and overwhelmed and did not know where to begin.

The latter instruction is less structured and requires the person to initiate ideas, make choices or decisions, and formulate goals. Thus, across all daily life activities, it is important to carefully observe the conditions which seem to enhance or support function as well as the conditions under which cognitive symptoms are most likely to emerge. Slight changes in instructions, environments, and activities can significantly impact performance. See Table 6.1 for additional management strategies for cognitive problems.

There may also be situations in which the information presented to the person with TBI is lost. This may occur due to factors such as the amount of information presented and the way it is presented (i.e., organized versus disorganized). As a result, the person may appear frozen, agitated, or anxious.

Cognitive fatigue is an additional symptom that is highly prevalent post-TBI. Cognitive fatigue is seen when the task requires a greater effort to complete than the person's current cognitive skills. The thinking effort causes a decrease in task performance. It is important to recognize the signs of cognitive fatigue and the warning signs of cognitive overload so that adjustments can be made to increase the functional abilities. See Table 6.1 for additional management strategies for dealing with cognitive fatigue.

Persons with brain injury experience cognitive and perceptual symptoms differently from one another. These symptoms are inter-related and can impact all aspects of everyday function.

Impact of Specific Cognitive and Perceptual Symptoms on Activities of Daily Living

Reduced initiation or "Adynamia": The drive or passion to engage in past activities may be diminished following a brain injury. Loss of spontaneity and drive or apathy may be observed and mistaken for laziness or depression. A disassociation between what one says they will do and what he or she actually does is often observed. The person may verbally state that they would like to take a walk or call friends but then fail to actually carry out their intentions.

> *Kathy was described as a "go getter" before her injury. In addition to juggling a full time job, she exercised daily, enjoyed swimming all year round at a local pool, participated in a reading club with friends, volunteered at a local charity, and loved to cook and try new recipes. Now, 6 months after her injury, Kathy sits around her house all day long and contentedly watches TV, day after day. She does not initiate or show any interest in exercise, swimming or cooking. Hours will pass and dishes are left in the sink, bills are left unpaid, phone messages are not returned and errands are not done. When her lack of activity and productivity is pointed out, Kathy states that tomorrow she will get to her errands, but day after day is the same. If someone directs Kathy to do activities, she does them, but she doesn't go any further. Kathy does not show signs of depression. She has a good appetite, has no difficulty sleeping and does not express sadness. She has good intentions but she has difficulty translating her intentions into actions and getting herself going.*

Difficulties in initiation can range from severe to mild. The person may not initiate routine everyday activities such as getting ready in the morning and preparing meals or snacks. If someone reminds the person to get washed or dressed, he or she typically can complete the task but they do not initiate these activities themselves. In a hospital setting, where others tell you where to go, when and what you should eat, and what to do, the difficulties in initiation can be less apparent. However, the lack of structure within a home environment can significantly increase these symptoms.

In mild cases, the difficulties in initiation may be less obvious but friends and relatives may perceive a drastic change in personality. A person that always had an opinion, and initiated questions, conversations and activities, may appear to be passive, dull, or "blank." The person may have difficulty generating ideas.

When Kathy was asked about all of the things she could make for dinner she was only able to state two things and then drew a "blank." When given hints, she could think of additional ideas but she needed someone to prompt her to keep the ideas flowing.

A fixed and structured daily routine can decrease initiation difficulties. In addition, external cues such as index cards with conversation starters or aids such as a vibrating pager or alarm on a cell phone can help someone initiate conversations or actions. A highly structured program that involves structured goal-directed activities, motivational incentives, and monitoring of the number and length of time spent of activities may be beneficial. See Table 6.1 for additional management strategies.

Filtering information/selective attention: Our brain acts as an automatic filter and helps to decide what we should pay attention to and what we should ignore. For example, while sitting in a room listening to a lecture, we are able to tune out the sound of the traffic on the street; we ignore the different decorations on the wall and focus on the lecture. If we tried to take everything in at once, we would not be able to process the lecture. Following a brain injury, the process of filtering out unimportant information may be disrupted. The person may get easily sidetracked by information that is unimportant or irrelevant to the task at hand. It may seem impossible to focus on a task when other things complete for attention. It may also be hard to make decisions or prioritize because everything may seem to have equal value. The person may be easily overwhelmed because they are not sure where to direct their attention.

Janet went to the supermarket but she didn't know where to begin. Everything looked the same. She looked at the shelf with soup cans but she couldn't decide which one to buy. The number of items on the shelf, and the noise, signs, and lights were overwhelming; she left to go home without purchasing any of the items that she needed.

Shopping involves negotiating crowds and busy environments and ignoring products that are not needed. A person with a brain injury may find the experience of shopping completely over-stimulating as they may not know where to focus their attention. They may find themselves wandering aimlessly up and down the aisles without buying anything, or conversely they may find themselves distracted by extraneous information or buying extra things they do not need. Activities such as shopping, going to a mall or restaurant, crossing the street and taking the subway or bus can all become very difficult because of the experience of "overload."

Processing speed: A person's actions and responses may be exceedingly slow. When processing time is slow, the person requires extra time to understand or comprehend information and to speak or respond. They may miss information during conversations, speak and move slowly and take twice the time to complete daily tasks.

Impulsivity/disinhibition: Difficulties in modulating the speed of response and thinking before acting or saying something is described as impulsivity and/or disinhibition. For example, a person may quickly take clothes out of the closet during dressing, without considering whether the clothes match and are appropriate for the weather or occasion. Crossing the street may be dangerous as the person may dart into the street without thinking or looking for moving vehicles. They may impulsively purchase things that they do not need or fail to consider prices. This can create financial strain and tension between other family members. The tendency to jump into a task quickly without planning ahead or without monitoring actions can result in disorganization as well as errors in judgment and safety. It can also affect the ability to drive, or sustain employment and interpersonal relationships as described later in this chapter.

Getting stuck/alternate attention: A person with brain injury may have difficulty shifting from one activity to the next. As they become involved in one aspect of the task (e.g., making a salad) they may have difficulty moving their focus of concentration to other parts of the activity (monitoring a casserole in the oven). Moderate–severe difficulties are called perseveration and are characterized by repetition of actions that are not related to memory difficulties.

> *Tim was making tea. He moved a tea bag in and out of the cup repeatedly. He seemed unable to move on to the next step. When he was asked if he was finished with the tea bag he said yes, but continued to move it in and out of the cup. When he was asked to put the tea bag down and put 1 teaspoon of sugar in his cup, he did so but instead of putting 1 spoon of sugar, he put 3 spoonfuls of sugar. Tim had difficulty stopping his actions and tended to repeat himself.*

In addition, to repetition of actions, a person may become stuck on a thought or past event. They may have difficulty "letting go" of insignificant events and bring up the same topic or issue again and again. This can be described as a "stickiness of thinking" or cognitive inflexibility.

> *Mary was upset that her physician told her she could not drive for the next 6 months as she felt she was ready to resume driving. She brought up the issue of driving multiple times in every conversation she had, regardless of with whom she was speaking.*

In addition, situations may be perceived from only one perspective and the person may have difficulty seeing other viewpoints or generating alternatives.

Processing visual perceptual information: Visual perceptual changes can result in difficulties in processing, understanding, or interpreting visual information. Although vision may be normal, the person may overfocus on some parts of visual information, while missing other parts. There may be misidentifications, omissions, and a failure to locate, align, or position objects accurately. Reading may be characterized by a tendency to skip over letters or words or misread letters.

Containers or objects that are similar in size and shape may become easily confused as key visual details may be missed. For example, a person may misidentify a tube of hand cream as a tube of toothpaste and put the hand cream on their

toothbrush. It may seem as though the person is disoriented and confused, however memory and attention may be intact. The brain may be unable to accurately process visual and spatial information in the world around them.

Spatial difficulties may result in improper alignment and positioning. For example, a person may put on a shirt backwards or inside out. They may put their hand through the wrong end of a sleeve or miss or misalign buttons without realizing it. Simple tasks such as fitting a plug in an outlet, opening a combination lock or putting batteries in a flashlight may seem impossible.

In some cases, the person may have difficulty attending to both sides of space. Attention may be over-focused on the right side of the environment and the person may miss information on the left side. This is sometimes described as left or right neglect or inattention (depending on the side of space that is ignored). Crossing the street or driving will be unsafe if the person has difficulty simultaneously attending to all aspects of the environment.

Visual perceptual difficulties can result in difficulty locating, distinguishing, and identifying needed items on shelves or cabinets. Tasks such as pouring, estimating quantities, measuring or dividing amounts, and arranging food on trays, platters, or within confined spaces may be challenging. Setting a table may be particularly difficult as it requires the ability to estimate space, and align or position items in relation to each other. Other aspects of cognition contribute to such limitations as well. Visual perceptual difficulties can also make it difficult to perform work tasks such as accurately entering or reading information on spreadsheets or space and align information accurately on a page during math or writing.

Language abilities: Language comprehension and expression are often impacted by TBI, as discussed in the previous section.

Loosing track during activities/working memory: The ability to keep track of what you just said, read, or did is referred to as working memory. Working memory is commonly affected after a TBI. The inability to hold all parts of an activity or situation in mind as one is performing an activity can result in continual errors in daily tasks. For example, a person may end up washing their face twice, because they lost track of steps they previously completed. They may forget how many pills they just swallowed while taking medications or during cooking, may forget an item they just placed in the oven. Decreased working memory can narrow the attentional lens and reduce the ability to multitask.

> *Jane previously loved to cook and entertain but she found that cooking a simple meal took her twice as long as it did before because she could only handle one thing at a time. "I make a salad first and then I heat up sauce and then I boil water for pasta. Before I did it all at the same time but now it is too confusing and I always end up forgetting something, so I just do it one at a time."*

Working memory is considered to be a foundation for higher cognitive processes. If a person is unable to keep track of all parts of a situation, it influences the ability to make sound decisions, organize information, and solve problems.

Remembering information over time/episodic memory: After a TBI, remote or long-term memory for events that occurred years prior to the injury is commonly unaffected, however new learning or the ability to remember from day to day, since the injury, is frequently decreased. The person may recall details of vacations taken years before the injury but at the same time they may completely forget a conversation or event that occurred the day before. Activities that involve active "doing" and are highly meaningful or have emotional value may be more likely to be remembered than conversations or facts.

The process of memory can be described as the three R's (registration, retention, and retrieval). Registration involves taking in all aspects of a situation and is related to attention and working memory. Retention involves storing or holding onto information over time (retaining) and retrieval includes pulling the information out of memory when it is needed. Other cognitive processes such as attention, the ability to filter distractions, and initiation influence memory processes. If a person does not fully attend to information that is presented, it is unlikely that they will be able to recall the information at a later point. Similarly, the process of retrieval or trying to recall where you left something involves searching your memory by initiating asking yourself questions. A person with difficulty in initiation may not be able to generate the systematic search of their memory.

Memory problems can be related to difficulty taking information in, storing it, retrieving it, or a combination of all three.

> *A therapist showed Jeff how to operate a new microwave oven that was just installed in his home kitchen. Memory for this activity can be affected in different ways. (1) Jeff was unable to attend or keep track of the directions during the activity (working memory) and therefore does not recall the instructions at a later time. (2) Jeff paid careful attention to the instructions, but the next day, he had little to no recollection of the activity that took place. In other words, Jeff was able to take in or register information but was unable to hold or store the information over time. (3) Jeff was unable to recall the activity but when he was reminded of the learning context, location and other key information, he was able to recall more details. This suggests that Jeff stored the information but was unable to search or locate it in his memory. (4) Jeff had no recollection of learning how to operate the microwave oven but when he saw the microwave oven, he automatically knew how to operate it. This type of memory is called procedural memory or the unconscious memory of how to do something. (5) Jeff recalls how to operate the microwave but he forgot that he was supposed to put something in the microwave at 3:00 p.m. Memory for future intentions is called prospective memory.*

Memory provides continuity from day to day and helps us learn from our experiences. Memory difficulties impact learning and all facets of daily life, thus it is important to understand the person's memory strengths and limitations when planning treatment. Different types of memory problems require different treatment strategies. In some cases, external aids such as a voice recorder, smart phone, notebook, or pocket personal computer that can store or hold information over time may be recommended. Persons who are comfortable with technology or used such devices prior to their injury may more easily accept using them to support their memory. External aids also require ability to anticipate and recognize problems. In other situations, the focus of intervention may be on helping a person use strategies

to more fully attend to and deeply process or take in information. Errorless learning, which capitalizes on procedural memory and is typically unaffected in persons with TBI could be used when learning new tasks through repetitive practice. Learning without errors may be used to enhance the ability to learn a specific task or routine. See Table 6.1 for additional management strategies for memory problems.

Organizing, planning, and problem solving/executive functions: The cognitive symptoms described above can reduce the ability to plan, organize, and solve problems. Inability to keep track of all aspects of a situation or activity, restrain impulses, self-monitor performance and plan or think things through before acting can result in a haphazard approach to problems and situations. As a person becomes involved in an activity, the main goal may fade away, and the person may become sidetracked or never complete what they set out to do. Problem solving may be reduced as the person is unable to consider all the variables of the problem simultaneously, anticipate consequences, recognize or choose the most important aspects and make decisions that follow a logical sequence.

Organization of time, materials, and/or thoughts is challenging. As one brain injury survivor stated …"*it feels like a bomb exploded in my head and all the pieces are floating around my brain but I can't connect the pieces*." The person may jump into activities without gathering the necessary materials.

> *Robert was making coffee for breakfast and realized he needed milk. He went to the store to get the milk but when he came home he also realized he did not have sugar and went back to the store. By the time he was finished breakfast, it was almost lunchtime. Robert failed to plan ahead and anticipate the materials that were needed. As a result, the simple task of making breakfast became time and energy consuming.*

Persons with brain injury often have difficulty keeping track of materials and time as they are doing an activity. For example, they may spend extra effort looking for materials that were misplaced, repeat steps that were already completed, or fail to consolidate steps and materials, resulting in inefficiencies or a disorganized quality of performance. Similarly, conversations or written communications may be characterized by a tendency to jump from one idea to another. The person may have difficulty expressing their thoughts in an organized way.

The cognitive perceptual symptoms described above can impact the same everyday activities in different ways. For example, managing finances requires the ability to make good judgments regarding purchases, compare and contrast prices, keep track of spending, plan and stay within a budget, use an ATM machine, organize and remember to pay bills, discriminate numbers, calculate and make change. Brain injury survivors may have difficulty with the task of managing finances for very different reasons, depending on the underlying cognitive perceptual problem.

> *Kay realized that she paid the same bill to a company 3 times but she neglected to pay 2 other bills and received overdue notices.* In contrast*, Jon paid all of his bills on time, however, he made frequent careless errors such as writing out the wrong amounts on checks and often purchased items he did not need while Monica had difficulty quickly discriminating coins and bills and selecting the right amount of money to pay for items in the store.*

A clinician can assist in analyzing the reasons why a person is having difficulty in a particular daily life activity as well as to provide methods to enhance everyday function. Careful manipulations or modifications of the environment and activity as well as training strategies within the context of everyday activities to help brain injury survivors learn to recognize, monitor, and compensate for cognitive symptoms is an important part of rehabilitation programs. See Table 6.1 for additional management strategies for cognitive behavioral problems.

Awareness/insight into physical and cognitive changes: One of the obstacles to rehabilitation after brain injury is diminished awareness of difficulties. After a TBI, the person may not be fully aware of physical impairments, limitations in activities, or changes in thinking skills, emotional control, and behaviors. This may be related to the brain injury and associated cognitive deficits, the person's psychological response or a combination of both. It takes time to recognize and accept the changes that have occurred. A person may not make the connection between the injury and changes in performance. They may not recognize or understand the changes that have occurred in themselves. Awareness often emerges slowly with time. After a brain injury, the way the brain processes information is different. The same methods that the person used before the injury may no longer work.

> *Jane never had to write things down. She was proud of her organized approach to tasks and situations and ability to always able to keep track of everything she needed. After a mild brain injury, Jane found herself constantly loosing things, and forgetting things she had just done. Her apartment was completely disorganized with piles of clothes and papers. She felt like she was losing her mind. She knew something was different but she blamed it on her fatigue and lack of energy and did not acknowledge any changes in thinking skills.*

Jane was approaching activities the way she did before the injury, without writing things down, or creating a list. Jane needs to learn about her new strengths and weaknesses and explore different methods or strategies that she may not have needed to use before the injury. See Table 6.1 for suggested strategies addressing self-monitoring and awareness problems.

Denial or a psychological response to an injury or illness is different than impaired self -awareness as a result of brain injury (Kortte & Wegener, 2004). Denial is a coping strategy or a defensive reaction that is associated with personality characteristics such as a history of denying inadequacies or a need to be in control. Denial can be adaptive in the early stages of an injury, however if it persists, it can prevent a person from developing realistic goals and plans. The person may have at least partial awareness of mistakes but denies problems, over-rationalizes mistakes, makes excuses, or places blame for difficulties on external sources such as the task itself or other people.

Impaired self-awareness as a result of brain injury is a lack of information or an inability to perceive the impairments (Stuss, Picton, & Alexander, 2001). The person does not recognize the changes that have occurred. In severe cases, the person may not acknowledge physical changes resulting from the injury and attempt to do tasks such as getting out of bed without assistance despite an inability to move one side of their

body or having casts on their legs. More typically, the person acknowledges physical limitations but does not recognize the less obvious cognitive and behavioral changes.

Often both denial and impaired awareness as a result of the brain injury interact together and are difficult to separate, such as in the example of Jane above. As the person begins to recognize changes that they do not understand, they may cope by denying that anything is wrong. Decreases in awareness therefore can be a combination of partial recognition of limitations and defense coping mechanisms. Reactions of blame, anger, or hostility to feedback tend to be more related to denial mechanisms, whereas reactions of perplexity or indifference tend to be related to impaired awareness resulting from neurological deficits (Prigatano, 2008).

Regardless of whether impaired self-awareness is related to neurological or psychological defense mechanisms, an inability to recognize, acknowledge, or accept difficulties can result in overestimation of abilities and prevent a person from developing adaptive strategies to manage cognitive symptoms, compensate for limitations, and safely perform functional tasks. Overestimation of one's abilities also creates repeated experiences of unexpected failures that can impact a person's sense of control over performance.

For example, one survivor said "*I never know when lightening is going to strike. Sometimes everything turns out well but other times everything seems to go wrong*." Decreased ability to accurately anticipate outcomes of everyday activities can cause a person to believe that their own performance is outside of their control or unpredictable. Decreased or partial awareness can lead to perceived loss of control, anxiety, decreased self-confidence and self-esteem as well as frustration, anger and depression as the person gradually experiences difficulties with activities they took for granted before the injury.

Very often, as awareness begins to emerge and the person recognizes that they are having difficulty, there can be accompanying feelings of loss of a sense of self. For example, one survivor said "*I think differently and I can't do the things that I did before…My memory is unreliable and my brain doesn't always take everything in. I feel different, but I look the same. Everyone expects me to do the things that I did before but I can't. I don't know who I am anymore. I say things without thinking and I made embarrassing mistakes. My brain is messed up.*"

In this case, the person is aware of their cognitive symptoms and changes in thinking but at the same time, the person perceives a lack of control over these symptoms and is experiencing a "shaken" sense of self or loss of self-identity.

Cognitive skills are frequently associated with a person's self-identify. For example, a person may be described by others as "detail oriented" or "well organized." When a person's brain no longer processes information the way it did before the injury and a person is unable to return to their former lifestyle, there is a sense of loss. The person has to rediscover their strengths and weaknesses as well as to rebuild their sense of self-identity. An important step in the recovery process is recognizing, understanding, acknowledging, or accepting difficulties so that the person can regain a sense of self-identity, perceived control, and competence over performance.

Participation

The myriad of symptoms following TBI often result in limitation in an individual's ability to participate fully in society. Physical symptoms (gait disturbance, slowness, weakness), cognitive symptoms (slowed processing speed), and psychological symptoms (depression) often preclude an individual from community re-integration. Additionally, the environment may be enabling or disabling. For example, ramps will facilitate entry of an individual with weakness into a local support group. A work environment with fewer distractions may facilitate employment.

The ultimate goal of rehabilitation following a TBI is helping a person re-integrate back into the community and his/her life. This includes independent living or competence in everyday tasks, social participation, and the ability to develop or maintain social relationships, resumption of productive, and meaningful activity such as employment, return to school, community activities, and leisure pursuits. Outcome studies indicate that between 26 and 45 % of people with severe TBI are poorly integrated into their community in the longer term (Temkin, Corrigan, Dikmen, & Machamer, 2009).

The Impact of TBI on Personality and Social-Emotional Functioning

Psychosocial functioning: Feelings of sadness, anger, and frustration are normal responses to the losses and changes a person faces after a TBI. It takes time and support to adjust and adapt to the changes that have occurred. High levels of anxiety and loss of self-esteem can also occur as a person experiences repeated and unexpected failures. If these feelings interfere with recovery or everyday functioning, treatment from a psychologist or psychiatrist is required.

Persons with TBI have a higher risk for depression than persons in the general population (Whelan-Goodinson, Ponsford, Schonberger, & Johnston, 2009). Depressed mood in persons with TBI is associated with irritability, frustration, anger, hostility, rumination, negative thinking, poor appetite, and sleep disorders. It is often difficult to diagnose major depression or other psychiatric disorders due to the cognitive, behavioral, and emotional symptoms that occur with brain injuries as these symptoms overlap with psychiatric disorders (Ciurli, Formisano, Bivona, Cantagallo, & Angelelli, 2010). Persons with TBI and depression or anxiety tend to considerably underestimate their abilities and self-report more cognitive and physical impairments than observed on testing. This is different than persons who exhibit unawareness and tend to overestimate abilities (Seel, Macciocchi, & Kreutzer, 2010).

Coping skills are significantly compromised after a TBI, resulting in increased vulnerability to the effects of stress, depression, and anxiety. Coping involves the ability to identify problems, generate alternate solutions or possibilities, and view a situation from different perspective; however, these skills may be directly affected by the injury. Life events such as a move to a new apartment, tensions in relationships or a death of a close relative or friend can create stress that is overwhelming.

A person that was functioning well can begin to slip backwards. Everyday function can quickly deteriorate under pressure and stress. The reduced coping abilities following a brain injury make it important to have long-term psychological supports in place to help a person deal with life challenges when needed.

Social participation: Social isolation is one of the main issues affecting life satisfaction.

The cognitive symptoms observed following a brain injury, significantly impact one's personality and social and interpersonal relationships. Social situations require the ability to simultaneously attend to the overall context of a situation and pick up on subtle nonverbal or emotional cues in facial expression or body language, as well as keep track of and understand the content of conversations. Many cognitive skills including the ability to infer what another person might be thinking or feeling, "reading between the lines," recognizing the intentions of others and hidden agendas, viewing a situation flexibly from different perspectives and anticipating consequences are involved in interpersonal situations. A person may fail to pick up on social cues and say things that are inappropriate to the context or situation. Slow processing speed can result in challenges in keeping up with the pace of a conversation, causing a person to withdraw. Difficulty in organizing one's thoughts may result in a tendency to jump from one idea or thought to the next. The person may stand out as "odd" because they may repeat things that were previously said, become sidetracked or say something that is inconsistent or inappropriate to the topic. Disinhibition or difficulty monitoring oneself can result in behavior that can be interpreted as rude, inappropriate or offensive. A person that was previously reserved or shy may suddenly shout things out in public, make inappropriate sexual advances, comments, or use profanities. They may raise their voice or speak in a threatening tone without realizing it and may say whatever is on their mind without thinking ahead of the consequences.

At the opposite end of the spectrum, a person that displays decreased initiation may have difficulty sustaining engagement in meaningful conversation. A person who was previously outgoing, and friendly may sit passively, without asking others questions or without the ability to generate ideas for questions or conversation. They may show little emotions and appear bored or disinterested in others.

Problems in cognitive flexibility or the ability to view situations from different perspectives can also be problematic. The persons may appear self-centered and less empathetic because they have difficulty understanding the other person's views or putting themselves in another person's shoes. A person may not see anything wrong with coming into a room and interrupting a serious conversation or changing the TV channel when others are in the midst of watching a movie because they may be overfocused on their own goals and be unable to see a situation from the perspective of others.

Persons with physical problems resulting from the injury may also face challenges and barriers to their participation. Restrictions in the person's physical ability to leave the home and/or enter into public spaces may prohibit the ability to be economically and socially engaged in the community. If the person is not able to drive a personal vehicle, alternative community mobility options may not be available or accessible to support community social participation.

All of these problems can decrease the ability to form new friendships or relationships as well as contribute to a breakdown of existing social relationships. The changes in social participation can be subtle. Gradually friends detect personality or cognitive changes but may not fully understand or know how to deal with these changes. They may not know what to say when the brain injury survivor cannot find the right words, drops a glass due to incoordination, repeats the same story three times or when he or she has an emotional outburst over an insignificant incident. Observed changes may be misinterpreted as laziness, lack of interest, resistance, irresponsible, unreliable, or moody. Friends may question whether the person is going "crazy." Over time, former friends gradually fade away or become fewer in number. Inability to form or sustain friendships and meaningful relationships over time is a frequent problem following TBI.

Cognitive limitations make it difficult to create new social networks. Comprehensive rehabilitation programs incorporate training in social communication and social skills within treatment. Social training may involve role playing or watching video scenarios of social problem situations and discussing alternative responses. It also may include group activities that require negotiation, compromise, and team work. Activities that involve working together for a common cause, such as producing a newsletter, designing a web page, creating fund raising activities such as bake sales, raffles, or craft fairs can be used to simulate the interpersonal skills required for collaboration in the workplace. Recently, an International Brain Injury Clubhouse model has been established in locations in the United States and Canada. The Clubhouse is a community of members (brain injury survivors, health professionals, and families) that encourages community re-entry and offers vocational and social support systems (International Brain Injury Clubhouse Alliance, 2016, www.braininjuryclubhouses.net/clubhouse.aspx). It provides long-term services to TBI persons living in the community.

Changes in family dynamics: A TBI can have a dramatic impact on the entire family. The focus of rehabilitation and recovery typically centers on the survivor but the injury can also have a negative impact on family members as well. Their lives, plans, and goals for the future have all been affected. Family members may feel frightened, anxious, and concerned about the cognitive and behavioral changes they are observing. All of the cognitive, emotional, and psychological changes described above can disturb and strain the existing family relationships. Even subtle cognitive difficulties can strain relationships. Changes in intimacy often occur and the person either fails to initiate or show interest in intimacy or may demonstrate inappropriate or aggressive sexual behaviors.

The cognitive and behavioral changes that can occur after an injury are a main source of stress and strain in relationships. It is not uncommon to feel that the person is no longer the same. A study that examined family members' reactions to neurological injuries found that one-third reported being "married to a stranger" and nearly half reported feeling trapped and not having a spouse (Mauss-Clum & Ryan, 1981). Family members may have mixed or ambivalent feelings about the person with the injury. They are happy that the person survived, but at the same time may

have negative feelings about the changes in the person's behavior and personality. Other friends and relatives who do not live with the person, may not readily see or understand the changes that have occurred. This can make it more difficult for those that are closest to the person with the injury, as it can create additional feelings of isolation, loneliness, resentment, and guilt. The process of dealing with the loss of a person they once knew, and adjusting to the new changes in that person requires time, support, and family counseling. It is not uncommon for many marriages to end in separation or divorce.

In addition to the challenges of adapting to personality changes, there are changes in roles and responsibilities that create further stresses on family members. Spouses or close family members may feel completely overwhelmed by loss of income, financial pressures, and the burden of extra responsibilities. It is not uncommon for family members to neglect their own personal needs and health or put their own goals and careers on hold, while focusing on the survivor. All of this increases vulnerability of family members to depression, anxiety, social isolation, and caregiver burn out. Family members have an essential role in providing support during recovery. Their ability to provide appropriate structure to enhance functioning is critical to the brain injury survivor's success; however, if family members are completely overwhelmed, it reduces their ability to support the person with the injury. It is essential for families to collaborate with rehabilitation professionals across all phases of recovery. Families need assistance and help in learning how to adapt to the changes with the individual (see Table 6.1 for sample strategies the family can use). They need long-term support to deal with their losses and to take care of themselves as well. Research indicates that a combination of family education, psychological support, family counseling, and skills training can benefit families (Kreutzer, Marwitz, Godwin, & Arango-Lasprilla, 2010). The Brain Injury Association of America (BIAA) and its State chapters are important resources that provide information, education, and support to persons with brain injury survivors and their families.

Driving: Driving requires the ability to scan and attend to all aspects of the environment, follow traffic rules, anticipate problems, and react quickly to unpredictable situations. Problems in concentration, restraining impulses and actions, or simultaneous attention to all aspects of the environment can interfere with the skills needed for safe driving. A person with a brain injury should be assessed for ability to return to driving by a professional who is knowledgeable in cognitive disabilities and their effect on driving. Occupational therapists typically perform both clinical and on-road assessments of driving performance. Inability to return to driving may increase dependence on others and reduce social and community participation. The person may need assistance and mobility training in learning to use public transportation independently.

Employment issues: One of the most common long-term consequences of a TBI is difficulty with or inability to return to work. Estimates of long-term return to work after TBI vary depending on the severity of the injury, cognitive functioning, the person's age and pre-employment status. One study found that less than half of persons with brain injury are able to maintain stable, uninterrupted work over time, after a TBI (O'Neil-Pirozzi, Corrigan, & Hammond, n.d.).

Work is a key issue as being employed has been associated with better life satisfaction and social re-integration of persons with TBI. Even persons with a mild TBI can experience significant cognitive problems that interfere with the ability to sustain competitive employment over time or earn pre-injury salaries. The recent American Community Survey (ACS; Gamboa, Holland, Tierney, & Gibson, 2006) found that when persons with mild TBI are able to return to work competitively, they are more likely to earn less than those without a disability. The economic impact on the individual and society is enormous. The loss of productivity and wages, together with costs associated with management of TBI, has been estimated to be 22 billion annually (Fadyl & McPherson, 2009).

Following a mild TBI, persons can also experience a number of symptoms that affect their capacity to work. Short-term memory difficulties can make it hard to learn new material. Problems in filtering can reduce the ability to stay focused on a task or goal and set priorities. Fatigue or other physical symptoms may result in limited energy or stamina. Language, visual, or emotional changes can further compound difficulties. It is important to have guidance and advice from health professionals as to when to return to work, as returning to work too soon can be detrimental.

Jody returned to work part time as a caseworker after a mild TBI. On the first day she felt dazed and "out of it." She had difficulty concentrating and was easily distracted by phones ringing and the nearby conversations of others. Her supervisor found her a quiet office space but Jody continued to struggle with difficulties in focusing. She was putting in extra effort and energy to complete only half of the work she did before and by early afternoon she found herself mentally exhausted and fatigued. She also experienced difficulty setting priorities, organizing her work and ensuring that her work was complete. "It seemed that everyone was working and speaking at lightning speed and I could not keep up." Although co-workers were initially sympathetic, some questioned her disability as they could not see that anything was wrong. During social conversations, she heard others quietly giggling and realized she had repeated the same sentence. She found herself increasingly isolated and withdrawn. Her self-confidence and self-esteem rapidly deteriorated and she could not understand why she couldn't function like she did before. On one occasion she was speaking to a client over the phone, and began raising her voice without realizing it. Her employer asked to take an extended medical leave.

Jody's case highlights the persisting and hidden symptoms that can occur after mild TBI, as well as the challenges that a person who returns to work may face. Co-workers may easily misinterpret errors or cognitive symptoms as laziness, lack of effort, or not caring. This can create resentment and tensions with co-workers. Accommodations such as a reduced work day and schedule, additional time to complete tasks, or additional structure (written directions) may be needed. If a person returns to work too soon and experiences failure, such as in the case with Jody, secondary problems such as anxiety and depression can occur and further compound the recovery process. A person with a mild TBI may find that as they re-enter the work force, they need to accept a position with lower salary and responsibility because they are no longer able to handle previous responsibilities.

Persons with moderate to severe problems may need intensive support and a specialized vocational program to return to work. Specialized programs typically include simulation and practice of work skills as well as guided practice in actual work situations. Such programs typically have access to special job placements and some programs use a supported employment model that includes use of job coaches. Job coaching includes one to one training within the work environment. In general, successful return to work after a TBI has been shown to improve with specialized vocational interventions (Fadyl & McPherson, 2009).

Return to school: The problems in returning to school to resume previous studies or to pursue future goals parallels that of returning to employment. Students may need additional resources, support, and accommodations to be successful including extended time for assignments and exams, use of a reader, reduction of course load, a note taker, tape recording of lectures, and structured directions for assignments. Even with accommodations, many students need to modify their course of study or revise vocational goals.

Leisure: Following a TBI, it is important for a person to find meaningful activities that bring enjoyment and satisfaction. When we immerse ourselves in hobbies such as gardening, photography, pottery or something else that we love doing, it stimulates our minds, structures our time, connects us with others, and helps us feel good about ourselves. Part of the process of rebuilding a sense of self is helping a person connect to those activities that bring pleasure, as well as a sense of accomplishment and fulfillment. Sometimes, this involves re-connecting with previous interests and activities and other times, it may involve discovering new activities to replace or substitute for activities in which the person is no longer able to engage. If a person is unable to return to work, leisure activities and interests become a main source of life satisfaction. Engagement in such activities is important to one's sense of accomplishment, self-esteem, self-confidence, and overall health (Bier, Dutil, & Couture, 2009).

Cultural Considerations

Defining independence, community participation or quality of life can differ depending on the person's cultural values, beliefs, and socioeconomic status as well as the environment in which they live (Sander, Clark, & Pappadis, 2010). Health professionals sometimes assume that everyone values independence in daily activities. Some family members may want to help the person with brain injury with routine activities because they believe that it is their duty to take care of him/her. Other activities such as participating in religious activities, working, or socializing with others may be more important to the person or their families than independence in routine activities such as dressing. Some cultures and communities place more importance on families or social networks, while others place more importance on work or engagement in competitive sports (Arango-Lasprilla & Kreutzer, 2010). Individuals with brain injury and their families are encouraged to collaborate closely with health professionals by sharing their values and identifying the goals that are meaningful and important to them.

Factors That Affect Recovery and Length of Recovery Time

Although the most rapid changes occur within the first 6 months after an injury, it has been shown that even 10 years after an injury, functional changes are still possible (Parish & Oddy, 2007). Factors that affect recovery include age, level of severity of the injury, cognitive functioning, social and family supports, and previous education and experiences.

Rehabilitation is often provided in the early phase of recovery but long-term supports are needed. Living with a brain injury is similar to living with a chronic illness. The person's needs and challenges in daily life will change across time as life circumstances naturally evolve and change. Periodic intense rehabilitation interventions may be successful at many different points across the person's life. An individual with brain injury and his/her family needs long-term resources and supports to maintain and maximize participation in the community and society.

Collaborating with health care professionals and networking through local chapters of the Brain Injury Association or Brain Injury Alliance can help the person with TBI and his/her family return to or create a new life that is satisfying and meaningful.

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Impact of Multiple Sclerosis on Daily Life

7

Yael Goverover, Helen M. Genova, John DeLuca, and Nancy D. Chiaravalloti

"People live with multiple sclerosis (MS) for decades, making it a disease of selves as well as cells."

(Joy & Johnston, 2001, p. vii).

Emma, a 28 year-old college student, was driving to school. Already late for her 8:45 a.m. class, she glanced down at her watch to check the time. When she looked up at the highway, the road in front of her was blurred. She rubbed her eyes, but it didn't help. She felt like she was seeing double. It was then that she noticed her fingers were slightly numb. She quickly

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pulled over, and called her parents. Three months later, after extensive physical and neurological testing including brain and spinal cord scanning, her doctor informed her that she had Multiple Sclerosis (MS).

Multiple Sclerosis

Multiple sclerosis (MS) is an immune-mediated progressive disease of the central nervous system (CNS) characterized by lesion formation and increased cumulative damage in the brain, spinal cord, and optic nerve. Nerve cells in the CNS are composed of axons that are covered by an insulating material called myelin, which are crucial for the transmission of messages (nerve impulses) through the CNS. In MS, demyelination of these CNS axons occurs and is associated with axonal injury and degeneration, which are the major causes of neurological disability in the disease (Irvine & Blakemore, 2008). MS can be viewed as a dual phase disease involving inflammation and degeneration of axons, which causes disruption in the conduction of nerve impulses. The former occurs during active myelin breakdown and the latter results in chronic demyelinated plaques in which the naked axon seems more susceptible to further damage (Brück & Stadelmann, 2003).

Approximately 400,000 individuals in the USA have MS, with over 2.5 million individuals suffering worldwide (Anderson et al., 1992). Prevalence rates are higher in women than in men. MS is typically diagnosed between the ages of 20–50, with the majority of individuals diagnosed in their 20s and 30s. Because the onset of the disease occurs in early adulthood, often individuals with MS are faced with a life time of disability that has major implications for career development, family life, and social integration. Recently, there has been an increase in the diagnostic rate of MS, possibly due to improved diagnostic tools and care, and more awareness of the disease (National Multiple Sclerosis Society, 2010).

Disease Course

MS is classified into four subtypes based on the progressive characteristics of the disease (Courtney, Treadaway, Remington, & Frohman, 2009). These subtypes include Relapsing Remitting MS (RRMS), Secondary Progressive MS (SPMS), Primary Progressive (PPMS), and Progressive Relapsing MS (PRMS) (Lublin & Reingold, 1996).

Relapsing-Remitting MS (RRMS) is the most frequent type of MS, with 80–85 % of patients diagnosed with this course. It typically begins in the second or third decade of life and has a female predominance of approximately 2:1. RRMS is characterized by acute episodes of neurological dysfunction over a few days to weeks, followed by a stabilization and improvement of symptoms (which can occur spontaneously or in response to corticosteroids). Recovery from the relapse can be complete or partial with persisting residual symptoms. These residual symptoms are typically stable between relapses.

Secondary Progressive MS (SPMS) is characterized by an insidious and progressive deterioration of neurological function. Many patients with an initial diagnosis of RR course of MS will eventually transition into SPMS after an extended period of time (can be as long as 10–20 years). In SPMS, progression of the neurological impairments occurs independently of relapses and between clinical attacks.

Primary Progressive MS (PPMS) occurs in about 10 % of patients with MS. This disease course affects men and women equally. There are no small or major attacks (relapses) during PPMS. Rather, it is characterized by steady deterioration of neurologic function from disease onset.

Progressive Relapsing MS (PRMS) is the rarest form of MS, with only 5 % of patients with MS diagnosed with this form. It begins as PP MS, but over time is associated with occasional relapses in addition to the progression of the disease. Health professionals may initially diagnose it as PPMS, subsequently changing the diagnosis to PRMS when a relapse occurs. Although this disease course is progressive from the outset, each person's symptoms and rate of progression will be different.

In addition to the four traditional MS subtypes, an additional clinical presentation is that of Benign MS. *Benign MS* is a rare form of MS that refers to a disease course in which patients have few attacks and make an excellent recovery. They are diagnosed with MS but they show minimal impairments or disability even after a lengthy disease course.

MS typically begins in early adulthood and has a variable prognosis. Studies of the natural history of MS have provided important prognostic information for patients and clinicians in regard to the disease course. Approximately 60 % of persons with MS can continue to be independent in their everyday life for the first 10 years after their first exacerbation (Tremlett, Paty, & Devonshire, 2005). However, 50 % of patients will need assistance walking within 15 years after onset (Scalfari et al., 2010; Weinshenker et al., 1989). Some patients experience complications and infections secondary to MS that could disable them and decrease their life expectancy (Tremlett et al., 2005). Predictors of a more severe clinical course of MS may include frequent relapses in the first 2 years, a progressive course from the onset, being a male, and early, permanent motor or cerebellar impairments. Factors associated with a more favorable prognosis include female gender, with predominantly sensory symptoms including optic neuritis.

Multiple Sclerosis: Common Symptoms

After Emma's diagnosis, her initial symptoms of impaired vision resolved, and Emma felt comfortable going back to school. However, around mid-terms, she noticed she felt very worn-down in the evenings when she had to begin studying for exams. During mid-terms, she found it difficult to recall the material she had learned in class. When she saw her mid-term grades, she was disappointed to see that she did poorly. Having always been an excellent student, Emma felt frustrated and depressed. Her friends tried to support her and asked her to study with them, but when she was in a group study session, she found it difficult to concentrate. These experiences led Emma to feel that she should drop out of school. Her neurologist suggested some behavioral and cognitive strategies to help her focus.

As a result of the widespread nature of the myelin lesions and axonal injuries, symptoms can vary among individuals. Symptoms can include motor, cognitive, and neuropsychiatric disruptions (Chiaravalloti & DeLuca, 2008; Frohman, Racke, & Raine, 2006). These symptoms can be divided into primary symptoms (symptoms that are a result of the demyelination in the CNS), secondary symptoms (symptoms that are a result of the primary symptoms, e.g., muscle spasm that results in joint pain), and tertiary symptoms (symptoms caused by the presence of a chronic type of disease).

Primary symptoms may include bowel and bladder problems, fatigue, pain, sexual problems, spasticity, speech and swallowing difficulties, tremors, visual and cognitive problems (Compston, 1996). Secondary symptoms may include pain, loss of balance, anxiety and depression, decrease in activities of daily living (ADL), and instrumental activities of daily living (IADL). Many symptoms of MS can be both primary and secondary in nature. For example, although fatigue appears to be a product of CNS demyelination, it may also be a secondary symptom related to the adverse effects of drug therapy, deconditioning, and other psychological aspects of the disease (Schapiro, 2002). Tertiary symptoms include, but are not limited to, shifts in roles and changes in responsibilities, social isolations, divorce, loss of independence, and unemployment.

In this section we expand more on the primary symptoms (i.e., physical, cognitive, emotional, and psychiatric), and explore the secondary and tertiary symptoms later in the chapter. As stated previously, primary symptoms are a direct consequence of the MS, including motor, cognitive, and neuropsychiatric impairments (Sturm, Gurevitz, & Turner, 2014).

Physical Symptoms

Spasticity and Weakness in muscle functions are central features of MS which manifest itself in weakness of the limbs and involuntary muscle actions. Lower limbs are most often affected in an asymmetric way. Weakness can cause problems such as toe drag or foot drop.

Sensory Deficits in MS include numbness in feet and/or hands resulting in affected individuals often not being able to feel the floor, feel their own movement, or feel objects they hold.

Balance issues are experienced by persons with MS and they may result in awkward gait, or limp, even in patients who appear healthy in other ways. Balance problems typically result in a swaying and "drunken" type of gait known as ataxia. People with severe ataxia would benefit from using an assistive device (e.g., cane, walker).

Vision problems are a common symptom of MS. In fact, some individuals may only experience visual problems. One very common visual problem in MS is optic neuritis. Optic neuritis may result in blurring or graying of vision, or blindness in one eye. A scotoma or dark spot may also occur in the center of the visual field.

Incontinence affects many MS patients throughout the course of the illness. Patients may suffer from bladder or bowel dysfunction, or both. This symptom is caused when MS lesions block or delay transmission of nerve signals in areas of the central nervous system that control the bladder and urinary sphincter.

Sexual problems are commonly reported amongst both men and women as the CNS is crucial to human sexuality. Sexual problems can also be categorized as secondary symptoms as they could stem from MS primary symptoms such as fatigue or spasticity, as well as from psychological factors relating to self-esteem and mood changes.

Fatigue is one of the most common and functionally limiting symptoms of MS, occurring in about 80 % of MS patients. Fatigue isn't the same thing as sleepiness, although it's often accompanied by a desire to sleep—and a lack of motivation to do anything else. Fatigue is often considered a state of exhaustion distinct from depressed mood or physical weakness (Krupp, 2003). Fatigue interferes with a person's ability to function at home and at work and often leads to difficulty in maintaining employment (Schiavolin et al., 2013).

Cognitive Symptoms

Cognitive impairment is common in MS, occurring in up to 65 % of individuals with MS. While there is heterogeneity of MS cerebral pathology that may result in significant variability in cognitive abilities, MS most commonly impacts specific realms of cognition (Amato, Zipoli, & Portaccio, 2006; Chiaravalloti & DeLuca, 2008). Decreased processing speed has recently been identified as a core deficit in persons with MS (DeLuca, Chelune, Tulsky, Lengenfelder, & Chiaravalloti, 2004; Genova, Sumowski, Chiaravalloti, Voelbel, & DeLuca, 2009). Deficits in processing speed are typically seen concurrently with other cognitive deficits that are common in MS, such as memory, or working memory (DeLuca et al., 2004). New learning and memory abilities (verbal and visual) are also commonly affected in persons with MS (Chiaravalloti & DeLuca, 2008; DeLuca, Gaudino, Diamond, Christodoulou, & Engel, 1998). Studies have demonstrated that this memory deficit is primarily due to difficulty learning new information, with intact recall and recognition when information is sufficiently encoded into long term memory (DeLuca et al., 1994; 1998). Recently Benedict and Zivadinov (2011) found that factors such as male gender, low premorbid intelligence or education, early onset of MS, and evidence of cerebral gray matter atrophy make an individual more prone to cognitive impairment. Studies have additionally found that high premorbid intelligence or high exposure to intellectually enriching activities, referred to as high cognitive reserve, is protective against cognitive deterioration in MS (Sumowski, Chiaravalloti, Wylie, & Deluca, 2009; Sumowski, Wylie, Deluca, & Chiaravalloti, 2010; Sumowski et al., 2014).

Emotional/Psychiatric Symptoms

Emotional symptomotology is commonly experienced by individuals with MS, specifically depression and anxiety (Schubert & Foliart, 1993). For example, in a large community sample of 739 participants with MS, clinically significant depressive symptoms were found in 41.8 % of the participants, and 29.1 % of the participants had moderate to severe depression. Participants with more advanced MS were more likely to experience clinically significant depressive symptoms than those with minimal disease (Chwastiak et al., 2002). Diaz-Olavarrieta, Cummings, Velazquez,

Garcia, and de la Cadena (1999) reported that 95 % of their participants, who had Relapsing Remitting MS reported psychiatric symptoms. 79 % of their sample reported symptoms of dysphoria, 42 % reported agitation, 40 % reported anxiety and 35 % reported irritability. It is important to note that, as with the other symptoms, psychiatric symptomatology has effects on major aspects of the person's life, ranging from poor adherence to treatment regimens to negative self-perceptions and reduced self-efficacy and overall quality of life.

Impact of MS on Overall Functioning

The World Health Organization (WHO) has generated a model to explain the impact of disease at different levels of functioning. This model, called The International Classification of Functioning, Disability and Health (ICF) framework (WHO, 2001), can be used to understand the impact of MS on overall functioning (Fig. 7.1). This classification includes: "body structure and function (impairments), limitation in activity (difficulty in everyday tasks) and restriction in participation (problems in social situations and work)." It also includes the contextual factors (personal and environmental), which further impact the individual's ability to function and participate in society. Thus, physical restrictions in MS, including weakness, spasticity, tremors, and problems with coordination, as well as cognitive impairments (in areas such as memory and processing speed) could limit activity (driving, managing finances, self-care) and restrict participation (work, social integration, and family roles). These limitations and restrictions increase over time and may cause the patient, and his/her family, stress and isolation. Recent evidence suggests that personal factors such as age, exercise adherence, attitude, comorbid conditions, and environmental factors, such as social support and financial resources, influence the

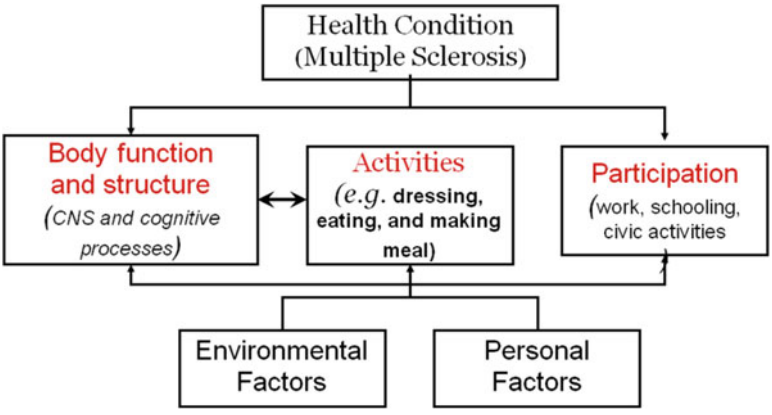

Fig. 7.1 The International Classification of Functioning, Disability and Health (ICF) framework (WHO, 2001) as it can be used to understand the impact of MS on overall functioning

development of functional limitations and the degree of quality of life a given patient enjoys (Marrie & Horwitz, 2010). In the following sections, issues related to activity limitations (Activities of daily living; ADL) and restriction on participation (employment issues and Quality of life [QOL]) are discussed.

At her most recent visit, Emma's neurologist explained that several lesions were present in the frontal lobe of her brain. He explained that these lesions may affect her ability to focus and problem-solve. Weeks later, Emma made plans go to a Broadway show in New York City with a friend. She told her friend she would meet her at the theater at 5:00 p.m. When she got to the subway platform, she realized she didn't know which subway to take. She stared at the map for 10 min, but couldn't figure out how to connect the lines on the map to the actual subway line. She finally decided to take the A line subway, but after riding through a few stations, she realized she was downtown, when the theater was uptown. She asked a subway passenger to help her; however, she was already an hour late to the theater. When she arrived, she found that her friend had already gone inside.

Following Emma's example, we can observe how new lesions in Emma's brain (body structures) caused cognitive impairments (body function), which manifested into inability to find her way on the subway (activity limitation), and as a result, she couldn't meet with her friend and see a show (participation). This case example illustrates the relationship among the constructs related to the ICF. Note that this relationship is not linear but dynamic. In the next sections the dynamic nature of the relationship is demonstrated.

Deficits in Activities of Daily Living (ADLs) in MS

Steve is a 52 year-old man who was diagnosed with MS 20 years ago. Having initially been diagnosed with RRMS, his diagnosis was recently changed to secondary progressive. Due to the symptoms of MS, Steve stopped working as an electrician 7 years ago. Symptoms include tremor in both hands, and weakness in his dominant right hand. In addition, he has trouble balancing and impaired vision. Recently, Steve has been relying on his wife more for remembering things (such as taking medication, and chores to be done around the house). His wife, while very supportive, has become frustrated by Steve's dependency. She has decided to seek advice on how to improve his activities of daily living.

Activities of Daily Living (ADLs)

Rehabilitation clinicians and researchers usually focus on two areas of activities of daily living. One area is related to self-care skills, referred to as personal ADL. These skills include tasks such as grooming and self-care, feeding, toileting, bathing, and transferring oneself to/from one place to another (e.g., wheelchair). The other area is related to independent living skills, referred to as Instrumental ADL (IADL). IADLs are tasks that require both motor and cognitive skills for successful completion and include more complex everyday tasks such as using the phone, shopping, driving, managing finances, etc.

Assessment of ADLs

Personal ADL and IADL performance can be assessed either by observation of task performance or by self and proxy report (Gitlin, 2001). Direct observation of performance would seem to provide the most accurate assessment. However, due to limiting factors such as time and/or space restrictions, or a patient's physical and/or medical condition, direct performance-based observations are not always practical. Because of these limitations, clinicians and researchers often rely on indirect reports of IADL performance, either from the individual patient or by a family member/significant other (proxy's reports). These reports, however, also have limitations. Individuals, especially those who have experienced cognitive decline, have difficulty evaluating their everyday competency accurately (e.g., Rubenstein, Schairer, Wieland, & Kane, 1984). There is additionally a growing body of research in MS on the biases of self-reports due to depression and anxiety that might be experienced by the person completing the questionnaire (e.g., caregiver, spouse) (Goverover et al., 2005; Goverover, O'Brien, Moore, & DeLuca, 2010; Goverover, Chiaravalloti, & DeLuca, 2016; Maor, Olmer, & Mozes, 2001). The question of how to best assess activity performance and limitations remains a challenge for researchers and clinicians.

Steve was assessed by both a neuropsychologist and an occupational therapist. When he was asked to report about his cognitive and functional abilities, Steve reported that all aspects of his daily life were difficult and nearly impossible. In fact, when describing his dependence on his family, Steve started crying. On a questionnaire designed to assess depression, Steve's scores were indicative of the presence of depressive symptomatology. However, his self-report of his abilities were likely not completely accurate, and were more reflective of his depression. Therefore, the occupational therapist and the neuropsychologist sought a more objective measure of the difficulties he experiences at home.

Previous research studies in MS have documented inconsistent relationships between self-report of functional status and direct observations of ADLs. Doble, Fisk, Fisher, Ritvo, and Murray (1994), examined the relationship between a measure of independence in ADLs and both standard clinical ratings on the EDSS, as well as subjective ratings of general health status on the *Sickness Impact Profile* (SIP) (Bergner, Babbit, & Pollard, 1976). MS patients were able to accurately assess their motor performance (self-report of motor difficulty correlated with the motor aspect of ADLs), but not their cognitive abilities. Specifically, MS patients' self-report of cognitive difficulties did not correlate with cognitive aspects of ADL assessed by an objective, performance-based measure (Fisher, 1993). Goverover et al. (2005) similarly did not find significant correlations between self-reports of functional status and the performance of ADLs. However, when examining the role of depressive symptomatology, these authors noted performance of ADLs to be significantly correlated with self-report of functional status. These authors found that patients diagnosed with MS tend to under-estimate functional abilities due to depressive symptomotology and lower levels of self-awareness. It is therefore essential that clinicians take depression into account when relying on patient self report and ideally include a collateral report or objective performance measure to assess functional status.

Factors Contributing to Limitations in ADLs

In the past, researchers have attributed decreased performance of ADLs in MS to physical impairments such as decreased ambulation, coordination, balance, and visual difficulties. However, La Rocca, Kalb, Scheinberg, and Kendall (1985) found that these physical factors, while important for successful completion of ADLs, are not the only reasons for impaired functioning. Cognitive abilities are also crucial for successful performance of ADLs. Recent research has examined the relationship between cognitive impairments in MS and limitations in the performance of ADLs (Goverover et al., 2005). For example, in one study, persons with MS were asked to perform a battery of cognitive tests and also complete a performance-based measure of IADL [the *Executive Function Performance Test* (EFPT); Baum & Edwards, 1993; Baum et al., 2008]. Results indicated that persons with MS who were cognitively impaired required more help (given with cues) to successfully complete the tasks in the performance based IADL measure, the EFPT. In addition, persons with MS who had greater cognitive deficits specifically related to processing speed, executive control, learning and memory showed worse performance on the EFPT (Kalmar, Gaudino, Moore, Halper, and Deluca, 2008). A study from our group found that participants with MS required significantly more time to complete a test of IADLs compared to healthy participants (Goverover, Genova, Hillary, & DeLuca, 2007). The time needed to perform IADL tasks was also significantly correlated with performance of neuropsychological tests designed to measure processing speed. The results of the studies described above indicate that cognitive impairments (such as processing speed difficulties and executive dysfunction) contribute to impairments in ADLs in persons with MS. Goverover, Haas, and DeLuca (2016), found that money management activities are being impaired in persons with MS due to cognitive limitations related to processing speed and executive functions.

Neuropsychiatric symptoms such as depression and fatigue also have affects on ADLs. For example, Kitis, Altug, Cavlak, and Akdag (2008) found that depression was significantly associated with decreased basic functional abilities in MS, as assessed by the Functional Independence Measure (FIM). Rosenblum and Weiss (2010) found that fatigue was associated with reduced performance of ADLs such as hand-writing. Based on these studies as well as others, neuropsychiatric symptoms can have a significant negative impact on multiple levels of functioning.

During his evaluation, Steve was asked to perform cognitive tests designed to assess memory, attention, processing speed and executive functions. The results of the cognitive paper and pencil tests showed that Steve was having some cognitive problems in the domains of learning new information and processing speed, but his executive functioning abilities were within the normal range. On one test, Steve was asked to purchase an airline ticket using the internet. During this test, he often needed to ask questions in order to stay on task, for example, "where should the flight go?" and "how much can I spend?" The task took Steve a long time, and it was hard for him to stay focused. Eventually, he was able to complete the task with cues from the examiner. This test provided valuable information on how his cognitive deficits contribute to his performance of IADLs.

New Advances in the Assessment of IADLs

It is important to remember, that no one measure of IADL can comprehensively capture the way people function in their daily lives. Our lives are composed of more than just personal and instrumental ADLs. Our lives are composed of daily patterns or activities that are meaningful for us; they are our personal hobbies or occupations. This individualism among patients renders it necessary to employ both types of measures, subjective and objective, while simultaneously developing measures of that are more representative of "actual" every day activities.

Goverover, O'Brien, Moore, and DeLuca (2010) designed a functional assessment tool specifically for persons with MS. This assessment uses a new and innovative approach for measuring actual, everyday life activities called "*Actual Reality*" (AR). AR is a performance-based assessment approach that involves the utilization of the internet to perform actual, everyday life activities. AR takes into account the overall performance of the task and also the cognitive capacities needed to complete it. When examining the difference between persons with MS and healthy individuals on AR task performance, results showed that the MS group displayed significantly more difficulties than the healthy group in accurately and independently completing the AR task (purchasing airline tickets via an actual internet website). This difference was primarily due to cognitive impairment, or specific impairments in processing speed, learning and memory and executive functions. Self-report of quality of life and functional status were not correlated with AR performance in the MS group. However, these self-report measures (i.e., of quality of life and functional status) were significantly associated with depressive symptomatology (Goverover et al., 2010).

In sum, reductions in the ability of individuals with MS to perform activities of daily living are indicated on both self and proxy rating scales and objective direct measures (Doble et al., 1994; Foverover, Chiaravalloti, & DeLuca, 2016; Goverover et al., 2005, 2010; Mansson & Lexell, 2004). Direct performance-based measures provide information on the process of task performance and additionally speak to the interaction between the performer, the task, and the environment. On the other hand, subjective perceptions of the person's own abilities and disabilities are gleaned from self-report tools, and are influenced by depressive symptoms. Both types of assessment approaches measure different aspects of everyday life and disability and should not be used clinically in isolation. Professionals and clients are best served by understanding the advantages and disadvantages of both approaches and choosing assessment instruments best suited to address specific questions.

Employment Issues

Individuals with MS comprise a productive, experienced labor resource. However, MS is a disease that has a wide-ranging impact on functioning and leads to a complex interaction of physical, cognitive, psychosocial, behavioral and environmental impairments, which can significantly impact the person's ability to work. Most

people with MS in the USA (95–97%) have previous employment histories (Roessler, Rumrill, & Fitzgerald, 2004), which is not surprising given that MS tends to affect people of working age who experience initial symptoms between the ages of 20–40 (Rumrill, Roessler, McMahonc, Hennessey, & Neath, 2007). Approximately two-thirds of Americans with MS were employed at the time of their diagnosis (La Rocca et al., 1985). Unfortunately, a large majority of patients with MS become unemployed shortly after diagnosis (Roessler, Rumrill, & Hennessey, 2002). The employment statistics for MS vary across the world with estimates of the percent of persons with MS employed ranging from 23 to 32% (Aronson, 1997; La Rocca et al., 1985) to 51–80% (Gronning, Hannisdal, & Mellgren, 1990; Jackson, Quaal, & Reeves, 1991; Kornblith, La Rocca, & Baum, 1986; Morales-Gonzáles, Benito-León, Rivera-Navarro, Mitchell, & GEDMA Study Group, 2004).

Numerous factors are associated with increased risk of unemployment in MS including: increased age (Beatty, Blanco, Wilbanks, Paul, & Hames, 1995); severe physical impairments (LaRocca, Kalb, Scheinberg, & Kendall, 1985); visual impairments, problems in mobility (Rao et al., 1991; LaRocca et al., 1985); low levels of education (LaRocca et al., 1985); and cognitive impairments (Beatty et al., 1995; Edgley, Sullivan, & Dehoux, 1991; Rao et al., 1991). Gender has been found to be inconsistently related to unemployment in MS (Roessler et al., 2004; Rumrill et al., 2007). For example: one study reported that women with MS are twice as likely to be unemployed than men with MS (LaRocca et al., 1985). However, in a study done by Rumrill et al. (2007), the authors examined the employment discrimination experiences of women and men with MS and found that men and women are not significantly different in their experiences of employment discrimination. Furthermore, Smith and Arnett (2005) found that fatigue and broad physical/neurological symptoms were responsible for participants' change in work status, more so than any other factor described above. Several studies have demonstrated the significant role of cognition on employment status (e.g., Goverover, Strober, Chiaravalloti, & DeLuca, 2015; Strober et al., 2012; Strober, Chiaravalloti, Moore, & DeLuca, 2013). In particular, impairments identified by measures of information processing speed, verbal learning and memory, and working memory consistently differentiate employed from unemployed individuals, with the largest effect observed on measures of information processing speed (Goverover et al., 2015; Strober et al., 2012, 2013).

Therefore it appears that there is no one factor that explains unemployment rates in MS, but rather a combination of demographic, disease-related, and personal factors likely impact employment.

Steve described the reasons he stopped working to the neuropsychologist. He had been working as an electrician for years. Five years after his diagnosis, Steve began to notice that he had trouble remembering appointments he had made, and often arrived at jobs without the necessary equipment needed to perform the job. He therefore had trouble executing activities in the work place. He described how he would need to take naps throughout the day due to increased fatigue, which sometimes resulted in him missing appointments. When clients complained about his performance or asked him to perform something unplanned, Steve became very angry. Furthermore, his coworkers complained to his supervisor that they could no longer work with Steve, due to his angry outbursts in front of clients and his inconsistent effort. His supervisor suggested that he resign.

Sweetland, Riazi, Cano, and Playford (2007) noted that persons with MS need support in the workplace in two distinct ways. Primarily, workplaces must be adapted so that the physical environment is more accommodating to the person with MS. In addition, the workload demands should be modified so that the individual with MS can be fully functional. To facilitate effective workplace activities for persons with MS, employers should become familiar with relevant legislation to provide knowledge and consultation in the workplace (and society in general) regarding MS-related disabilities and counseling on how to adapt, adjust, and resolve complex issues.

Several studies have been performed to examine the efficacy of vocational rehabilitation in MS with inconsistent results. One study, for example, showed that vocational rehabilitation had no effect on job retention after 1 year (LaRocca, Kalb, & Gregg, 1997). However, in a separate study, it was found that vocational rehabilitation focused specifically on job placement strategies had a positive effect on self-efficacy and employment status (Rumrill, Roessler, & Cook, 1998). Employment is part of the adult identity in the western world (Dyck, 1995) and it presents benefits in relation to both financial issues and status in society (Catanzaro & Weinert, 1992). Employment is further important in perceived quality of life (QoL) and well-being (Aronson, 1997; Waddell & Burton, 2006). As such, individuals with MS are at greater risk for experiencing diminished quality of life, given that the disease often develops during peak years of employment, and is accompanied by numerous physical, cognitive, and emotional side effects. Vocational rehabilitation strategies have not been consistently examined in MS and therefore, continued research should focus on this critical issue in MS.

The Impact on Social Functioning/Participation in Society

Participation in society is a well-defined construct, although it has been somewhat neglected in MS research. MS causes neurological changes that typically have a negative impact on a number of life domains including social functioning (Green & Todd, 2008; Green, Todd, & Pevalin, 2007), employment, finances, and standards of living, which can then lead to reduced social participation (Hakim et al., 2000). Several domains of social participation have been found to be limited in persons with MS, including, recreation and leisure, community life, employment, and intimate relationships (Holper et al., 2010). Amato et al. (2006) reported that restricted participation in social activities can cause limitations in one's work and social life.

After Steve lost his job, he became very lonely. Most of the friends in his life were coworkers, and once his job ended, he stopped speaking to them. As a result, he became even more dependent on his wife, which caused further strain on their marriage. In addition to assisting with Steve's daily functioning, his wife also found herself in the role of Steve's only friend. She suggested that he try to make new friends by joining a social club. However, many of the clubs he found focused on physical activities such as golf and bowling. Steve felt trapped in his home, and in his life. His neurologist provided him with the number of a local MS support group. Steve joined the group and began attending weekly meetings, which provided him not only social support, but also new friendships. Steve now leads some of the meetings, and is very active in his local chapter of the National Multiple Sclerosis Society.

Studies have attempted to determine the major factors that restrict social functioning and participation in persons with MS. Cognitive dysfunction is thought to be an important factor in determining participation in leisure activities (Hakim et al., 2000; Rao et al., 1991). Physical factors that have been associated with reduced social functioning in MS include visual impairments (Rudick et al., 2007), muscle spasticity/ motor dysfunction and severe physical disability (Cervera-Deval et al., 1994; Hakim et al., 2000). For example, some individuals with MS report that lack of handicapped accessible facilities, including adaptations for wheelchairs, as well as lack of handicap bathrooms, could be a major deterrent for social participation. In some cases, restrictions are too great to be overcome, and people stop going out, and therefore lose opportunities for social interaction (Green & Todd, 2008). For example, Green and Todd (2008) described a participant in their study who said that he could fall at an unpredictable time because of his leg weakness; he therefore tends to stay home, because it can be uncomfortable to the people around him. However, physical barriers are not the only deterrent to adequate social participation. Individuals with MS have also reported that the negative attitudes of others (Green & Todd, 2008) restrict their participation in social activities.

Research also suggests that individuals with MS also have specific impairments in emotional processing (e.g., Henry et al., 2009). Specifically, it has been reported that individuals with MS may have difficulty interpreting the facial effect of others, and that in turn, can impair their social integration and communication. For example, Henry et al. (2009), found that individuals with MS were impaired on a facial affect discrimination task, specifically identifying the emotions of anger and fear. Impairments in facial affect recognition have been related to decreased quality of life both socially and psychologically (Phillips et al., 2011). It is thus possible that these emotional impairments lead to decreased social participation, including less rewarding personal relationships with spouses and friends, socialization in the community and in the workplace. More research is needed to foster a complete understanding of emotional processing in MS.

MS thus has not only a medical impact but can also have a social impact (Green & Todd, 2008). Lack of social participation affects not only the individual with MS, but the immediate family on which they depend. As the disease progresses, individuals can become more and more isolated. Studies have shown that personal limitations (such as cognitive and physical disabilities), also restricted opportunities and increased dependency are key elements in social participation. Social participation should be a treatment priority and clinicians should seek to provide patients with strategies to overcome personal and environmental barriers to social participation.

Quality of Life (QOL)

Improving and maintaining quality of life (QOL) is a primary goal in MS care (Foley & Brandes, 2009). QOL refers to the person's perception of their place in life in context of the culture and value systems in which they live and in relation to their goals, expectations, standards, and concerns (WHO, 2007). An important area of QOL is how health related problems and treatment affect the ability to perform

valued activities and roles (Fischer et al., 1999; Rudick &Miller, 2008). Self-report measures of health related QOL have demonstrated that health-related issues impact the domains of physical, emotional, and social functioning. In MS specifically, motor, cognitive, and other clinical symptoms, combined with limitations in activity and participation, can lead to decreased QOL (e.g., Rudick &Miller, 2008).

It has been demonstrated that, compared to the general population, individuals with MS have compromised health-related QOL (e.g., Miller & Dishon, 2006; Marrie, Miller, Chelune, & Cohen, 2003; Nortvedt, Riise, Myhr, & Nyland, 1999). Specifically, research has shown that individuals with MS are impaired on various domains related to QOL. These include more physically focused domains such as actual physical functioning, bodily pain, general health, and vitality. As an example, physical disability and bodily pain restrict one's ability to perform work and regular activities. *Using our case example, Steve's job as an electrician could not be performed because of his fatigue and weakness in his limbs.* Thus, in this example, a physical disability and fatigue restricted the individual's ability to participate in work related activity, and thus impact this individuals health related QOL. However, significant decreases are also noted in domains such as social functioning, and mental health (Shawaryn, Schiaffino, LaRocca, & Johnston, 2002), domains that have a tremendous impact on a given individual's role in life. As an example, mood and anxiety can exert a significant impact on work performance and interpersonal relationships. *Again referring to our case example, Steve's depression and mood issues impacted his ability to maintain friendships and enjoy a stable and rewarding marriage. Thus, impacting his perceived QOL.*

The assessment of QOL can be divided into two broad categories of measurement: objective and subjective (Brown et al., 2004). Objective measures include those based on observation (e.g., frequency of activity or time use patterns). In contrast, subjective measures include self-reports of personal perspective of the activity, such as satisfaction or importance of the activity and self-evaluation of how well the patient believes that he or she will perform the activity (Cicerone, Mott, Azulay, & Friel, 2004; Johnston, Goverover, & Dijkers, 2005). Research is advocating for greater implementation of subjective measures of QOL because the judgment of the individual is the ultimate determinant of whether his or her level of activity is adequate (Hemmingsson & Jonsson, 2005; Johnston et al., 2005; Perenboom & Chorus, 2003). Numerous self-report measures of QOL exist and more are in development.

While generic measures of QOL are often used by clinicians and researchers (e.g., SF-36 (Ware & Shebourne Donald, 1992); Satisfaction with Life Scale (Diener, Emmons, Larsen, & Griffin, 1985), other QOL measures have been designed specifically for persons with MS in an effort to capture the many issues specific to this population (Fischer et al., 1999). The Multiple Sclerosis Quality of Life Inventory (MSQLI) assesses Health-related QOL specific to individuals with MS via a battery of various assessments. Cella, Dineen, Arnason, and Reder (1996) developed a QOL instrument for use specifically with people with MS, called the Functional Assessment of Multiple Sclerosis (FAMS). The FAMS contains six subscales: mobility, symptoms, emotional well-being (depression), general contentment, thinking/fatigue, and family/social well-being. For example, a question that relates

to "mobility" is: "Because of my physical condition, I have trouble meeting the needs of my family." More recently, the PROMIS scales have been developed to measure self-reported health related QOL for clinical research and practice. PROMIS assessment instruments are drawn primarily from calibrated item banks (sets of well-defined and validated items) measuring concepts such as pain, fatigue, physical function, depression, anxiety, and social function (Cella et al., 2007, 2012).

The assessment of QOL in MS can be challenging. Physical restrictions such as visual problems and hand spasticity may prevent the use of self-completed questionnaires and fatigue or communication impairment can make interviewing problematic. In addition, cognitive impairments such as memory, self-awareness, and attention can impact the reliability of the information collected through the questionnaires. However, the assessment of QOL is an important aspect of a complete evaluation and, even when challenging, such as assessment should be attempted in the best interest of the patient.

Various cognitive, emotional and physical challenges are associated with reduced QOL in persons with MS. For example, Benito-Leon, Morales, and Rivera-Navarro (2002) found that health-related QOL was significantly associated with physical disability and cognitive functioning. In addition, Barker-Collo (2006) found that impaired processing speed specifically is a significant predictor of impaired health-related QOL. Goverover et al. (2005, 2010) found that lower QOL ratings were correlated with increased depression and anxiety. However, no relationship was noted between reduced QOL and participants' ability to perform ADLs. This lack of relationship between the ability to perform everyday activities and self-reports of QOL suggests that self-report measures describe another dimension related to person perceptions of his/her performance and QOL (Johnston et al., 2005). Therefore, QOL is not necessarily related to a person's ability to function independently in daily life, rather it likely a multifaceted concept that can only be truly assessed by taking the patient's perspective into consideration about what is important in his/her life.

Cultural Considerations

An individual's culture includes arts, beliefs, customs, inventions, language, technology, and traditions. Cultural differences are likely to affect the manner in which patients perceive and cope with MS. Concepts such as "illness" and "family" are often interpreted differently across cultures and countries (Pluta-Fuerst et al., 2010). Thus, to improve individual health and build healthy communities, health care providers need to recognize and address the unique culture, language and health literacy of diverse consumers and communities.

MS is common in certain geographic areas with separate defined cultures. For example, MS is most common in North America and Scandinavia, but is relatively uncommon in countries such as South America, Japan, and China. In Western society (where MS is prevalent), there is a cultural emphasis on independence and self-determination. However, when someone becomes diagnosed with lifelong illness such as MS, independent living is jeopardized. Many individuals with MS eventually require full-time caregivers, and may rely on assistive devices such as

wheelchairs, walkers, and scooters. This shift from independent living to dependent living could trigger anxiety and depression in individuals with MS, as it contrasts with the widely held cultural values. In addition, in western societies, where there is a strong belief in medical care, there is an unrealistic expectation that all diseases should be cured and all symptoms should be alleviated. Therefore, being diagnosed with a lifelong condition that has no cure can cause a significant crisis for the person with MS in western society. The loss of basic functional skills such as taking a shower by oneself and losing control of bodily functions, resulting in an increased dependence on others, can cause the person to feel a loss of dignity (Toombs, 2004). Health care professionals and society in general must consider the strongly embedded cultural values of independence when caring for individuals with MS, who may lose their independence fully or partially.

Other factors related to MS that may be impacted by culture are related to disease management. For example, it has been reported that Italians with MS prefer a more passive role in decision making about their treatment and management of disease than Americans with MS (Giordano et al., 2008). Thus, Americans may seek second opinions, alternative medicine, and additional information about the disease via the internet or other sources, more so than in other cultures. Also, there are some cultures in which discussion and treatment of symptoms may be considered taboo. For example, Turkish women with MS have more problems speaking with their physician about sexual functions, compared to the general population with MS (Idiman et al., 2006). In this example, it is apparent that clinicians need to consider cultural values in the assessment of symptomatology related to MS.

Summary

This chapter describes aspects in functioning and disability affected by MS, as well as the many environmental and cultural factors relevant to persons with MS. MS is associated with physical, cognitive, and psychological disabilities and various functional limitations that can have a significant impact on an individual's daily life. The impact of MS on the everyday lives of any given patient is broad and varied. Patients, families, and clinicians must be sensitive to the highly individualized nature of MS and recognize that they are not alone in the challenges to daily life functioning faced as the disease progresses.

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The Impact of Epilepsy on Quality of Life

8

Linnea Vaurio, Stella Karantzoulis, and William B. Barr

Prior to epilepsy, I lead a healthy, active lifestyle, which included high school wrestling and I was a competitive baseball player until the age of 21. College included late nights out, drinking and socializing like other students. Shortly after graduation my idiopathic seizures [seizures without a known cause] began, initially once every 3 weeks; about 10 years into epilepsy I was having 20 cluster seizures/month with Trileptal [antiepileptic drug] providing the best, albeit not very effective, control. I believe stress played a role in some of the activity.

From 22 to 44 years of age I had approximately 3000 seizures; mostly complex partial and simple with about 15 generalized seizures that were triggered by sleep deprivation.

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Epilepsy is one of the most common chronic neurological conditions. The impact of epilepsy extends well beyond the direct effects of seizures and includes a number of challenges, which may lead to disability and severely reduced quality of life (QOL). Epilepsy can affect social, psychological, and physical health. For example, people with epilepsy, particularly those with refractory epilepsy (i.e., seizures that are not well-controlled with seizure medications), face diminished social support and family function, cognitive challenges, medical and psychiatric comorbidities, and stigmatization. Those with epilepsy also report more disability days, physical limitations in their daily activities, and lower annual income than other chronically ill groups (Wiebe, Bellhouse, Fallahay, & Eliasziw, 1999). QOL has now been acknowledged as an important clinical endpoint and has been reflected in the exponential rise in related research studies over time (Leone, Beghi, Righini, Apolone, & Mosconi, 2005).

The chapter will begin with a review of epilepsy as a syndrome, including incidence and causal mechanisms, and then proceed to outline the specific effects of epilepsy on quality of life for different subgroups and in different life spheres. A review of the current methods for assessing quality of life will be followed by treatment approaches for epilepsy.

Epilepsy: A Review

Epilepsy is a disorder that involves recurrent seizures. A seizure is the result of abnormal cerebral discharges that manifest as alterations in sensation, motor functions, and/or consciousness. Behavioral manifestations of seizures range from brief lapses of consciousness to stereotypic motor movements to full body convulsions.

Approximately 1–2 % of the population is affected by epilepsy, making it one of the most common neurological conditions. In the United States alone, more than two million individuals have epilepsy and in any given year, hundreds of thousands of new cases of epilepsy are diagnosed (Hirtz et al., 2007). The diagnostic criteria for epilepsy have remained unchanged for several years, and require the occurrence of at least two seizures, unrelated to any other illness or metabolic upset. There is a slightly higher rate of epilepsy in men than in women. The condition develops most commonly among individuals under 20 years of age, although increased rates are also seen in those over the age of 60. There are a number of epileptic syndromes associated with specific age groups, such as the neonatal seizures, infantile spasms, and febrile convulsions observed in young children. When new onset cases emerge in adulthood, epilepsy often is seen as a consequence of brain tumors, stroke, or traumatic brain injury. Epilepsy occurs at higher rates in individuals who fall in the range of intellectual disability or have some form of developmental delay.

The diagnosis of epilepsy is made by incorporating a comprehensive clinical history with documentation of electroencephalographic (EEG) changes. Clinical history integrates an individual's medical background and details of the seizure semiology which is defined as the changes in behavior observed before, during, and after events. The EEG provides a method for examining the underlying electrical brain activity associated with the seizures. Many seizures are characterized by specific patterns of electrical

abnormality. However, abnormal electrical discharges also occur in conditions that do not involve seizures. Many patients require comprehensive monitoring with simultaneous EEG and video recording for proper diagnosis. This enables physicians to observe the direct relationship between behavioral changes and abnormal brain activity.

The most comprehensive system currently in use to classify seizures types was formed by the Commission of the International League Against Epilepsy (Berg et al., 2010). This classification system has been developed and revised to reflect the most recent scientific knowledge of how seizures begin, spread and can best be treated. The first descriptor in the classification syndrome defines seizures based on how they begin. Generalized seizures are thought to arise throughout the brain or originate at one point and spread very quickly to networks in both sides of the brain, including cortical and subcortical structures. Focal seizures originate in one hemisphere, and sometimes in one specific small area of one side of the brain.

The second portion of the classification system considers the degree of impairment that occurs during a person's seizure and applies only to the generalized seizure types. Some seizure types include tonic–clonic (muscles stiffening—muscles spasms and jerking); other seizure types include absence (brief, sudden lapses of consciousness, staring spells) and myoclonic (brief twitching of muscle or muscle groups). With the current classification system, subtypes of focal epilepsy are not specified, although factors such as level of change in consciousness, and the nature of behavioral features of these seizures can be helpful in diagnosing and treating focal seizures.

This seizure classification system differs from causes of seizures or syndromes that are associated with particular patterns of seizures. Many forms of epilepsy have an identifiable cause, such as the presence of a tumor, the result of a traumatic brain injury, or some other demonstrable brain lesion. Some diseases or conditions are associated with increased risk for seizures. Some of these causes include genetic abnormalities or systemic factors, such as the lack of a certain enzyme. Some epilepsies are considered idiopathic—without a currently known cause. However, advances in structural brain-imaging techniques, such as magnetic resonance imaging (MRI), have allowed for improved detection of the cause of the seizures. Functional brain-imaging methods, such as positron emission tomography (PET), single photon emission computerized tomography (SPECT), functional MRI (fMRI), and magnetoencephalography (MEG) have advanced our ability to localize and understand the brain and the behavioral abnormalities associated with epilepsy. Therefore, some cases previously labeled as idiopathic are now found to be associated with subtle brain abnormalities. Having better understanding of the cause of the seizures can lead to improved treatment for individuals affected by epilepsy.

Epilepsy and Its Impact on Activities of Daily Living and Quality of Life

The World Health Organization defines health-related quality of life (HRQOL) as a state of complete physical, mental, and social wellbeing, and not merely the absence of disease or infirmity (Jochheim, 1980). Stated differently, HRQOL refers to the

functional effect of an illness on a patient, as perceived by the patient. While seizures occur episodically, epilepsy is a chronic condition. The focus of HRQOL in epilepsy is on life *between* the seizures (i.e., in the inter-ictal period). The impact of stigma and fear of seizure occurrence are aspects that contribute to the continuous impact of the disorder and also major determinants in patient-reported quality of life (Giovagnoli, da Silva, Federico, & Cornelio, 2009).

The Effect of Stigma

Throughout history, those with epilepsy have been labeled holy or possessed as a result of changes in behavior during seizures. In other societies, these individuals were considered "insane" and were placed in asylums. The stigma related to epilepsy often compounds the negative physical impact of the disease and affects how individuals respond to disease burden. Research has shown that for adults with epilepsy, if a person experiences more exposure to stigma, they feel that they are less able to manage their own epilepsy, have more negative feelings about whether their seizures can be treated, tend to fill and take their medications less reliably, and report lower satisfaction with health care (DiIorio et al., 2003).

Cross-Cultural Influences

Social attitudes toward epilepsy and disability vary across ethnic and cultural groups. Fifteen percent of Austrian survey respondents indicated that they would object to their child marrying a person with epilepsy (Spatt et al., 2005). In the Czech Republic, one investigation showed that 29 % of survey respondents considered epilepsy to be a form of insanity (Novotna & Rektor, 2002). More than half of 1600 randomly selected informants in the United Kingdom agreed that people with epilepsy are treated differently, primarily by means of social avoidance and exclusion. Differences in treatment were attributed in part to views that people with epilepsy were not reliable and not normal (Jacoby, Gorry, Gamble, & Baker, 2004). In the same study, over one-fifth of the respondents agreed that people with epilepsy have more personality problems than those without. In East Timor, almost all people with epilepsy do not receive medical intervention, because Timorese communities hold the belief that epilepsy is not a physical health problem but rather is caused by evil spirits or curses (Amoroso, Zwi, Somerville, & Grove, 2006). At present, most East Timorese children with epilepsy do not attend school. Results of a survey in the United States showed comparable levels of stigma associated with epilepsy and AIDS, whereas stigma associated with diabetes mellitus was much less (Fernandes et al., 2007). In Cambodia, epilepsy has been long conceptualized by the public as a contagious disorder, including by inheritance, through sharing of saliva, sharing of food, via sexual contact, or casual contact (rubbing shoulders/shaking hands) (Bhalla et al., 2012). This conceptualization can contribute to fear of interacting with individuals with epilepsy, and is one contributing factor to stigmatization. In an ethnically diverse urban population, perceived stigma was at least as important as seizure freedom in determining quality of life, suggesting

this is an essential factor in treating individuals with epilepsy (Grant, Prus, & Nakhutina, 2013). Given the prevalence of these negative attitudes worldwide, it is likely that people with epilepsy will encounter them routinely. Higher rates of epilepsy in minority populations have been documented by some, however this finding might relate to differences in socioeconomic status, degree of access to health care, and regional environmental exposures (Banerjee, Filippi, & Hauser, 2009). Further investigation to understand these complex factors will help in determining risk and guiding interventions for the many individuals affected by epilepsy.

Epilepsy in Youth

Childhood epilepsy is among the most prevalent neurological conditions in the developing years, affecting between 0.5 and 1 % of children globally (Shinnar & Pellock, 2002). Treatment management for youth with epilepsy can be very complex and a number of patient and family factors must be considered to optimize treatment success and improve patient QOL. In addition, QOL is a dynamic process in children diagnosed with epilepsy, with some individuals experiencing significant improvement in QOL in the 2 years following diagnosis, and others experiencing poorer quality of life after being diagnosed with epilepsy. The individuals who reported poorer quality of life often experienced cognitive changes in that 2-year interval (Speechley et al., 2012). Issues related to ongoing development must also be considered. For example, adolescence marks the period during which autonomy and independence are fostered and when peer relationships are particularly important. Adolescents with epilepsy are at risk for developing social difficulties relative to their peers; this includes stigmatization, decreased social competence, increased social problems, and marked social isolation (Elliott, Lach, & Smith, 2005; Jakovljevic & Martinovic, 2006). As a result of factors related to seizures and their treatment, children with epilepsy are prone to academic underachievement secondary to multiple issues affecting learning and behavior (Sabbagh, Soria, Escolano, Bulteau, & Dellatolas, 2006).

Stigma is a critical component of QOL for adolescents with epilepsy. A large proportion of 19,000 teenagers surveyed in the United States carried negative perceptions of people with epilepsy (Austin, Shafer, & Deering, 2002). Just over half (52 %) of the teens had never heard of epilepsy, almost half (46 %) were not sure if it was contagious, and 40 % were not sure if people with epilepsy were dangerous. Only 31 % reported they would consider dating someone with epilepsy and 75 % thought teenagers with epilepsy were more likely to be bullied or picked on than their healthy peers. The way in which youth with epilepsy are being viewed in their surrounding environments is a crucial factor when considering QOL.

Women with Epilepsy

Relative to men with epilepsy, women with epilepsy face unique challenges. Women who are prescribed antiepileptic medication are at increased risk for osteomalacia (i.e., softening of bones), osteoporosis, bone fractures, as well as reduced vitamin D

levels (Yerby, 2000). Some women tend to experience seizures associated with their menstrual cycle (catamenial seizures), and thus can benefit from special consideration when physicians are selecting antiepileptic medications and regulating hormones.

With regards to pregnancy and fertility, women with epilepsy are at increased risk of experiencing a seizure during pregnancy (Yerby, Kaplan, & Tran, 2004) and while giving birth. There are also risks to the developing child. If a child is exposed to antiepileptic medications in utero (particularly valproate used in the first trimester) the child is at increased risk for abnormal physical development or abnormal cognitive development (Harden et al., 2009). Use of multiple medications simultaneously (polytherapy) to control seizures in the pregnant woman also leads to increased risk for physical malformations in the developing child and can have a negative impact on cognition after the child is born. One specific set of malformations that appears to occur at increased rates for children who are born to women with epilepsy are neural tube defects (Yerby et al., 2004).

If a woman experiences a seizure while she is pregnant, the developing neonate is at risk for physical trauma, if the mother falls and her abdomen is injured. If a pregnant woman experiences a generalized and/or prolonged seizure, it can put the developing child at risk for experiencing periods of low oxygen and ischemic injury (stroke) (Yerby et al., 2004). Women with epilepsy are also at increased risk for spontaneous abortion, as well as death of the developing child in utero or during birth (Yerby et al., 2004). Seizure control can be difficult to attain and prescribing physicians are often hesitant to modify a successful medication regimen. Therefore, medications need to be closely monitored and adjusted to provide the best seizure control in addition to the safest conditions for the developing child. It should be emphasized that most women with epilepsy can have healthy children, particularly when vitamin supplementation and medication monitoring are appropriately conducted.

Household Duties and Activities of Daily Living

Given the often unpredictable nature of seizures, safety concerns can restrict an individual's ability to engage in some aspects of household duties. For example, those with uncontrolled seizures are often discouraged from using power tools or other motorized machines that might lead to injury. Increased risk of burns while cooking or showering during a seizure or due to confusion in the post-seizure period (Spitz, Towbin, Shantz, & Adler, 1994) can lead to reduced participation and/or required supervision of these activities. Other activities, such as swimming, can be limited due to fear that the individual will experience a seizure and be at risk for drowning (Mayes, 2009). Air travel also has been known to increase risk of seizures, which can reduce desire or ability to travel long distances (Trevorrow, 2006). Depending on seizure frequency and predictability, it can be the case that loved ones prefer that a person with epilepsy not travel on their own.

Employment

There is a long history of legal discrimination against people with epilepsy, which includes restrictions on marriage, fertility, and immigration. In some countries, these discriminatory practices have only recently been abandoned. One major area of restriction is employment. People with epilepsy have higher rates of unemployment, underemployment, and diminished earning power as a result of their condition (Chaplin, Wester, & Tomson, 1998; Smeets, van Lierop, Vanhoutvin, Aldenkamp, & Nijhuis, 2007). Higher rates of unemployment have been identified in individuals with more frequent seizures (Gloag, 1985). While some evidence suggests that for those with well-controlled epilepsy, employment rates are similar to the general population, people with epilepsy are more likely to be employed in manual labor/unskilled positions and are less likely to achieve employment levels that correspond to their qualifications (Chaplin et al., 1998). The causal mechanism for unequal employment has been hypothesized to relate to an interaction of environmental/social factors (e.g., stigmatization) as well as internal factors (e.g., diminished locus of control) (Smeets et al., 2007). In most developed countries, there are only a handful of occupations that are prohibited for people with epilepsy, including airline pilots and certain roles in the armed forces. However, restrictions in operating motor vehicles can limit access to some employment opportunities. These restrictions are in place to protect the life of the individual with epilepsy or others, in the event of a seizure. An additional factor that people with epilepsy consider in employment settings is whether to share their neurological history with coworkers/supervisors. Disclosure can be an important safety precaution (so that others know the best course of action for the individual if they experience a seizure), but many individuals report being treated differently in employment settings after coworkers become aware of their status as a person with epilepsy (Kerr, Nixon, & Angalakuditi, 2011). Vocational rehabilitation services are available to address the individualized needs of people with epilepsy.

> *Professionally, on occasion I was called upon to drive to a client. I'd hire a car service not thinking to bill it to the company. Figuratively and literally I viewed epilepsy with a shrug of my shoulders, "it's my allergy, sometimes I space out."*

Social Functioning/Participation in Society

Lack of social support can be more debilitating to individuals with epilepsy than high seizure rates. For persons with epilepsy, social support networks tend to be restricted to family, neighbors, and health care providers (Hills & Baker, 1992). While many individuals with epilepsy do not have entire or any recollection of the nature of their events, it can be distressing for loved ones or even strangers to witness a seizure (Kerr et al., 2011). Adolescents and young adults with epilepsy report that it is difficult for them to be in romantic relationships because of having experienced rejection and/or because they feel frustrated by what is perceived to be

over-involvement by parents or guardians (McEwan, Espie, Metcalfe, Brodie, & Wilson, 2004). Social support consistently has been found to be a protective variable for persons with epilepsy and lack of social support has been shown to be a significant predictor of depressive symptoms (Bishop, Berven, Hermann, & Chan, 2002). Strong social support contributes to increased perceived self-efficacy, which leads to improved quality of life (Amir, Roziner, Knoll, & Neufeld, 1999). Increasing strength and number of interpersonal relationships is a potentially modifiable domain that might lead to improved quality of life for these individuals.

I never married when most of my contemporaries were starting and building families. Was this because of the seizure activity? I wish I knew and that I had married. In my early 30s I met a wonderful woman, we lived together for 3 years and it was the same time that I was starting my company. I was unable to focus on both the business and the relationship and eventually, the young lady got tired of waiting for a proposal. I think the seizures clouded my emotions as well as focusing ability. Plus, did I want to/was I capable of taking on that responsibility while having so many seizures? I was very non-committal with other relationships thereafter, too.

I wonder.... had it not been for thousands of seizures during my 20s into early 40s, would I have married? The biggest challenge today, my contemporaries have made families, I still want one but did I miss that opportunity? I tend to be with people younger than me as we've similar social interests.

Driving

To assure the safety of the individual with epilepsy as well as others on the road, most states have policies in place to determine if an individual who has experienced a seizure is eligible to drive. Typically, one requirement for a person with epilepsy to obtain their driver's license is that they have been seizure free for a specific period of time (often 1 year). Documentation from a physician, stating that the individual is able to drive safely, is often required. Many states require regular submission of medical reports. The required documentation of medical reports can either be required for a specified amount of time or can be required for as long as the person remains licensed.

Restrictions on driving can create a stigma (i.e., mark an individual as different from peers) and very often leads to decreased freedom of movement. For individuals who are affected by epilepsy prior to driving-age, restrictions on driving can become a focus during adolescence, when peers are first obtaining their driver's licenses and gaining independence from parents or caregivers. Often, adults who experience seizures after they have been driving for some time experience significant alteration in their previous activities. Such individuals may rely on individuals in their social networks, or find alternatives such as hiring drivers or moving to locations with accessible public transportation. The loss of this ability can lead to restricted employment, educational, and social opportunities.

My license of course was suspended, but living in NYC limited the consequences. Never did I let epilepsy dictate my life, nor did I ever hide my condition. Weekends on Long Island, friends, family and taxis provided adequate mobility without too much frustration. There were instances where I was disappointed about having to wait for a ride, or not being able to pick up a date by car.

Emotional Problems

Overall rates of psychiatric illness are higher among persons with epilepsy than in the general population. Higher rates of psychosis, depression, anxiety, personality disorders, suicidality, and sexual dysfunction have been reported (Morrell, Sperling, Stecker, & Dichter, 1994; Rai et al., 2012; Tellez-Zenteno, Patten, Jette, Williams, & Wiebe, 2007; Whitman, Hermann, & Gordon, 1984). However, it is unclear whether the rates of psychiatric disturbance are higher in individuals with epilepsy in comparison to populations with other chronic medical conditions. Individuals with all subtypes of epilepsy are at increased risk for experiencing psychosis, and family history of seizures also leads to increased risk for psychosis (Clarke et al., 2012). Some caution is warranted when interpreting these results, as these investigations are typically conducted on patients appearing at specialized centers for treatment of the most severe forms of epilepsy.

There are striking parallels between behaviors resulting from seizures and symptoms associated with various psychiatric conditions. For example, some hallucinations and perceptual alterations resulting from temporal lobe seizures (i.e., during the seizure) closely resemble symptoms experienced by patients with schizophrenia (Stevens, 1999). The brain mechanisms underlying epilepsy therefore provide a valuable model for understanding the biology of schizophrenia and other psychiatric illnesses. Epilepsy has been used as an analog for understanding the brain basis of aggression and the cyclical disorders of mood and behavior (Post & Weiss, 1996). Controversies exist over whether some forms of aggressive behavior may actually represent the effects of "subclinical" seizures (Ito et al., 2007). Aggression in the context of postictal psychosis (difficulty understanding reality that occurs in the period after a seizure) has been documented in some individuals (Hilger et al., 2013).

Epilepsy can affect mood and personality. Some investigators have reported that patients with temporal lobe seizures are prone to changes in personality, reflecting increased electrical activity in the limbic region (Hermann & Riel, 1981). Manifestations of this personality type may include increased writing behavior, higher levels of emotionality, and changes in sexual behavior. Depression and anxiety are commonly experienced as a result of biological factors and as a psychological reaction to chronic illness. Individuals with epilepsy commonly experience "learned helplessness" as epilepsy is a condition characterized by an unpredictable and abrupt loss of control (Hoppe & Elger, 2011).

> *As the seizures accumulated, I'd become slightly depressed, though didn't realize until post-surgery. Now that I'm cured; as time passes, I continue to get stronger cognitive skills; processing items faster and able to multi-task. The lingering effects of epilepsy are; very poor short term memory, focusing is a bit weak at times, and depression. Depression was actually made worse immediately following the surgery, I would not get off the couch, found myself at times crying for no apparent reason and regularly doing so, each morning. My seizures were right front temporal, had the activity continued the depression would probably have eventually surpassed the level precipitated by surgery. Zoloft and therapy have controlled the bouts of sadness.*

Nonepileptic Events

Nonepileptic events are events that look like seizures but are not due to abnormal electrical activity in the brain. Some persons are known to exhibit recurrent, short-term behavioral changes that might appear to be a seizure but that do not have underlying electrical brain abnormality. It can be difficult to determine if such events are caused by seizures, and simultaneous EEG and video recording, interpreted by an epilepsy specialist are needed for proper diagnosis. Further, individuals who have seizures also at times have nonepileptic events. Therefore, appropriate diagnosis requires specialists to determine the best course of treatment. Misdiagnosis of nonepileptic seizures as epileptic seizures leads to potentially dangerous medical interventions such as inappropriate use of medications and at times has even led to invasive (i.e., surgical) interventions (Reuber, Fernandez, Bauer, Helmstaedter, & Elger, 2002). Several explanatory models have been proposed to explain nonepileptic seizures and they are often considered to be the result of complex psychological factors that may include conversion reaction or attempts to obtain secondary gain. The onset of nonepileptic seizures is often preceded by physical and/or psychological stressors (Bowman & Markand, 1999). High prevalence of physical/sexual abuse and other trauma are noted in groups with nonepileptic seizures (Fiszman, Alves-Leon, Nunes, D'Andrea, & Figueira, 2004) and elevated rates of post-traumatic stress disorder (PTSD) have been documented in this population (Betts & Boden, 1992). It is therefore important that these individuals be identified and provided with appropriate treatment. Psychotherapy has shown some promise for treating nonepileptic seizures (Goldstein et al., 2010).

Cognitive Problems

An important subgroup of people with epilepsy is those with learning disability and developmental delays. Epilepsy occurs much more frequently in people with intellectual disabilities than in the general population (approximately 20–30 times more common), with higher prevalence rates noted among those with more severe intellectual disability (Espie et al., 2001). In this subgroup, problems with expressive and receptive language and impairments in abstract, conceptual, and reflective thinking are common. This represents a major obstacle when trying to gather information from the patient, which can also make it more challenging to design appropriate interventions.

In addition to, or independent of, more generalized effects on intellectual functioning, other cognitive deficits are a common consequence of epilepsy. Children with epilepsy, as a group, are at risk for developing learning and behavioral problems (Bourgeois, 1998). Earlier age of seizure onset often predicts more severe cognitive difficulties later in life (Berg et al., 2008; Dikmen, Matthews, & Harley, 1977).

However, just as the cause, frequency of seizures and the nature of seizures varies widely, so does the range of cognitive ability/impairment in the population. Many individuals with epilepsy experience mild impairments in memory and

attention that may be a result of direct (i.e., the seizures, an underlying brain abnormality) or indirect (i.e., medication side effects, affective disorders) effects of epilepsy (Baker, Taylor, Aldenkamp, & Grp, 2011; Loring, Marino, & Meador, 2007). Seizures can affect other aspects of cognition, including slowed thinking speed, slowed motor speed and/or impaired coordination/fine motor skills, difficulty coming up with words, difficulty thinking abstractly, and difficulty with problem solving, among others. Specific patterns of cognitive dysfunction may be seen among patients with seizures arising from focal brain regions. For example, it is well known that patients with left temporal lobe seizures exhibit relatively specific impairments in verbal memory while their recall of spatial (visual) information is less affected (Delaney, Rosen, Mattson, & Novelly, 1980; Milner, 1972).

These cognitive difficulties, whether as a direct result of seizure activity or due to medication side effects, can significantly affect an individual's ability to engage effectively in everyday tasks. As an example, an activity often required in this population is managing medications. Some cognitive requirements of this task include memory ("Did I take my morning dose?") and planning ("I need to call the pharmacy ahead of time and refill my prescription"). If a person has difficulty in with either of these cognitive abilities, it can affect their ability to be able to manage their own medical care.

Neuropsychological testing provides the most sensitive and reliable means of identifying cognitive abnormalities. Studies of patients undergoing surgical procedures such as temporal lobe resection and callosotomy (surgically separating the fibers that connect the right and left hemisphere) have contributed to knowledge of neuroanatomic theories of memory functioning and hemispheric specialization. Information from these studies has enriched the body of knowledge on brain–behavior relationships, which can be extended to better understand other neurological conditions. In addition to neuropsychological testing, improvements in functional and structural neuroimaging, advances in pharmacotherapy and surgical interventions have led to more diverse interventions for treatment of epilepsy.

> *I think the seizures impacted my ability to focus on tasks and overall processing… the accumulation of seizures compounded this challenge. Despite this, at age 31, I started my own media company working around these challenges; I used a dictaphone to make notes and I probably worked about 15% longer to accomplish a task than if had I not had seizures in order to compensate for my inability to focus.*

Assessment of Quality of Life in Epilepsy

Historically, the efficacy of a new intervention for treatment of epilepsy was based on clinical endpoints (e.g., seizure type, severity, frequency, adverse effects), rather than on psychosocial factors. In 1998, the Commission on Outcome Measurement emphasized that quality of life is an important consideration to better understand the burden of epilepsy (Baker et al., 1998). In response, a number of general and epilepsy-specific QOL scales have been developed. Many of these tools are not routinely used in clinical practice and at present, and there are no specific guidelines

to identify the best measures and methods for assessing QOL in patients with epilepsy. This makes it difficult for researchers and clinicians to determine the most appropriate instruments for their purpose. Two approaches to the measurement of HRQOL utilize *quantitative* analyses or *qualitative* information from the patient and/or his or her family.

Quantitative Approaches

The more recognized and widely used HRQOL measures in epilepsy are the *generic* and *disease-* or *condition-specific* instruments. Generic instruments are not specific to any age, disease, or treatment group. Well-known generic instruments include the *RAND 36-Item Health Survey* (*SF-36*; Hays, Sherbourne, & Mazel, 1993; Ware et al., 1995), the *Sickness Impact Profile* (Bergner, Bobbitt, Carter, & Gilson, 1981), *McMaster Health Index Questionnaire* (Sackett et al., 1977), and the *Dartmouth COOP Functional Charts* (Nelson, Landgraf, Hays, Wasson, & Kirk, 1990). These instruments have the advantage that the data acquired can be compared across demographic or clinical populations. A potential limitation of these tools is that they might lack the sensitivity to detect subtle aspects of specific conditions or disorders (in this case, epilepsy) in a way that provides meaningful information to patients and professionals. A recent initiative, funded by the National Institute of Neurological Disorders, has been to develop the Neuro-QOL, an instrument to assess HRQOL associated with common neurological disorders (stroke, multiple sclerosis, Parkinson's disease, epilepsy, amyotrophic lateral sclerosis) (Gershon et al., 2012). This instrument could prove to be sufficiently general to serve a large population of affected individuals, while being specific enough to address aspects of QOL that arise specifically in disorders with neurological involvement.

Disease- or *condition-specific* HRQOL instruments assess aspects of a particular condition. They are generally considered to be more relevant and sensitive to the nuances of each disorder. On the other hand, they provide data that address a narrower range of issues than generic instruments, and it is usually difficult, if not impossible, to combine data from one disease-specific measure to another. The focus of the next section is primarily on condition-specific measures that explore the HRQOL of adults with epilepsy using quantitative measures. Measures previously identified as preferred for use in epilepsy are reviewed (Jacoby, Baker, Crossley, & Schachter, 2013; Leone et al., 2005).

Single Disease-Specific Scales

The *Epilepsy Surgery Inventory-55 (ESI-55)* was developed to assess outcome following epilepsy surgery (Vickrey, 1993; Vickrey et al., 1992). Three domains are assessed: general functioning (health perception, energy/fatigue, overall QOL, social function), mental functioning (emotional well-being, cognitive function,

role limitations due to emotional problems, role limitations due to memory problems), and physical functioning (role limitations due to physical problems, physical ability, freedom from pain). *The Quality of Life in Epilepsy Instruments (QOLIE 89, 31, and 10)* can be used with a wider range of epilepsy severities, including those with low-to-moderate seizure frequency. The original version of the instrument has 89 items with four primary factors (cognitive, mental health, and physical health). The epilepsy-related items include seizure severity, fear of having a seizure, the associated loss of control over one's life, cognitive and behavioral dysfunction, social limitations and stigma, sexual functioning, driving restrictions, and medication side effects. The *QOLIE-31* (Cramer et al., 1998) is reduced to 31 items and two factors: emotional/psychological issues and cognitive issues. The *QOLIE-10* (Cramer, Perrine, Devinsky, & Meador, 1996) is a 10-item brief screening instrument which yields three factors: epilepsy-specific effects, mental health, and role limitations.

The *Epilepsy Foundation (EF) Concerns Index* (Gillham et al., 1996; Viikinsalo, Gilliam, Faught, & Kuzniecky, 1997) contains 20 items reflecting concerns related to driving, independence, work, school, family, seizure and medication side-effects, mood and anxiety, and social functioning. The *Subjective Handicap of Epilepsy Scale (SHE)* was developed to assess the subjective impact of epilepsy on functional ability (O'Donoghue, Duncan, & Sander, 1998) via domains of mobility, orientation, physical independence, occupation, social integration, and economic self-sufficiency. The *Side Effects and Life Satisfaction (SEALS)* inventory focuses on the individual's experience with antiepileptic medication therapy (Gillham, Bryant-Comstock, & Kane, 2000) with five subscales included in the battery focusing on: Worry, Temper, Cognition, Dysphoria, and Tiredness.

Test Batteries to Assess HrQOL

The *Health-Related Quality of Life Questionnaire for People with Epilepsy (HRQLQ-E)* (Wagner et al., 1995) consists of 171 items selected on the basis of literature review and discussions with patients and clinicians. The *HRQLQ-E* is comprised of the UK version of the *RAND 36-item Health Survey* (Jenkinson, Wright, & Coulter, 1993), in combination with measures of general health, epilepsy burden (Jacoby, Baker, Smith, Dewey, & Chadwick, 1993), seizure severity (Baker et al., 1991), epilepsy-specific concerns, an epilepsy-specific mastery scale (adapted from Pearlin & Schooler, 1978), symptom occurrence and AED-related effects, as well as two open-ended questions. *The Liverpool Battery HRQOL Battery* includes measures of physical, social, and psychological functioning. Various instruments can be selected and combined to address specific research or clinical questions (Baker, Jacoby, Smith, Dewey, & Chadwick, 1994; Baker, Smith, Dewey, Jacoby, & Chadwick, 1993; Jacoby et al., 1993). However, this strategy limits cross-study comparisons.

Psychosocial Assessments

Washington Psychosocial Seizure Inventory (WPSI) (Dodrill, Batzel, Queisser, & Temkin, 1980) focuses on psychosocial problems associated with epilepsy, including family background, emotional adjustment, interpersonal adjustment, vocational adjustment, financial status, adjustment to seizures, medicine and medical management, and overall psychosocial functioning.

Assessments in Children and Adolescents with Epilepsy

Fewer QOL scales are developed for use with youth with epilepsy. While there has been a tendency to supplement self-report measures with proxy (typically parent/guardian) reports, it is preferred that young people themselves, and not a proxy, should be the primary source of information regarding their QOL (McEwan, Espie, & Metcalfe, 2004). Therefore, tools that are developed for this population have had the goal of accurately measuring QOL from the young person's perspective.

Condition-Specific Scales for Children and Adolescents

The *Quality of Life Instrument for Adolescents* (Cramer et al., 1999) was developed for use with adolescents, aged 11–18 years. The 48 items comprise eight subscales, including Epilepsy Impact, Memory and Concentration, Attitudes toward Epilepsy, Physical Functioning, Stigma, Social Support, School Behavior, Health Perceptions, and a total summary score. The *Glasgow Epilepsy Outcome Scale for Young Persons (GEOS-YP)* (Townshend et al., 2008) is a 50-item measure, which was developed based on the perspective of young people, aged 10–18. Correlations were also found between the *GEOS-YP* and measures of generic QOL, self-esteem, and seizure frequency. The *Quality of Life in Childhood Epilepsy Questionnaire (QOLCE)* (Sabaz et al., 2000) is a parent-reported HRQOL for youth aged 4–18. The measure is sensitive to epilepsy severity and shows significant relationships with number of antiepileptic medications and neuropsychological variables. Originally developed in Australia, it has been adapted for use for North American populations (Sabaz et al., 2003).

The *Adolescent Psychosocial Seizure Inventory (APSI)* (Batzel et al., 1991) is an adolescent version of the *WPSI.* Adolescents with epilepsy from five centers in North America completed the *APSI* and were interviewed by professionals with respect to their adjustment in eight psychosocial areas to develop this measure. The *Impact of Pediatric Epilepsy Scale (IPES)* (Camfield, Breau, & Camfield, 2001) is designed to be completed by a parent/guardian of a child with epilepsy. Three components of the measure were identified: Outside Activity Participation, Social Well-being, and Home Life.

QOL Assessment with Individuals with Epilepsy and Intellectual Disability

Clinicians often rely on information from caregivers, given the challenges in obtaining the individual's perspective. To date, only two measures were developed specifically to assess self-reported HRQOL in persons with epilepsy and diminished cognitive functioning: *The Glasgow Epilepsy Outcome Scale (GEOS)* (Espie et al., 2001) and the *Epilepsy and Learning Disabilities Quality of Life Questionnaire (ELDQOL)* (Buck, Smith, Appleton, Baker, & Jacoby, 2007).

Treatment

Medication and Surgical Treatment

Antiepileptic drugs (AEDs) provide the most common and effective form of treatment for epilepsy. AEDs act by altering the potential for abnormal cerebral discharge to reduce seizure activity. The number of drugs available to treat epilepsy has increased dramatically in the last several decades (Chong & Bazil, 2010). While many patients may require more than one AED for optimal seizure control, the goal is to minimize the number of drugs to reduce possible side effects. Drug-related adverse events are not uncommon, especially when several AEDs are needed to control seizures, and, as mentioned above, side effects in themselves can be disabling.

Approximately 30 % of treated individuals do not respond adequately to drug management (Cascino, 2008). In these cases, many benefit from treatment with epilepsy surgery. Surgical intervention involves removing the abnormal portion of the brain that has been identified as causing the seizure, guided by extensive presurgical testing. For those individuals whose seizures cannot be controlled with only AEDs, consideration of surgery depends on a number of factors, including whether the seizure origin is identifiable, and if the seizure origin lies in a resectable area of the brain (most commonly the temporal lobes). In the last two decades, the role of intracranial surgery has grown considerably.

Behavioral and Alternative Treatment

Alternative methods for treating epilepsy are available, though their efficacy remains less established. For example, individuals with some forms of epilepsy may benefit from changes in diet (e.g., ketogenic diet) (Neal et al., 2008). There is also evidence for a reduction in seizures after surgical implantation of an electrical device designed to stimulate the vagal nerve (Cascino, 2008). Others exhibit a reduction in seizure frequency after receiving focused behavioral treatment (Tan et al., 2009).

More recently, there have been investigations focused on psychosocial interventions with the goal of improving quality of life in epilepsy. While the sample sizes in these investigations are small, positive effects on quality of life or other mood

variables have been detected. Some studies have focused on psychoeducation, leading to reduction of fear for individuals with epilepsy (Helde, Bovim, Brathen, & Brodtkorb, 2005; Helgeson, Mittan, Tan, & Chayasirisobhon, 1990) or for parents of children with epilepsy (Shore, Perkins, & Austin, 2008). Education of family/friends and provision of support groups may increase social support for adults with epilepsy and further decrease internal stigma. Other studies have incorporated interventions with a cognitive-behavioral orientation to increase self-management of epilepsy and decrease stigma (Wagner, Smith, Ferguson, van Bakergem, & Hrisko, 2010). Interventions that are initiated at the time of first diagnosis may prevent the development of internal stigma, leading to improved outcomes. Clearly, based on the large population affected by epilepsy and the risk for diminished quality of life, ongoing investigations to identify appropriate interventions aimed to serve the diverse array of individuals affected by epilepsy are invaluable.

> *Never did I allow epilepsy to define me nor get in the way of a great life …. It's a choice, who's going to win, me or the epilepsy? I never hid the disorder, if anyone had a problem with it that was their issue, not mine. Everyone has something, for me the biggest challenge was epilepsy, and I won.*

Conclusion

Epilepsy is a rather frequent neurological condition exerting significant impact on QOL, secondary to the direct effects of seizures and the effects of the seizures themselves on behavior and cognition. Because of numerous social and culturally based misconceptions, people with epilepsy have undergone centuries of stigma, which has had a continuing effect on their social status. In spite of increased understanding of the condition, people with epilepsy continue to experience restrictions in their household, occupational, and social functioning, creating a marked impact on QOL. Individuals trained in the assessment, treatment, and study of epilepsy now recognize QOL as an important clinical component and target of treatment interventions and have thus developed a number of empirically validated instruments for assessment of QOL in this population. Nonetheless, further research is needed into the factors contributing to reduced QOL in patients with epilepsy with a greater number of interventions designed to address this critically important clinical endpoint.

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Cancer Survivorship

9

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Brain tumors can have a dramatic impact on an individual, as well as their family members and friends. The tumor or its treatment (i.e., chemotherapy, radiation) may directly or indirectly cause neurological impairments that affect the physical, social, vocational, and emotional capabilities of the individual. The available treatment options for both primary and metastatic brain tumors have improved and brought with them improved patient survival. This has made it more important than ever for clinicians to be aware of the potential long-term neurological impact of these potentially devastating disorders and its treatment (Kirshblum, O'Dell, Ho, & Barr, 2001; Mukand, Blackinton, Crincoli, Lee, & Santos, 2001).

This chapter highlights the neurological changes associated with cancer and its treatment. We first start by describing the various types of cancer that affect the brain, then we discuss available treatments. Additionally, we discuss the impact of cancer and its treatment on activities of daily living and quality of life (QOL), discussing some rehabilitation options.

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Primary Brain Tumors and Metastases

Michael, a 42-year-old computer programmer, began to notice blurred vision and difficulty using his right hand for typing in January. He then noticed that his balance was off, resulting in falls outside his home, and that his girlfriend could not understand his speech. He sought advice from his primary care physician and was found to have an expansile enhancing mass originating in the right medial cerebellar hemisphere. He underwent resection of this mass in February. Pathology of his tumor revealed that it was a medulloblastoma, a type of primary brain tumor.

Cheryl is a 61-year-old female with history of left sided breast cancer, treated with left modified radical mastectomy, chemotherapy, and radiation therapy to the left chest wall. Post treatment she noticed difficulty writing and stumbling while walking. She also noticed that her memory was "hazy." She reported these symptoms to her Oncologist who recommended further work up. Her work up revealed a right temporal lobe lesion. She subsequently underwent a craniotomy for tumor resection. Pathology of her tumor was consistent with metastatic breast adenocarcinoma.

Brain tumors can be primary, arising from neuroepithelial cells (i.e., cells that develop into the nervous system during embryonic development; within the brain, neuroepithelial cells differentiate into neurons, astrocytes, and glial cells) or secondary to metastatic disease, and can arise anywhere from the cerebral hemispheres above the tentorium to the posterior fossa. Before treatment is initiated, patients with brain tumors may present with neurological impairments related to the location of the lesion (Cotran, Kumar, Collins, 1999; Mukand et al., 2001).

The major classifications of primary brain tumors include gliomas, neuronal tumors, poorly differentiated neoplasms, other parenchymal tumors, meningiomas, and peripheral nerve sheath tumors. Their locations vary with tumor type and the patient's age. Table 9.1 lists tumors of neuroepithelial tissues and their location.

Brain metastases are the most common non-terminal neurological events in patients with cancer. In adults, most brain metastases originate from lung cancer, breast cancer, and cutaneous melanoma. Renal cell carcinoma, colon cancer, and gynecologic malignancies are also known to metastasize to the brain. In individuals under the age of 21, sarcomas including osteogenic sarcoma, rhabdomyosarcoma, Ewing sarcoma, and germ cell tumors are the most common causes of metastases. The majority of metastases reach the brain through the arterial bloodstream; however, they can also reach the brain via the vertebral venous system (Batson's plexus). Metastasis can also occur by direct extension into adjacent meninges (system of membranes that cover the brain) or the skull base (Lu-Emerson & Eichler, 2012; O'Neill, Buckner, Coffey, Dinapoli, & Shaw, 1994; Patchell, 1996).

Brain metastases tend to occur at the junction of the grey-white matter, a pattern characteristic of an embolic event, and are characteristically associated with severe peritumoral edema (swelling in surrounding area). Metastases are multiple in approximately 50 % of individuals and are typically well demarcated and solid. Occasionally, brain metastases may be cystic, necrotic, or hemorrhagic.

Table 9.1 Tumors of neuroepithelial tissue

Major classification	Type of tumor	Location
Gliomas	Fibrillary astrocytoma and glioblastoma multiforme	Cerebral hemispheres Cerebellum Brainstem
	Pilocytic astrocytoma	Cerebellum Floor of fourth ventricle Walls of third ventricle Optic nerve Cerebral hemispheres
	Pleomorphic xanthoastrocytoma	Temporal lobe
	Oligodendroglioma	Cerebral hemispheres
	Ependymomas	Third and fourth ventricles
Neuronal tumors	Gangliocytomas	Floor of third ventricle Hypothalamus Temporal lobe
	Cerebral neuroblastomas	Cerebral hemispheres
	Dysembryoplastic neuroepithelial tumor	Intracortical
Poorly differentiated neoplasms	Medulloblastoma	Cerebellum
Other parenchymal tumors	Primary central nervous system lymphoma	Frontal lobe Corpus callosum Deep periventricular brain structures
	Germ cell tumors	Pineal and suprasellar regions
Meningiomas		Parasagittal aspect of brain convexity Dura over the lateral convexity Wing of the sphenoid Olfactory groove Sella turcica Foramen magnum
Peripheral nerve sheath tumors	Schwannomas	Cerebellopontine angle Cranial nerve V and VIII

Reference (Cotran et al., 1999)

The distribution of brain metastases roughly correlates with cerebral blood flow and brain volume. Approximately 80 % of metastases occur in the cerebral hemispheres, 15 % in the cerebellum, and 5 % in the brainstem (Lu-Emerson & Eichler, 2012).

Neurologic impairments from primary brain tumors and metastases are the result of destruction or displacement of normal brain tissue by the growing lesion and its associated edema. Hydrocephalus, increased intracranial pressure and vascular injury may also ensue and play a role (Lu-Emerson & Eichler, 2012). Typically, individuals have a subacute to chronic progression of symptoms;

however, symptoms may appear rapidly and episodically from associated hemorrhage, non-convulsive seizures, or by cerebral infarction from embolic or compressive occlusion of a blood vessel (O'Neill et al., 1994; Patchell, 1996).

The clinical presentation of neurological impairments related to primary brain tumors and metastases is similar to that seen in individuals with stroke and traumatic brain injury. Signs and symptoms may be generalized such as headaches, seizures, and personality changes. Localized findings include focal weakness, sensory changes, gait ataxia, visual-perceptual deficits, language dysfunction, cognitive impairments, and dysphagia. The neuroanatomical location of the tumor determines the presenting signs and symptoms (Huang, Cifu, & Keyser-Marcus, 1998; Stubblefield & O'Dell, 2009).

In order to predict neurological impairments it is important to understand their anatomical basis (Braddom, 2007).

Motor Control

Motor control includes all components of volitional movement, such as strength, coordination, and balance. The primary motor area is located along the precentral gyrus anterior to the central sulcus of both cerebral hemispheres, and extends from the paracentral lobule within the longitudinal fissure to the frontal operculum within the Sylvian fissure. Axons from these cortical cells descend through the internal capsule to the pyramidal tract in the brainstem and the corticospinal tract in the spinal cord (Braddom, 2007). Tumors involving the primary motor area can result in hemiparesis, hemiplegia, paresis, plegia, tetraparesis, tetraplegia, and poor control over voluntary movement.

Complex extrapyramidal systems, or the neural network that is part of the motor system that causes involuntary reflexes and movement, and modulation of movement (e.g., coordination), are responsible for trunk control and stability, coordination of movement patterns, and balance. The premotor area, anterior to the precentral gyrus in the frontal lobe, is important in motor planning. The premotor area receives afferent (sensory) input from the vestibular, visual and somatosensory systems. Efferent (motor) tracts descend from the premotor through the anterior limb of the internal capsule to the basal ganglia and the cerebellum. Injury to either the afferent or efferent pathways, resulting from a tumor, can result in poor static and dynamic sitting and standing balance, as well as movement disorders such as ataxia, chorea, hemiballismus, and tremors (Braddom, 2007).

Spasticity, a velocity-dependent increased resistance to passive muscle stretch, is a common complication with injury to the motor areas of the central nervous system. Spasticity can result in decreased flexibility, joint pain and contractures, and lead to impairments in positioning for comfort and hygiene, functional use of an extremity, and functional mobility (Braddom, 2007).

Sensation

Sensation encompasses perception of light touch, pain, temperature, vibration, joint proprioception, and stereognosis (the ability to recognize an object by touching or

lifting it). Pain and temperature sensations are relayed centrally by fibers that enter the spinothalamic tract from the contralateral dorsal root ganglion and ascend to the ventral posterior lateral nucleus of the thalamus. Sensory fibers for joint proprioception and stereognosis ascend ipsilaterally from the dorsal root ganglion within the dorsal columns of the spinal cord and synapse in the nucleus gracilis and cuneatus. These fibers then cross to the contralateral side within the lower medulla and ascend to the ventral posterior lateral thalamus. The ventral posterior lateral thalamus then relays sensory information to the primary sensory cortex, which is located posterior to the central sulcus in the post central gyrus. Injury along the sensory pathways can result in hypoesthesia (decreased sensation), hyperesthesia (increased sensation), or pain. Involvement of the sensory pathways also affect joint and skin protection, balance, coordination, and motor control (Braddom, 2007).

Language and Communication

Language is considered to be a function of the left or dominant hemisphere, but some elements such as prosody have nondominant hemispheric control. Tumor involvement of motor and sensory areas of the brain can affect comprehension and speech. Lesions near the oral motor cortex can result in a Broca-type aphasia, with impaired fluency, expression, repetition, naming, and mildly impaired comprehension. Wernicke-type aphasia with normal fluency, but impaired expression, comprehension, repetition, and naming, can be seen in lesions near the primary auditory cortex (Braddom, 2007).

A transcortical motor aphasia can be seen in lesions near but not involving Broca's area. Transcortical motor aphasias often present with intact comprehension and repletion, mildly impaired naming and expression, and impaired fluency. Similarly, lesions near but not involving Wernicke's area can occur and result in a transcortical sensory aphasia. Normal fluency and repetition, with mildly impaired comprehension, expression and naming are seen in this type of aphasia. Individuals with involvement of both motor and sensory areas can present with a global aphasia, manifesting as impaired fluency, expression, comprehension, repetition, and naming. Disorders of reading (alexia) and writing (agraphia) can also be seen and are the result of tumor involvement at the junction of the occipital and temporal lobes (Braddom, 2007).

Apraxia

Disorders of motor planning characterized by the loss of ability to execute learned purposeful movements in the absence of motor, sensory, or cognitive impairments are referred to as apraxia. Individuals with apraxia often have difficulty performing simple functional activities, such as upper extremity dressing. Apraxia is the result of a disconnection of the right cortical motor association area from the left hemisphere with injury of the anterior callosal fibers. They are often seen in lesions involving the left hemisphere and affect the left non-hemiparetic limb (Braddom, 2007).

Neglect Syndrome

Heilman, Watson, and Valenstein (1993) define hemispatial neglect as failure to report, respond to or orient to novel or meaningful stimuli presented to the side opposite a brain lesion. Neglect syndrome is a disorder of visual and spatial attention, and can be seen in individuals with tumor involvement of the frontal eye fields, cingulate gyrus, thalamus, and reticular formation. Neglect can negatively impact balance, visual perception, mobility, safety awareness, skin and joint protection (Braddom, 2007).

Dysphagia

Dysphagia can be seen with primary tumors and metastases involving unilateral or bilateral hemispheres and the brainstem. Individuals with dysphagia may present with delayed initiation of pharyngeal swallow and prolonged pharyngeal transit times. They may also present with decreased labial and lingual mobility or sensation, unilateral neglect with pooling of pharyngeal residue within the vallecula and pyriform sinuses, or cricopharyngeal dysmotility (Braddom, 2007). Dysphagia increases the risk for aspiration pneumonia which can have deleterious effects in the immunocompromised population.

Bowel and Bladder Function

Bowel and bladder incontinence can occur in the setting of brain involvement in individuals with cancer. Bladder incontinence in this setting is typically caused by lack of voluntary inhibition to void, signifying involvement of the frontal lobe micturition center. The pontine micturition center is typically preserved, allowing for normal pelvic floor, external and internal sphincter relaxation prior to detrusor contraction. When voiding, the bladder should empty completely in the absence of prostatic hypertrophy or other forms of bladder outlet obstruction. Neglect, impaired awareness, communication deficits, and immobility also play a role as they impair an individual's ability to use equipment or ask for assistance. Similar impairments can be seen in relationship to bowel habits. It is important to pay careful attention to changes in an individual's bowel and bladder habits, as incontinence can be a major source of disability.

Clinical Manifestations

Individuals with brain involvement from primary tumors or metastases can present with a myriad of neurological manifestations. These manifestations may be broadly divided into those of lobular, hemispheric, cerebellar, subcortical and brainstem, and generalized types (Gilbert, Armstrong, & Meyers, 2000).

Individuals with frontal lobe involvement may present with impairments related to destruction or displacement of normal brain tissue within the region or secondary to damage of the afferent and efferent connections the frontal lobe has with all other brain regions. Frontal lobe involvement may manifest with contralateral hemiparesis/plegia involving the leg more than the arm, contralateral hemianesthesia, disconnection apraxia, transcortical motor aphasia, or akinetic mutism. Individuals may also present with cognitive impairments related to abstract thinking, motivation, planning, and organizational skills. These impairments may manifest as apathy, difficulty with cognitive flexibility, inability to learn from experience, personality changes, and inability to evaluate potential outcomes of a situation (Braddom, 2007; Gilbert et al., 2000; Meyers, Weitzner, Valentine, & Levin, 1998).

The cerebral hemispheres can be involved with both primary tumors and metastatic disease. Lesions in this region can result in contralateral hemiparesis/plegia, contralateral hemianesthesia, visual impairments, dysphagia, and an uninhibited neurogenic bladder. Bowel function may also be affected. Involvement of the dominant (left) hemisphere may result in language deficits and apraxia. Speech and communication deficits such as Broca-type aphasia, Wernicke-type aphasia, transcortical sensory aphasia, and global aphasia can occur. Individuals may also exhibit impaired verbal learning and memory as well as difficulty with verbal reasoning. Involvement of the nondominant (right) hemisphere may produce aprosody of speech, affective agnosia, visuospatial deficits, and neglect syndrome (Braddom, 2007; Gilbert et al., 2000; Meyers et al., 1998).

Posterior fossa tumors can result in injury to the occipital and temporal lobes and the cerebellum. Lesions in the occipital lobe may result in hemi-sensory deficits, visual impairments, visual agnosia, prosopagnosia, dyschromatopsia, and alexia without agraphia. Temporal lobe involvement can result in impairments in memory, hearing, spatial orientation, sleep–wake cycle, as well as behavioral changes. Individuals with cerebellar involvement may develop ipsilateral limb ataxia, balance impairments, and visual changes. Lesions involving the cerebellum may also cause obstruction of the fourth ventricle and hydrocephalus (Braddom, 2007). Tumor involvement of the lateral, third, and fourth ventricles can also result in hydrocephalus which, if severe, can cause increased intracranial pressure.

Subcortical and brainstem involvement often presents with cranial nerve deficits, loss of sensation to pain, temperature, and joint position sense, hemiparesis/plegia, ataxia, chorea, dysphagia, dysphonia, and decreased levels of arousal. Generalized types of neurocognitive manifestations include attention deficits, memory impairments, impaired reasoning, difficulties with speech and language, visual perceptual problems, mood disorders, impaired executive functioning, and neurobehavioral slowing (Gilbert et al., 2000).

While the symptoms discussed above tend to be specific to the brain structure impacted by disease, individuals with primary and metastatic cancer can also present with more generalized symptoms that are not tied to neuropathology in specific brain structures. Such symptoms are common and include headache, seizures, attention deficits, poor memory, impaired reasoning, difficulties with speech and language, visual perceptual deficits, mood disorders, and fatigue

(Gilbert et al., 2000). The presence of mood disorders in particular, such as anxiety and depression, can lead to additional complications of their own. That is, mood symptoms have been associated with cognitive impairments and fatigue in multiple populations and the effective alleviation of such symptoms is essential to overall quality of life. For example, The National Comprehensive Cancer Network defines cancer-related fatigue as a "persistent" subjective sense of tiredness related to cancer or cancer treatment that interferes with usual functioning (Stubblefield & O'Dell, 2009). Cancer related fatigue is likely different than the generalized fatigue seen in stroke and traumatic brain injury populations, and can be a major source of distress in these individuals. Anemia, medications and medical comorbidities can also contribute to fatigue in this population (Stubblefield & O'Dell, 2009).

Treatment of Primary Brain Tumors and Metastases

Survival factors including age, extent of systemic disease, neurological status at time of diagnosis, and number and sites of metastases are considered when determining optimal treatment (Patchell, 1996). Surgical resection and radiation therapy remain the mainstay of treatment for primary and metastatic tumors. Chemotherapy also plays a role in the treatment of patients with brain tumors. With recent therapeutic advances in traditional modalities, as well as the introduction of new techniques such as immunotherapy, survival times for individuals with brain involvement from primary brain tumors and metastases have increased. Unfortunately, increased survival does not directly correlate with improved functional status, as individuals may have residual deficits related to their tumor or develop neurological impairments resulting from their cancer treatment (Mukand et al., 2001).

Vicki is a 70-year-old female with a history of small cell lung cancer, treated with chemotherapy and thoracic radiation. After these procedures, she then underwent prophylactic whole brain radiation. Several months after completion of radiation therapy she began to notice difficulty with recalling dates, performing calculations in the grocery store, spelling, and with word retrieval. She reported these symptoms to her Radiation Oncologist who recommended an MRI to further evaluate her symptoms. Her MRI ruled out brain metastases, but revealed mild enlargement of the lateral and third ventricles as well as patchy periventricular hyperintensities. These findings were considered suggestive of volume loss and gliosis secondary to whole brain radiation.

Laura is a 54-year-old attorney with a history of left sided breast cancer. She was treated with lumpectomy and sentinel lymph node biopsy, followed by chemotherapy and radiation therapy to the left chest wall. During chemotherapy she began to notice difficulty with multitasking, attention, and naming. Work up of her symptoms did not reveal any intracranial abnormalities. She underwent neuropsychological testing which showed deficiencies with sequencing numbers, fluency for generating words beginning with a specific letter, and attention. Based on her clinical findings, her symptoms were felt to be related to her treatment with chemotherapy.

Surgical Intervention

Surgical intervention is a standard treatment option in individuals with surgically accessible single lesions, good functional performance status, and controlled or absent extracranial disease, as it provides tissue for definitive diagnosis and immediate relief of neurological symptoms due to mass effect (Lu-Emerson & Eichler, 2012). With the assistance of intraoperative monitoring, surgery aims at removal of as much tumor as possible with little or no damage to adjacent normal nervous tissue. Nevertheless, postoperatively, individuals may experience residual neurological deficits from subtotal resection of their tumor, or new deficits related to post operative edema and resection of functional brain tissue along with tumor (Giordana & Clara, 2006).

Postoperative neurological deficits may present with generalized signs and symptoms such as headache, seizures, and personality changes, or focal deficits such as weakness, sensory changes, gait abnormalities, visual-perceptual deficits, language dysfunction, cognitive impairments, and dysphagia. The neuroanatomical location of the tumor and site of surgical intervention determines the presenting signs and symptoms.

Radiation Therapy

Radiation therapy is a mainstay in the treatment of both primary and metastatic tumors in the brain. The brain may also be radiated prophylactically in an attempt to prevent the development of metastases, as seen in individuals with newly diagnosed small-cell lung cancer, medulloblastoma, or leukemia. Finally, the brain may be exposed to radiation when it is included in the field of treatment of primary head and neck cancers (Rogers, 2012).

The goal of radiation therapy is to achieve maximal effect to the tumor with minimal toxicity to normal brain tissue (Giordana & Clara, 2006). The typical radiation dose used is 30–40Gy delivered in daily fractions of 2–3Gy (Lu-Emerson & Eichler, 2012). It is important to emphasize that no "safe" dose has been identified for all individuals, and in most instances, tissue or vascular injury from radiation therapy is unavoidable. In general, increasing the total dose used, fraction size, and area treated, as well as concomitant administration of chemotherapy has been shown to increase the risk of neurotoxicity (Correa et al., 2004; Rogers, 2012). The very young (age <10) and the elderly (>70) appear most vulnerable to the adverse effects of radiation therapy (Rogers, 2012).

External beam radiation therapy (EBRT) is the modality most commonly used. EBRT can be delivered focally for primary parenchymal tumors, skull base tumors, and meningioma. Whole brain radiation therapy (WBRT) is a type of EBRT prescribed for tumors such as medulloblastoma, germinoma, primary central nervous system lymphoma, and to treat or prevent brain or leptomeningeal metastases (Rogers, 2012). Other types of radiation therapy include stereotactic radiosurgery and interstitial brachytherapy. Stereotactic radiosurgery delivers a highly focused

single dose of radiation locally to destroy tissue, rather than a radiation dose calculated to be just below levels that are harmful to normal cells. Interstitial brachytherapy uses radioactive implants within the area of the tumor to deliver high dose focal radiation to the tumor while minimizing the risk of significant radiation exposure to surrounding normal brain tissue (Patchell, 1996).

The exact pathophysiologic mechanism of neurotoxicity from radiation therapy is not fully known, but vascular injury, neuronal loss, inflammation, demyelination, necrosis, and disruption of neurogenesis have been identified (Correa et al., 2012; Rogers, 2012). Adverse effects occur most commonly with EBRT, and three clinical phases of adverse effects have been identified as acute, subacute, and delayed (Rogers, 2012).

Acute phase adverse effects. Adverse effects occurring during radiation therapy are usually temporary, but can be disturbing enough to mandate symptom-based therapy. Common symptoms during the acute phase include headache, nausea, vomiting, fever, and new or progressive focal neurological deficits. Individuals experiencing acute effects should be assured that they are temporary (Rogers, 2012).

Subacute phase adverse effects. Subacute effects develop within the first 6 months of receiving radiation therapy and are usually temporary. They can persist longer and be more severe than acute symptoms. During the subacute period, individuals may experience increased fatigue/lethargy, impaired cognition, and new or worsening focal neurological deficits. Symptoms of fatigue can be especially pronounced in children, and are termed "somnolence syndrome." In the pediatric population, fatigue can be accompanied by irritability and nausea. Transient demyelination is suspected in the etiology of subacute phase symptoms (Rogers, 2012).

Subacute symptoms may require treatment and education regarding their reversible nature. Steroids are often recommended as they can speed the recovery from symptoms. When evaluating a patient with worsening neurological deficits, especially cognitive decline in the subacute period, it is important to rule out other organic causes such as tumor progression, new metastases, medications, metabolic derangements, mood disorders and infections (Rogers, 2012).

Delayed phase adverse effects. Delayed effects occur several months to years post treatment. Damage to microvasculature resulting in tissue hypoxia appears to be the primary event leading to delayed phase adverse effects. These adverse effects are the most feared complications, because they are generally considered irreversible and can be disabling (Correa et al., 2004; Rogers, 2012). Classically described delayed phase adverse effects include cerebral radiation necrosis, leukoencephalopathy, and vascular abnormalities. These adverse effects will be described below.

Cerebral radiation necrosis typically occurs after treatment with high dose local radiation therapy, the type used in stereotactic radiosurgery and interstitial brachytherapy. It can also be seen as a complication of focal EBRT, and in the temporal lobes following radiation therapy to treat head and neck cancers. Neurological deficits that occur as a result of cerebral radiation necrosis depend on the location and size of the necrotic lesion. Thorough evaluation and brain imaging is important as these deficits are indistinguishable from those of a mass lesion of any kind in the brain (Rogers, 2012).

Standard MRI findings suggestive of cerebral radiation necrosis include "Swiss cheese" and "spreading wave front enhancement" in an area of previous radiation therapy. PET scan can also be useful in the evaluation of neurological deficits, but the most accurate method for diagnosis remains tissue resection. Pathological findings of cerebral radiation necrosis include ischemic tissue necrosis, demyelination, and reactive gliosis (Rogers, 2012).

Treatment of cerebral radiation necrosis includes surgical resection of the necrotic lesion; however, complete resection is not always possible and radiation necrosis can recur postoperatively. In individuals with unresectable lesions and recurrence of radiation necrosis, additional medical management is indicated. Steroids can be beneficial in reducing associated vasogenic edema and mass effect. Recent studies have demonstrated that bevacizumab, a monoclonal antibody against vascular endothelial growth factor, has a beneficial effect in reducing the volume of the necrotic lesion and improving neurologic symptoms. There is also anecdotal evidence that shows anticoagulation therapy, hyperbaric oxygen therapy and the combination of Vitamin E and pentoxifylline may be efficacious treatment options (Rogers, 2012).

Leukoencephalopathy occurs as the result of microscopic injury to the brain white matter. The exact cause for this tissue damage is unknown, but direct toxic effects of radiation, axon loss, oxidative damage, upregulation of cytokines, and inflammation have been suggested. Autopsy studies of individuals with leukoencephalopathy show demyelination, mild edema, and gliosis (Rogers, 2012).

In adults with brain metastases, leukoencephalopathy is most commonly seen after treatment with WBRT. It can also be seen after WBRT for treatment of primary central nervous system lymphoma. The elderly and individuals receiving concomitant neurotoxic chemotherapeutic agents are particularly susceptible. In the pediatric population it occurs most commonly after radiation therapy for treatment of primary brain tumors, or prophylaxis or treatment of leptomeningeal metastases from a primary brain tumor, or acute lymphoblastic leukemia (Rogers, 2012).

Leukoencephalopathy presents with cognitive impairments including reduced intellect and impaired memory and attention. Gait abnormalities, emotional lability, apathy, and urinary incontinence may accompany these cognitive impairments (DeAngelis, Delattre, & Posner, 1989; Rogers, 2012). As with cerebral radiation necrosis, a thorough evaluation including imaging studies is recommended. Brain MRI in an individual with leukoencephalopathy is characterized by diffuse white matter hyperintensity on T2 weighted images. Diffuse cerebral atrophy may be seen in severe cases (Armstrong et al., 2000; Rogers, 2012).

Medical management of leukoencephalopathy has been studied to assess effects on cognition, mood, and motor symptoms. Studies have included methylphenidate, modafinil, and donepezil as potential treatment options. Methylphenidate is the most common agent used in clinical practice, as there is anecdotal evidence for positive effects on symptoms and tolerability. Ventricular shunting can be considered a treatment option in individuals with leukoencephalopathy and progressive ventricular enlargement (Meyers et al., 1998; Rogers, 2012).

Radiation therapy can result in injury to large, medium, and small brain blood vessels, particularly in the pediatric population. Radiation induced vascular damage may result in vessel stenosis or occlusion, moyamoya, aneurysms, mineralizing microangiopathy, and arterial venous malformations (Rogers, 2012). Blood vessel involvement may result in tissue ischemia or cerebral hemorrhage. Neurologic deficits related to blood vessel involvement depend on the vascular structures involved and the area of the brain affected. A rare delayed phase vascular effect is the SMART (Stroke-like Migraine Attacks after Radiation Therapy) syndrome. Individuals with SMART syndrome present with migraine-like headaches and focal neurological deficits. Seizures may also be present as part of the clinical picture (Rogers, 2012).

MRI of the brain is recommended in individuals with new or worsening neurological deficits and can demonstrate vascular abnormalities as well as localize areas of ischemia or hemorrhage that can occur. Vascular abnormalities should be monitored closely. Surgical intervention should be considered for symptomatic lesions and those associated with hemorrhage (Rogers, 2012).

Cranial nerves are also susceptible to injury from radiation therapy. The optic nerve and optic chiasm are susceptible when radiation is administered to treat retinal, optic nerve, optic chiasm, pituitary, and anterior skull based tumors. Individuals with optic nerve or optic chiasm involvement may present with painless and progressive unilateral loss of vision or constriction of visual fields. The hypoglossal nerve and other lower cranial nerves may be included in the field used to treat skull base tumors. Involvement of these cranial nerves may present with speech and swallowing impairments (Rogers, 2012).

The exact pathogenesis of cranial nerve involvement is unknown, but demyelination has been found at autopsy and in animal studies. Thorough assessment of cranial nerves should be performed to identify those involved. Formal visual assessment and swallowing evaluation is also recommended. MRI can be helpful in identifying the site and extent of nerve injury (Rogers, 2012).

Chemotherapy

Chemotherapeutic agents play a role in the treatment of both intracranial and extracranial malignancies and have contributed to significant improvements in clinical outcomes. These agents exert their antineoplastic effect on cancer cells through a reduction in cellular proliferation, and induction of apoptosis and other forms of cell death (Newton, 2012). Unfortunately, chemotherapeutic agents can result in unintended toxicity on normal cells, including the neuronal cells of the central nervous system (Raffa, 2011).

Neurological involvement after treatment with chemotherapeutic agents can range from cognitive impairments and visual changes to encephalopathy, leukoencephalopathy, cerebrovascular complications, and cerebellar syndromes. These complications may arise during treatment, or months to years post treatment (Lee, Arrillaga-Romany, & Wen, 2012). Factors contributing to the development of

neurological involvement include total dose received, route of administration, presence of structural brain lesions, exposure to concomitant radiation therapy, and interactions with other medications (Newton, 2012).

Cognitive dysfunction ("chemobrain or chemo-fog") is a well described adverse effect of intrathecal and intraventricular administered chemotherapy for primary and metastatic brain tumors, but can also occur after treatment for non-central nervous system cancers (Lee et al., 2012). Moderate cognitive impairments are reported in 15–50 % of breast cancer survivors following chemotherapy, and recent literature suggests that many more may experience subtle cognitive changes (Christie et al., 2012). Risk factors associated with development of cognitive dysfunction include patient age, level of cognitive function prior to treatment, concurrent toxic metabolic abnormalities, fatigue, and other medical comorbidities. Survivors of pediatric cancers are particularly susceptible to the development of cognitive impairments (Lee et al., 2012). Clinical manifestations of cognitive dysfunction include impairments in verbal and visual memory, language, processing speed, attention, motor skills, executive functioning, and changes in mood (Christie et al., 2012; Lee et al., 2012; Raffa, 2011).

Cognitive deficits may occur during and immediately after treatment with chemotherapy, and are self-limited in some individuals. In others, symptoms may present in a chronic, progressive fashion. The severity of these deficits ranges from mild memory impairments to severe dementia. The pattern of cognitive deficits demonstrates preferential involvement of the frontal and subcortical white matter networks (Lee et al., 2012). The exact pathogenesis of underlying brain changes remains under investigation; current hypotheses include disruption of hippocampal cell proliferation and neurogenesis, chronic inflammation, increased oxidative stress, white matter disruption and changes in cerebral blood flow and metabolism. Imaging occasionally demonstrates structural and functional brain changes (Christie et al., 2012).

Management strategies for cognitive deficits involve prevention and treatment. Oncologists will often adjust treatment regimens to minimize toxicity. Limited data exists regarding treatment of chemotherapy-induced cognitive deficits. Erythropoietin, methylphenidate, modafinil, cholinesterase inhibitors, nonsteroidal anti-inflammatory drugs (NSAIDs), and non-pharmacologic interventions are under investigation, but at this time no definitive recommendations can be made (Lee et al., 2012).

Posterior reversible encephalopathy syndrome (PRES) can occur during or shortly after treatment with a variety of anticancer drugs. Clinical manifestations of PRES include headache, seizure activity, and visual changes including blurred vision and cortical blindness. The pathogenesis is thought to involve cerebral blood flow autoregulation and endothelial dysfunction. Parietal and occipital lobes are most commonly affected, followed by the frontal lobes, inferior temporal-occipital junction, and cerebellum. MRI typically demonstrates focal regions of symmetric hemispheric edema on T2 weighted images. Symptoms are often reversible with discontinuation of the offending agent and supportive care (Lee et al., 2012).

Encephalopathy can occur as a direct toxic effect of high dose intravenous and intra-arterial chemotherapeutic agents. Symptoms of encephalopathy typically manifest during the acute and subacute phase of treatment. Individuals with

encephalopathy may present with confusion, delirium, visual hallucinations, mutism, focal motor deficits, facial nerve palsy, dysarthria, aphasia, dysphagia, Parkinsonism, drowsiness, and seizure activity (Lee et al., 2012; Newton, 2012). Imaging, including CT and MRI performed during work up of these symptoms, may reveal transient white matter abnormalities. EEG often reveals diffuse background slowing. The exact pathogenesis remains unclear. Most cases resolve with removal of the offending agent; however, in rare cases a chronic encephalopathy may ensue (Newton, 2012).

Individuals with cancer are susceptible to cerebrovascular accidents secondary to coagulation defects, infections, tumor infiltration, and cancer treatment. Chemotherapeutic agents are a rare cause of cerebrovascular accidents; however, ischemic strokes, intracranial hemorrhages, venous sinus thrombosis, and other thromboembolic events have been documented (Lee et al., 2012). Individuals with chemotherapy-induced cerebrovascular accidents may present with a myriad of neurological manifestations including headache, loss of consciousness, cognitive impairments, visual impairments, dysphagia, speech and language deficits, focal neurological deficits, and seizure activity.

Work up including MRI and CT scans should be performed in a patient suspected of having cerebrovascular involvement. MRI is more sensitive for detection of early infarction, posterior fossa infarctions, and small infarcts. CT scan with and without contrast is useful in evaluation of intracranial hemorrhage and may show filling defects in the setting of venous sinus thrombosis.

Cerebellar syndromes can also be seen in the setting of treatment with neurotoxic chemotherapeutic agents. Individuals with cerebellar involvement may present with confusion, dysarthria, dysmetria, ataxia, balance impairments, and gait abnormalities. Imaging, including MRI, reveals cerebellar atrophy with loss of Purkinje cells. There is no specific treatment for cerebellar involvement, but discontinuation of the offending agent is recommended. Cerebellar findings are self-limited in some individuals, but can become permanent in others (Lee et al., 2012).

Chronic or late adverse events after treatment with neurotoxic chemotherapeutic agents typically manifest 6 months or more after initial drug exposure. The most characteristic late adverse event is leukoencephalopathy. Leukoencephalopathy is most likely to occur in individuals who receive combination therapy with chemotherapy and cranial irradiation. It has been well described in the pediatric literature after treatment for acute leukemia, but can occur in adults. In children, leukoencephalopathy may manifest with developmental delay, progressive learning disorder, memory loss, gait abnormalities, and urinary incontinence. In adults, the presentation is similar, with symptoms of confusion, memory loss, dementia, somnolence, irritability, visual impairments, dysphagia, ataxia, gait abnormalities, urinary incontinence, and seizure activity (Newton, 2012).

Imaging with CT and MRI in a patient with leukoencephalopathy reveals cortical atrophy, ventricular enlargement, punctate areas of calcification within the basal ganglia and deep white matter. Demyelination, multifocal white matter necrosis, astrocytosis, dystrophic calcification of deep cerebral vessels and axonal damage

play a role in development of pathologic brain changes (Newton, 2012). There is no effective medical treatment for leukoencephalopathy (Lee et al., 2012).

Impact of Neurological Impairments on Daily Life

Nina is a 35-year-old piano player with a history of a right hemispheric ganglioma, diagnosed in the setting of left hemiparesis and sensory loss. She underwent surgical resection of her tumor but continued to experience residual left hemiparesis and sensory loss post operatively. Six months after her resection she began to notice changes in her speech and memory. Work up of her symptoms showed progression of disease. She subsequently underwent treatment with partial brain radiation therapy and concurrent chemotherapy. Her disease is felt to be stable, but she continues to experience left hemiparesis, sensory loss, memory impairments and expressive aphasia.

As a result of her physical impairments, she has difficulty with mobility, self care, household tasks and grocery shopping, caring for her son, keeping track of doctor's appointments, and playing the piano. Her husband has been cooking and grocery shopping, and she has a home health aid for household tasks such as cleaning and laundry. Her mother is visiting from Korea to assist in child care. Her husband and mother have also been assisting her with mobility and self care. Nina's Neurological Oncologist referred her to rehabilitation for further recommendations.

Neurological impairments in individuals with cancer may affect their physical, social, vocational, and emotional capabilities. Individuals with neurological impairments may have difficulty with both basic and instrumental activities of daily living. Basic activities of daily living (B-ADL) reflect self care and include: personal hygiene and grooming, bowel and bladder management, dressing, personal device care, eating, functional mobility, sexual activity, and sleep.

Upper extremity dressing is an example of a basic activity of daily living (BADL) that can become challenging. Individuals with hemiparesis may lack the ability to position the collar of an overhead shirt at the crown of the head and thread the affected limb through a sleeve. They may lack the fine motor skills and coordination needed to fasten buttons. Individuals with neglect syndrome or visual-perceptual deficits may have difficulty orienting an overhead shirt or perceiving the borders of a button down shirt. With apraxias, individuals may have breakdowns in ideation or execution, and be unable to sequence the movements required to don a shirt. In the case of Nina presented above, one can observe difficulties with basic ADLs due to her illness, including basic self-care and mobility.

Instrumental Activities of Daily Living

Instrumental activities of daily living (IADL) reflect an individual's usual family and social roles. They include care of others (including selecting and supervising caregivers), care of pets, child rearing, use of communication devices, community mobility, financial management, health management and maintenance, home establishment and management, shopping, meal preparation and

clean up, safety procedures and emergency responses (Koretz & Moore, 2001). These impairments may make it difficult for an individual to live independently or return to work.

As in the case of Nina, motor deficits, cognitive impairments, apraxia, and balance impairments may make a task such as meal preparation difficult. Meal preparation requires functional mobility within the kitchen to gather desired food items. Bilateral hand use is necessary to open packaging and assemble ingredients. Static balance is required to safely stand at a counter or kitchen table. Cognitive impairments may prevent recognition of utensils and identification of their use, or impact safety awareness. All of these individual deficits together result in significant difficulty carrying out IADLs, such as meal preparation.

Impact on Social Functioning and Participation in Society

Individuals with brain involvement from primary tumors, metastatic disease, or as a result of cancer treatments may develop physical impairments and behavioral, intellectual, and emotional difficulties that compromise their ability to live independently and return to work.

The impact of brain tumors on neurological and psychological functioning is multifaceted (Ownsworth, Hawkes, Steginga, Walker, & Shum, 2008). For example, individuals with a brain tumor experience the trauma and uncertain prognosis associated with a cancer diagnosis *and* the direct neurological effects of the tumor and treatment related to the cognitive, and physical symptoms, not to mention the psychosocial adjustment associated with the life change events. In fact, the psychosocial challenges associated with brain tumors and their treatment range from general behavioral problems to depressive symptoms and poor understanding to more severe symptoms such as personality change and even psychosis (Ownsworth et al., 2008). Additionally, cancer and its treatment can alter social roles and limit social activities of patients (Syrjala, Stover, Yi, Artherholt, & Abrams, 2010). As studies of long-term survivors accumulate, it is increasingly apparent that perceived reductions in social function extend many years following treatment completion.

Community and Family

Neurological impairments may be a source of individual, financial, and family distress as they can drastically affect an individual's ability to function in their usual roles. Motor deficits, language and communication deficits, apraxia, visual perceptual impairments, dysphagia, and bowel and bladder impairments can impact community access and interpersonal relationships.

Visual perception and safety awareness are crucial to community access for topographical orientation as well as reading and understanding signs. Depth perception is a fundamental skill that allows an individual to discern the distance a car may be from an intersection, the rate of speed the car is traveling, and whether there is time

to cross the street safely. Depth perception is also required to judge the distance and height of a curb, which is crucial for safe ambulation and fall prevention.

Cognitive impairments including attention, memory, motivation, executive function, and mood, as well as speech and language deficits greatly impact interpersonal relationships. Individuals with these impairments may have difficulty with childcare tasks. They may be unable to coordinate meal preparation or transportation to and from activities, communicate information regarding pertinent events or behaviors, or interact with their children on a meaningful level.

Patients with brain involvement from cancer require support from caregivers for the various symptoms as described above. They most frequently report requiring support to overcome fatigue, uncertainty about the future and not being able to do the things they used to do. Caregivers have voiced a need for assistance in dealing with fears about the patient's mental or physical deterioration, the impact caring has on their own life, and reducing stress in the patient's life (Janda et al., 2008).

Work and Leisure

Only 18 % of all individuals with brain tumors return to work full time after their diagnosis. In addition, many require a full time or part time caregiver. Consequently, the cost to the individual, family and society are a significant concern and range from lost income and need for paid disability to loss of productivity and decreased quality of life.

Reading and writing may be impacted by visual-perceptual deficits and cognitive impairments. Letters are symbols and if there is impaired symbol recognition, understanding these symbols individually and in context will be impaired. Additionally, if the visualization of the symbols is impaired, writing will also be impacted. The ability to read and write is integral to the majority of work and leisure tasks. It follows that financial management may also be impacted. Individuals may have difficulty perceiving numeric symbols, navigating spreadsheets or understanding bills received in the mail.

Rehabilitation

Rehabilitation efforts for individuals with cancer require a comprehensive treatment approach to address their unique and often multidimensional problems. The optimal rehabilitation team includes physiatry, nursing, physical and occupational therapy, speech and language pathology, recreational therapy, nutritionists, social workers, psychologists, orthotists, and prosthetists among others. The patient and their family members are also a vital part of the rehabilitation team. Chaplains, vocational counselors, hospice liaisons, home care agencies, support groups, and educational outreach programs are an extension of the rehabilitation team and may play an important role. Oncologic surgeons, medical oncologists and radiation oncologists are instrumental in maximizing the function and quality of life in cancer patients and survivors. A close working relationship with these practitioners is imperative to the overall success of rehabilitation efforts (Davis, Zimmermann, Feyer, & Ortner, 2011).

The physiatrist serves as the link between the clinical oncology and the multidisciplinary rehabilitation team to coordinate rehabilitation services. Rehabilitation can take place on an acute inpatient rehabilitation unit for individuals with moderate to severe physical disability and ongoing medical needs. Those with relatively mild physical and cognitive impairments will likely be referred to outpatient therapy services, and those with advanced disease may be cared for in a subacute rehabilitation setting, skilled nursing facility, or hospice setting.

Neurological impairments in individuals with cancer are similar to those seen in stroke and traumatic brain injury. Given these similarities, many individuals have the ability to improve their function at home and performing vocational and leisure pursuits, resulting in an improved level of independence and quality of life. Studies have shown that treatment approaches originally developed for patients with traumatic brain injuries are effective in patients with primary brain tumors; these effects are maintained for an average of 8 months post rehabilitation intervention (Giordana & Clara, 2006).

Despite the similarities, there are significant differences between these populations. Chief among these are the potential for progressive functional decline, constantly changing disease states and prognosis and psychological adjustment to diagnosis and prognosis (Kirshblum et al., 2001). These differences must be acknowledged when formulating realistic rehabilitation goals for this population.

In 1947, Dr. Herbert Dietz introduced several cancer specific rehabilitation approaches that are still in use today (DeLisa, 2001; Dietz, 1981). His approaches included preventive rehabilitation, restorative rehabilitation, supportive rehabilitation, and palliative rehabilitation described below.

1. Preventive rehabilitation is the approach indicated when the disability can be predicted and focuses on reducing the severity and duration of its effect (Davis et al., 2011; Dietz, 1981).

   Nina's physiatrist and orthotist utilized this approach to prevent left hand and ankle contractures related to her spasticity. She was provided with a left resting hand splint to maintain a "c" shaped position of the hand with her wrist in extension, and a left ankle nocturnal stretching splint to maintain a neutral ankle position.

2. Restorative rehabilitation attempts to restore premorbid function in a patient when a permanent impairment is not expected (Davis et al., 2011; Dietz, 1981).

   Nina's physical and occupational therapists utilized this approach in her treatment plan. Her occupational therapist focused on left upper extremity range of motion and weight-bearing to promote integration of the left upper extremity as a stabilizer during functional tasks such as brushing her teeth. Her physical therapist incorporated left lower extremity range of motion and strengthening exercises into her sessions for functional use in transfers, standing, and ambulation.

3. Supportive rehabilitation focuses on maximizing function when a permanent impairment exists (Davis et al., 2011; Dietz, 1981).

Nina's physiatrist, physical therapist, occupational therapist, and orthotist utilized this approach in her care. She was evaluated for a left ankle foot orthosis to increase ease of transfers, standing and ambulation. She was also provided with adaptive equipment including a universal cuff to promote functional use of the left upper extremity, a rolling walker to increase the ease and safety of ambulation, and a wheelchair to promote community mobility.

4. Palliative rehabilitation provides comfort and support, and reduces complications that may develop when increasing disability is expected from disease progression (Davis et al., 2011; Dietz, 1981).

Nina's entire rehabilitation team will incorporate this approach into her care plan should her neurologic and oncologic status change. Rehabilitation goals will be modified to place more focus on family training to ensure her self care needs can be met, her equipment and bracing needs will be reassessed, and information on home modifications will be provided if necessary.

Rehabilitation for individuals with neurologic impairments from primary brain tumors, metastatic disease, or as a result of cancer treatment has received greater attention in recent years. Studies have shown that these individuals are capable of making significant functional gains thus improving their independence and quality of life.

Quality of Life

Quality of life is a multifaceted concept that reflects the social, physical, and psychological aspects of an individual's life and the influence of disease and treatment related symptoms (Armstrong & Gilbert, 2007; Gilbert et al., 2000). Neurological involvement can result in physical, cognitive and emotional difficulties, which can reduce an individual's quality of life by compromising the patient's premorbid professional and social functions. Assessment of quality of life in individuals with neurologic involvement from cancer or its treatment is an increasing area of interest as cancer treatment options continue to improve and survival times continue to increase.

Rehabilitation interventions are aimed at promoting functional independence and improving quality of life. As treatments for this population continue to improve and survival rates increase, rehabilitation will play an increasingly crucial role in overall management.

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Real-World Impact of HIV-Associated Neurocognitive Impairment

10

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An estimated 1.1 million individuals in the USA live with HIV infection (CDC, 2010), with over 34 million individuals infected worldwide (UNAIDS, 2012). In the early days of the HIV epidemic, infection was typically associated with a rapidly deteriorating immunovirologic course and high rates of mortality. Advances in the clinical management of HIV disease over the past two decades, however, have significantly reduced morbidity and mortality rates associated with infection. In particular, the wide-spread use of combination antiretroviral therapy (cART) beginning in 1996 has lead to more effective viral suppression and improved immune functioning, fewer opportunistic infections, and better health-related quality of life

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(HRQoL; CDC, 2010). Nevertheless, the cART era has introduced new clinical and scientific challenges to maximizing health and other real-world outcomes in persons living with HIV, which is now perceived as a chronic, manageable illness. Younger and middle-aged HIV-infected individuals are faced with the challenges of developing and maintaining independence in everyday functioning (e.g., employment) while managing a chronic disease. Improved survival rates have also increased the prevalence of older adults infected with HIV (CDC, 2010), who may be more likely to experience chronic immune activation, longer exposure to cART, and an increased burden of non-HIV associated medical conditions (e.g., cardiovascular diseases; High et al., 2012), all of which may adversely impact real-world outcomes. Although real-world functioning is complex and multidetermined, one factor that may play an important role in a variety of different everyday activities is neurocognitive impairment, which remains highly prevalent among persons living with HIV in the cART era (Heaton et al., 2010). This chapter reviews the literature regarding the effects of HIV-associated neurocognitive impairment on real-world functions, including activities of daily living, medication adherence, employment, automobile driving, HIV transmission risk behaviors, and HRQoL.

HIV and the Central Nervous System

HIV crosses the blood–brain barrier early in the course of infection via a "Trojan Horse" mechanism (i.e., inside infected monocytes or cluster of differentiation 4 [CD4+] lymphocytes), and causes injury to both immunological and neurological systems (Gonzalez-Scarano & Martin-Garcia, 2005). Although HIV does not typically infect neurons, it exerts adverse effects on the central nervous system (CNS) through both direct viral mechanisms (e.g., multinucleated giant cells, a hallmark of HIV encephalitis) and secondary processes (e.g., cytokines, chemokines) that are associated with synaptodendritic neural injury (Hult, Chana, Masliah, & Everall, 2008; Kaul, Garden, & Lipton, 2001). Approximately 50 % of HIV-infected persons evidence neuropathology, which in the cART era is diverse and can include HIV encephalitis, gliosis, and vasculopathy (Everall et al., 2009). HIV-associated structural and metabolic abnormalities are observed throughout the brain, though they are primarily found in the striatum, frontal cortex, medial temporal lobe, and broadly throughout the cerebral white matter (Ellis, Calero, & Stockin, 2009).

HIV-associated neurocognitive disorders (HAND) are observed in up to 50 % of HIV-infected adults (Heaton et al., 2010) and are thought to primarily arise from neural injury to frontostriatal networks (Archibald et al., 2004; Castelo, Sherman, Courtney, Melrose, & Stern, 2006). Although the prevalence of HIV-associated dementia (and CNS opportunistic infections) has dropped dramatically with cART (Grant et al., 2005), the prevalence of milder forms of HAND is largely unchanged and may have even increased among persons with less severe HIV disease (Heaton et al., 2011). HAND is observable even in the asymptomatic phase of infection (Heaton et al., 2011) and is most likely to

emerge in persons with histories of severe immunosuppression (Ellis et al., 2011). Other notable risk factors for HAND in the cART era include older age (e.g., Valcour, Shikuma, Watters, & Sacktor, 2004), alcohol (e.g., Sassoon, Rosenbloom, Fama, Sullivan, & Pfefferbaum, 2012) and substance (e.g., methamphetamine; Rabkin, McElhiney, Ferrando, van Gorp, & Lin, 2004) use, and a host of non-HIV-associated medical comorbidities, such as vascular disease (e.g., Becker et al., 2009), metabolic syndrome (e.g., McCutchan et al., 2012), and coinfection with hepatitis C (e.g., Hinkin, Castellon, Levine, Barclay, & Singer, 2008). The profile of HAND is characterized primarily by mild-to-moderate impairment in the domains of executive functions (e.g., cognitive flexibility, novel problem solving, and inhibition), episodic learning and memory, attention/working memory, and psychomotor speed and coordination (Heaton et al., 2010). HIV is also a risk factor for neurobehavioral symptoms of frontal systems dysfunction, including impulsivity (Marquine et al., 2014) and apathy (e.g., Kamat, Woods, Marcotte, Ellis, & Grant, 2012).

HIV-associated neurocognitive impairment and related declines in real-world functioning are fundamental elements of the diagnosis of HAND. As outlined by the Frascati criteria (Antinori et al., 2007), there are three primary subtypes of HAND. A diagnosis of *HIV-associated Asymptomatic Neurocognitive Impairment (ANI)* requires at least mild global neuropsychological impairment (i.e., performance > 1 SD below a normative mean in at least two cognitive domains) that is related to HIV infection, but does not ostensively affect real-world functioning. Although there is some controversy regarding the prevalence and syndromic nature of Asymptomatic Neurocognitive Impairment (Blackstone et al., 2012), the diagnosis is thought to comprise approximately 50 % of the cases of HAND (Grant et al., 2005). Diagnoses of *HIV-associated Mild Neurocognitive Disorder a*nd *HIV-Associated Dementia,* on the other hand, require the presence of notable functional declines in multiple domains that may be attributable to global cognitive impairment. The severity of both the neurocognitive and functional problems required for a diagnosis of Mild Neurocognitive Disorder are less than those of Dementia, which is present in only 2–5 % of persons infected with HIV.

A Model of Real-World Outcomes in HIV

Twenty years of clinical research demonstrates that HIV-associated neurocognitive impairment increases risk of adverse real-world outcomes independent of important cofactors, such as depression (Gorman, Foley, Ettenhofer, Hinkin, & van Gorp, 2009). From a historical prospective, the first empirical study to report a case of HIV-associated dementia, which by definition involves severe functional problems related to cognitive abilities, was Navia and colleagues in 1986. In 1989, McArthur et al. reported the first data directly linking neurocognitive complaints and vocational functioning among HIV+ individuals, which revealed no significant relationship. On the other hand, Heaton and colleagues (1994) published the first study

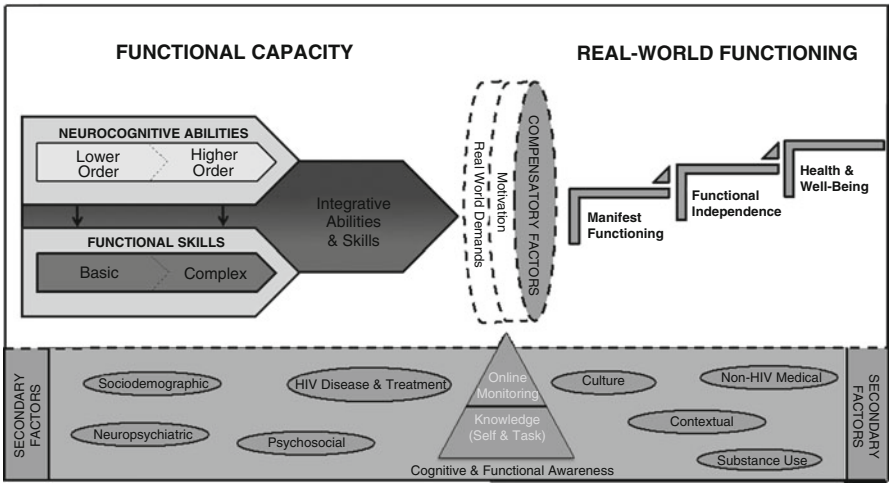

Fig. 10.1 Conceptual model depicting the role of HIV-associated neurocognitive deficits in real-world outcomes, which is influenced by the match between the specific profile of deficits and the particular demands of the real-world function, motivation, awareness of cognitive and functional deficits, biopsychosocial cofactors, and the availability, effectiveness, and use of compensatory strategies

showing that HIV associated neurocognitive impairment was a risk factor for unemployment and poorer vocational functioning. Since these studies, neurocognitive declines in HIV infection have been associated with an array of poorer functional outcomes, including problems with basic and instrumental activities of daily living (BADLs and IADLs; Heaton et al., 2010), poor cART adherence (Hinkin et al., 2004), risky automobile driving (Marcotte et al., 2004), vocational difficulties (Heaton et al., 2004), lower health-related quality of life (e.g., Tozzi et al., 2003), and HIV transmission risk behaviors (e.g., Martin et al., 2007). Figure 10.1 represents our efforts in integrating multidisciplinary approaches to everyday functioning from neuropsychology (e.g., Marcotte & Grant, 2010; Morgan & Heaton 2009), occupational therapy (Baum & Katz, 2010), and HRQoL (Wilson & Cleary, 1995) to better understand how real-world outcomes may be associated with neurocognitive functioning in a chronically ill population such as persons living with HIV. The model is based on the premise that the association between functional and neuropsychological deficits and real-world outcomes depends on multiple factors, including the match between the specific profile of deficits and the particular demands of the real-world function, motivation, awareness of cognitive and functional deficits, the availability, effectiveness, and use of compensatory strategies, and the presence and influence of a host of biological, psychological, and social cofactors. The model is also highly dynamic (i.e., changes in one area may impact other areas of functioning) and reciprocal, such that real-world declines may also feedback to adversely influence neurocognitive functions, which in turn may exacerbate disability

(Ettenhofer, Foley, Castellon, & Hinkin, 2010). A case example illustrating the elements of this model is provided at the end of the chapter.

Real-World Functioning

A primary distinction is made between related but separable aspects of health outcomes: "functional capacity" and "real-world functioning" (Brunswik, 1949; Christiansen & Baum, 1991; Goldstein, 1996). In this model, real-world functioning refers to what the person can actually do, which is one's "manifest" status. Manifest real-world functioning is typically measured by self-report and/or objective behavioral indicators of what one *actually does* in everyday life (e.g., medication adherence). At the first level is *Manifest Functioning*, describing an individual's success in accomplishing various real-world activities in daily life; for example, adhering to a complex medication regimen or maintaining gainful employment. Failures at this first step of the model can compromise *Functional Independence*, which refers to one's level of autonomy in their activities of daily living, with varying levels of "dependence" ranging from requiring occasional assistance from others to frank disability and assisted living placement. The *Health and Well-being* endpoint of the model is one's perceived health (e.g., perceptions of experienced symptoms and functional status) and HRQoL, which includes mental, physical, and social aspects (Wilson & Cleary, 1995).

Functional Capacity

Functional Capacity represents the cognitive abilities and functional skills that are typically measured in laboratory settings that assess what an individual *can do*, or is capable of completing in everyday life. Traditional clinical neuropsychological tests of list learning and trail-making are examples of relevant cognitive abilities, whereas tests of medication management and bill paying are examples of functional skills. Cognitive abilities may be further separated into lower-order (e.g., simple attention) and higher-order (e.g., information processing speed, working memory, episodic memory) functions. Similarly, functional skills may be classified as basic (e.g., opening a pill bottle) and complex (e.g., planning a dosing schedule). Cognitive abilities are thought to influence functional skills, which are generally learned competencies; for example, medication management skills may be largely dependent on learning and executive functions (e.g., Patton et al., 2012). The two constructs (i.e., cognitive abilities and functional skills) are nonetheless independently predictive of real-world functioning in HIV. For instance, Heaton et al. (2004) found that summary scores from a large standard clinical neuropsychological battery and a novel battery of functional tasks (e.g., bill paying and checkbook balancing as measured by performance in the laboratory) were concurrent, unique predictors of declines in instrumental activities of daily living in a large HIV-infected cohort.

Integrative Abilities and Skills

An emerging body of literature in HIV (and other clinical conditions) now shows that "integrative" cognitive and functional constructs are unique predictors of real-world outcomes (e.g., Woods et al., 2009). Here we define *Integrative Abilities and Skills* as complex functions that bridge higher-level cognitive abilities (e.g., memory) and functional skills (e.g., medication management) with real-world outcomes (e.g., medication adherence). An example is prospective memory, which describes one's ability to successfully execute a delayed intention and is a strong predictor of real-world outcomes in HIV independent of traditionally measured neurocognitive abilities, such as retrospective memory (e.g., Woods et al., 2008). Although prospective memory comprises familiar neuropsychological ability areas, most notably retrospective memory and executive functions, it nevertheless represents a unique constellation of these abilities in service of a specific cognitive goal (i.e., "remembering to remember") and is dissociable from them in terms of its cognitive architecture (Gupta, Woods, Weber, Dawson, Grant, & The HIV Neurobehavioral Research Center (HNRC) Group, 2010) and neurobiological underpinnings (Woods et al., 2006). In other words, these integrative, translational constructs "work with" established cognitive and functional skills in an applied setting (see also Moscovitch, 1992), and thus may be considered macro-level functions for which the whole is greater than the sum of their parts. Other examples of integrative constructs potentially relevant to real-world outcomes in HIV include multitasking, decision-making, health literacy, and social cognition**.** Thus, these ability areas are essential to understanding the link between laboratory abilities and real-world outcomes because they capture one's ability to use cognitive and functional skills in the context of day-to-day life.

Cofactors Affecting Functional Capacity and Real-World Functioning

Of course, the path from cognitive and functional capacity to real-world functioning outcomes is replete with a complex series of twists and turns. Indeed, the two constructs are separable, such that deficits in functional capacity alone, although a formidable risk factor, are neither necessary nor sufficient for poor real-world outcomes. It is also important to consider the match between *demands* of a real-world activity (e.g., its overall complexity and cognitive and functional requirements) and an individual's *profile* of neuropsychological strengths and weaknesses. Another critical cofactor is the use of compensatory strategies, which can dampen the influence of neurocognitive and functional deficits on real-world functioning by capitalizing on relatively intact processes (e.g., basic attention), for example by using internal (e.g., chunking) and/or external (e.g., cueing reminders) strategies to enhance overall performance (Twamley, Jeste, & Bellack, 2003). For example, an individual with mild prospective memory deficits may be able to properly adhere to their medication regimen with timely reminders from a significant other.

Effective deployment of compensatory strategies, however, may depend in part on one's motivation and the accuracy of one's perception and assessment of his/her cognitive, functional, and real-world abilities and performance (i.e., self-awareness). With regard to motivation, it can be viewed in terms of apathy/self-initiation, as well as both internal and external representations regarding the importance of the real-world task. As concerns the latter, we separate *Cognitive and Functional Awareness* into: (1) knowledge, which refers to a general understanding of one's own cognitive and functional abilities/disabilities, as well as knowledge of their performance (and experience with) the real-world outcome; and (2) online awareness, which represents the ability to monitor and apply one's knowledge about his/her abilities/disabilities appropriately during task performance (Toglia & Kirk, 2000). Finally, there is a variety of secondary factors that can influence both real-world functioning outcomes independent and/or in concert with functional capacity. Most notable among these secondary factors in the HIV literature are: (1) sociodemographics (e.g., age, education, socioeconomics); (2) HIV disease severity (e.g., a history of severe immune compromise) and treatment (e.g., type and complexity of cART regimen); (3) neuropsychiatric (e.g., mood, apathy); (4) substance use (e.g., alcohol, methamphetamine); (5) non-HIV medical (e.g., hepatitis C coinfection, cardiovascular disease, frailty); (6) psychosocial (e.g., coping, self-efficacy, social support); (7) cultural; and (8) contextual (e.g., health care infrastructure) factors.

A Case Example

To illustrate some of the points in this conceptual model, consider the case of a 62-year-old HIV-infected man with 14 years of education, who is referred for neuropsychological evaluation based on his complaints of everyday memory problems. This gentleman has been living with HIV infection for 25 years, and although he has received a diagnosis of AIDS based on a history of severe immune suppression and opportunistic infections, his HIV disease has been well-controlled since beginning cART in the late 1990s. He is currently prescribed cART, his viral load is undetectable in blood, and his current immune health is good. Aside from HIV disease, he has type II diabetes mellitus and hypertension, which are also well-controlled with daily medications. There was no indication of significant current mood or substance use comorbidity, but he does have a lifetime history of alcohol and cocaine dependence. Within the last 3 years, he has noticed increasing forgetfulness in important daily tasks, such as leaving the stove burner on, forgetting laundry in the washer for days, and inability to maintain his social role functioning (e.g., running errands for ill relatives). As such, he reported he now only orders take-out meals, sends his laundry out for cleaning, and has become socially isolated. He has worked as a secretary for an accounting firm for 30 years and is able to carry out his work responsibilities adequately. Additionally, he has been adherent to his medications, which he attributes to his use of a pillbox and a reminder alarm on his cell phone. On assessment, he evidenced mild executive dysfunction (i.e., cognitive inflexibility) and low average performances on both verbal and visual memory, but was generally above average with respect to working memory, information processing speed, language, and motor skills. Functionally, he performed within normal limits on medication management and a vocational-based assessment, but demonstrated impairment on a laboratory test of everyday multitasking.

With respect to the guiding conceptual model (Fig. 10.1), this older HIV-infected gentleman is in tact with regard to his basic neurocognitive (e.g., attention) and functional (e.g., grooming, bathing) abilities. However, he shows deficits in higher-order neurocognitive abilities, namely executive dysfunction, as well as multitasking, which is a critical integrative ability. These deficits are adversely affecting his actual (i.e., "manifest") everyday functioning in the area of household management and social role functioning. Given the remote nature of his substance use history and the absence of severe neuropsychiatric and medical comorbidities, we can more confidently attribute his IADL problems to his neurocognitive deficits. Given his awareness of his cognitive difficulties and success using compensatory strategies to manage his medications, it would be recommended that he extend his deployment of external strategies (e.g., calendars, alarms) to circumvent his executive deficits in order to improve his IADL functioning (e.g., home cooked meals, increased social interaction), and ultimately, increase his quality of life.

Real-World Outcomes in HIV Disease

With this guiding conceptual model in mind, below we review the literature regarding the role of neurocognitive impairment in selected real-world outcomes (i.e., ADLs, cART adherence, automobile driving, employment, risk, and HRQoL) in persons living with HIV during the cART era. We focus our review on the real-world outcomes for which there was a reasonable body of literature at the time of writing, although it should be noted that HIV-associated neurocognitive impairment is also associated with other important outcomes not reviewed here, including mortality (Sevigny et al. 2007a, 2007b), cognitive complaints (e.g., van Gorp, Baerwald, Ferrando, McElhiney, & Rabkin, 1999) and psychosocial functioning (e.g., Mustanski et al., 2007). Figure 10.2 provides a graphical display of the strength of the associations between key neurocognitive domains and all of the individual real-world outcomes examined in this review.

Activities of Daily Living (ADLs)

In the cART era, HIV-associated functional declines are most commonly observed on complex or "instrumental" activities of daily living (i.e., one-third of HIV+ persons demonstrate, such as cooking or financial management). One fifth of HIV+ persons show declines on Basic ADLs, such as grooming or dressing (Crysta, Fleishman, Hays, Shapiro, & Bozzette, 2000). Across the literature, ADL declines are associated with advanced HIV disease severity, lower socioeconomic status, older age, mood and substance use disorders, and larger non-HIV-associated comorbidity burden (e.g., Malaspina et al., 2011; Morgan, Iudicello et al., 2012). However, there appears to be a dissociation in which Instrumental-ADLs are more commonly related to deficits in higher-order neurocognition (e.g., executive dysfunction), whereas Basic ADLs are more commonly linked to physical

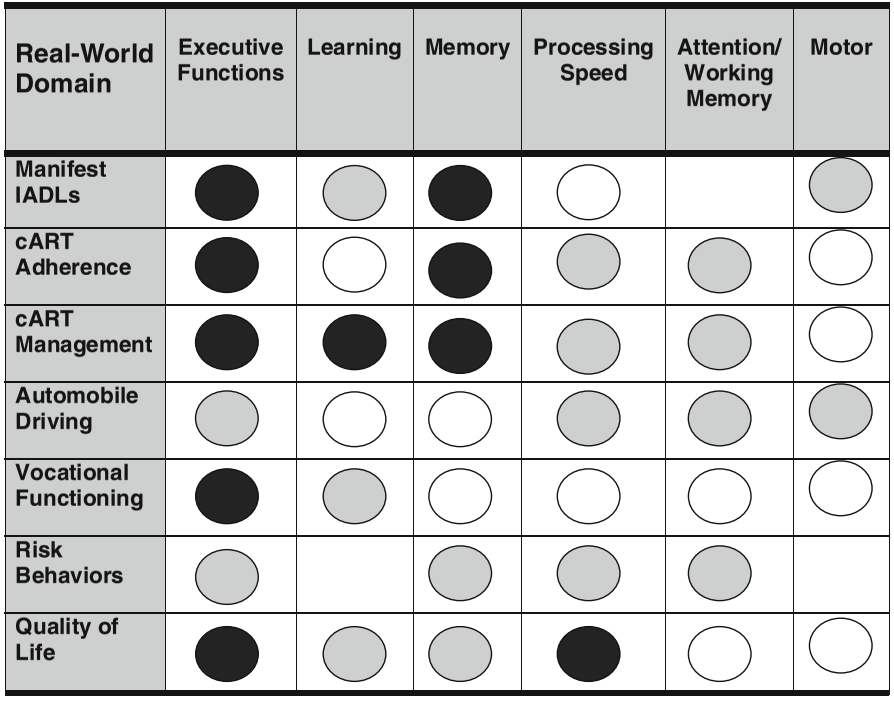

Fig. 10.2 A visual representation of the relative strength of the associations between specific neurocognitive ability areas and real-world functioning outcomes in persons living with HIV during the cART era. Darker shading indicates stronger, more reliable associations evident across the literature, while empty cells indicate that too few studies have evaluated the relationship to base a judgment. *cART* combination antiretroviral therapies. *IADL* instrumental activities of daily living

HIV-associated symptoms in individuals with more advanced disease (Blackstone, Iudicello et al., 2013; Crystal, Fleishman, Hays, Shapiro, & Bozzette, 2000). Given that Basic ADL decline does not appear to be a primary outcome of HIV-associated neurocognitive disorders, this review focuses on HIV-related IADL functioning, which is typically measured via performance-based everyday functioning tasks (i.e., "capacity") or self-report of actual (i.e., "manifest") functioning.

IADL Capacity

Given the complex and oftentimes fluid cognitive demands implicit in many instrumental everyday tasks (e.g., household and fiscal management), it is not surprising that HIV-associated global neurocognitive impairment is consistently and strongly related to deficits in performance-based IADL tasks, i.e., "IADL capacity" (Gandhi et al., 2011; Heaton et al., 2004; Thames et al., 2011, 2012). At the domain level, executive functions (including tests of abstract thinking, set-shifting, and inhibition) and working memory were two of the most consistent cognitive domains linked to IADL-based skills in the laboratory among persons living with HIV (e.g., Heaton et al., 2004; Thames et al., 2011). Learning and verbal fluency have also been associated with performance failures on a comprehensive functional battery that included measures of telephone communication and financial management (Heaton et al., 2004). Taken together, these studies demonstrate the important roles that HIV-associated neurocognitive impairment, and especially higher order cognitive deficits, play in IADL capacity as measured in the laboratory.

In the "real world," instrumental everyday functioning tasks rarely occur in isolation, and instead draw upon simultaneous task performance skills, or multitasking abilities. Multitasking represents the ability to complete a subgoal while maintaining a main goal in mind and draws upon interrelated neural (i.e., frontostriatal) and cognitive systems (i.e., executive functions such as planning as well as retrospective and prospective memory; Burgess, Veitch, de Lacy Costello, & Shallice, 2000) that are particularly vulnerable to dysfunction following HIV infection. In the context of our proposed model (Fig. 10.1), multitasking may represent an "integrative" ability that combines critical aspects of both cognitive and functional capacities. Recently, Scott et al. (2011) developed a novel performance-based IADL skills assessment to objectively measure such everyday multitasking abilities in HIV infection. In this largely unstructured test, individuals must attempt four everyday tasks (i.e., medication management, telephone communication, cooking, and financial management), and, in order to obtain the most optimal score, some of the tasks must be completed simultaneously. HIV+ individuals performed more poorly than HIV− comparison subjects across several aspects of the multitasking test, including fewer overall points scored, fewer simultaneous tasks attempted, and increased omission errors. Importantly, multitasking performance was associated with impairments in executive functions (i.e., abstract thinking, set-shifting, and inhibition), episodic memory, working memory, and psychomotor speed (Scott et al., 2011). Further exploration of the mechanisms driving such complex, "real-world" abilities (e.g., multitasking)

may be especially valuable in elucidating the cognitive skills necessary for successful everyday functioning abilities in HIV.

Manifest IADLs

"Manifest" IADL functioning indicates those tasks on which the patient identifies him or herself as actually completing in daily life. These are in contrast to IADL "capacities," which denote those abilities that an individual is capable of carrying out in the laboratory (i.e., has the capacity to complete in a structured environment). Although IADL "capacity" is necessary, it is not sufficient for successful "manifest" IADL functioning. That is, an individual may have the basic cognitive capabilities to complete a given task (e.g., financial management), but when placed in context of complex real-world demands (e.g., balancing a payment while talking on the phone), s/he may not successfully execute the task in real time. Of interest here are these significant "manifest" IADL declines that are commonly reported following HIV infection (Blackstone et al., 2012). Convergent with the IADL capacity literature, global neurocognitive impairment is reliably associated with difficulties in manifest IADLs (Benedict, Mezhir, Walsh, & Hewitt, 2000; Gandhi et al., 2011; Heaton et al., 2004; Morgan, Iudicello et al., 2012). Among the many neurocognitive domains examined in this literature, executive dysfunction is the most robust predictor of manifest IADL declines. The most consistent executive subdomains implicated in IADL declines included deficits in cognitive flexibility, problem-solving, abstraction, planning, and verbal fluency (Benedict et al., 2000; Cattie, Doyle, Weber, Grant, & Woods, 2012; Iudicello, Woods, Cattie, Doyle, & Grant, 2012, 2013; Woods et al., 2006; Woods, Morgan, Dawson, Cobb Scott, & Grant, 2006). Following executive dysfunction, deficits in delayed episodic memory were the next most consistent cognitive factor associated with HIV-associated deficits in reported IADLs. Both complex and structured visual and verbal delayed memory significantly predicted manifest IADL functioning across several studies (Benedict et al., 2000; Woods et al., 2006, 2008). Yet it remains unclear whether deficits at a specific stage of memory processing (i.e., encoding, consolidation, and retrieval) may be differentially impacting this relationship; however, in a recent study, Fazeli et al. (2014) found that shallow encoding and forgetting were associated with IADL declines in older, but not younger HIV-infected adults. Future studies are warranted in order to continue to better delineate these memory-based component relationships with an eye toward potential intervention points (Woods et al., 2005). Fine-motor skills showed mixed results in predicting manifest IADLs in HIV, with one study reporting a positive relationship (Woods et al., 2006), but another reporting a no significant relationship (Benedict et al., 2000). Similarly, no significant findings were reported in one study examining speed of information processing (Benedict et al., 2000). Surprisingly, no studies to date have prospectively examined the mechanisms of attention and working memory on manifest IADL declines, which represents an important future direction given that these are domains that are affected by HIV infection (e.g., Bartok et al., 1997) and, as mentioned earlier, are associated with IADL capacity skills.

Medication Management and Adherence

As noted earlier, cART has dramatically changed the landscape of HIV infection (e.g., (Gifford & Groessl, 2002). However, in order to effectively manage the immunovirological aspects of HIV, relatively strict adherence to sometimes complex, cumbersome, and habitual cART regimens is required (e.g., Bangsberg et al., 2006). Current rates of cART adherence vary widely, and nonadherence remains a problem in up to 50 % of the population (e.g., Hinkin et al., 2002). A recent study examining adherence behaviors among HIV+ individuals identified several groups of "adherence behavior patterns," which ranged from a subset of individuals (10 % of cohort) who had very poor adherence across the entire study period (i.e., mean adherence 24 %) to individuals who demonstrated good adherence only on weekdays but not weekends (12 % of cohort), and those who showed consistently good adherence (Levine et al., 2005). Suboptimal adherence (i.e., below 90–95 %) is associated with viral rebound, evolution of drug-resistant strains of the virus, more rapid progression to AIDS, and death (Arnsten et al., 2001; Bartlett, 2002; Bangsberg et al., 2000, 2001); thus, there is a continued need to characterize and identify those factors that may be contributing to differential patterns of suboptimal adherence. In fact, a number of variables have been shown to adversely influence adherence to cART regimens including active substance use (e.g., methamphetamine; Hinkin et al., 2004), comorbid psychiatric conditions (e.g., bipolar disorder; Moore et al., 2012), increased regimen complexity (e.g., Hinkin et al., 2002), poorer health literacy (e.g., Waldrop-Valverde, Jones, Gould, Kumar, & Ownby, 2010), younger age (e.g., Barclay et al., 2007), and lower socioeconomic status (e.g., Falagas, Zarkadoulia, Pliatsika, & Panos, 2008).

Drawing upon the Wilson and Park (2008) model, successful cART adherence may be modulated by medication-induced side effects (e.g., nausea), beliefs regarding cART efficacy (e.g., "I don't feel sick so why should I take cART?"), environmental complexities (e.g., HIV-related disabilities and cofactors may lead to a less structured daily schedule), and neurocognitive impairment. As articulated in the Wilson and Park (2008) model, the cognitive aspects of cART management and adherence include comprehending instructions associated with each medication or task (i.e., attention and working memory), integrating information across different items into a plan for each day (i.e., working memory, executive functions), remembering the plan (i.e., retrospective memory), and remembering to execute the plan (i.e., prospective memory). Taken together, there are a number of cognitive mechanisms that may subserve successful cART management and adherence, the supporting literature for which is reviewed below for medication management capacity and manifest medication adherence.

Medication Management Capacity

Medication management refers to an individual's real-time abilities to manipulate, understand, calculate, and dispense their medication regimen. Management skills may

be dissociated from adherence behaviors in that successful management is a necessary but not sufficient component for actual adherence; for instance, one may have the capacity to correctly calculate and dose a medication regimen, but still not take the medication as prescribed. In the context of HIV infection, although complexity of antiretroviral regimens has been reduced with single medication combination formulas (e.g., triple-drug combinations formulated into one pill), persistent difficulties in medication management are still observed. For instance, in a recent study, Patton and Colleagues (2012) reported that 19 % of their HIV+ sample was impaired on a performance-based task of medication management abilities. Of note, medication management errors were associated with poor cART adherence only among HIV+ individuals with current immunosuppression (i.e., CD4 count <200) in this study (Patton et al., 2012). In terms of neurocognition, global neuropsychological impairment is consistently related to poorer performance-based management skills among HIV+ individuals (Gandhi et al., 2011; Heaton et al., 2004; Patton et al., 2012; Thames et al., 2011, 2012). Specifically, medication management skills in HIV are most consistently associated with an array of executive functions, including inhibition (Patton et al., 2012; Thames et al., 2011, 2012), planning (Waldrop-Verde et al., 2010), abstract thinking (Patton et al., 2012; Thames et al., 2011, 2012), and set-shifting (Patton et al., 2012; Thames et al., 2011, 2012; Waldrop-Valverde et al., 2010). Additionally, both verbal and visual learning and memory are strongly associated with medication management abilities, including complex list learning as well as more structured learning tasks (e.g., story and figure memory; Albert et al., 1999; Patton et al., 2012; Thames et al., 2011, 2012). Though less consistently, sustained attention, working memory, verbal fluency, and speed of information processing have also all been at least modestly related to medication management skills (Patton et al., 2012; Thames et al., 2011). Considering the strength of the executive functions domain reviewed above, one possibility is that it is the executive aspects (e.g., verbal fluency requires executively laden generation and switching abilities) of these other cognitive abilities may be driving their associations with medication management. Although one may conceptualize pill-dispensing as requiring some physical coordination (e.g., opening pill bottles, allocating pills to a pillbox compartment), fine-motor skills demonstrated the weakest association with medication management performance. In the one study that did find an association (Albert et al., 1999), performance on grooved pegboard was only associated with the pill dispensing component (not medication calculations) of the medication management task, suggesting that the match between the motor abilities and functional skills assessed may show some specificity.

Manifest Medication Adherence

Medication adherence encompasses the actual skill of applying medication management capacities in order to take medications as prescribed in real-world settings. Consistent with the literature on medication management in HIV, cART adherence is reliably and uniquely associated with neurocognitive abilities (Barclay et al., 2007; Ettenhofer et al., 2009, 2010; Hinkin et al., 2002, 2004; Wagner, 2002). In fact, HIV+ individuals with global neurocognitive impairment appear to be at a 2.5-fold increased risk for cART nonadherence compared to HIV+ individuals without

impairment (Hinkin et al., 2004). Given that cART adherence findings differ slightly depending on how adherence was assessed (i.e., self-reported versus objectively monitored adherence; Liu et al., 2001; Wagner & Miller, 2004), we chose to highlight the literature examining the role of neurocognition on only objectively measured adherence (i.e., the current "gold standard" behavioral measures of adherence, including medication event monitoring systems; see also Lovejoy & Suhr, 2009).

With regard to specific cognitive domains, deficits in executive functions such as accurately completing complex, speeded set-shifting tasks, demonstrated the strongest relationship with adherence among HIV+ individuals (Barclay et al., 2007; Ettenhofer et al., 2009, 2010; Hinkin et al., 2002, 2004; Solomon & Halkitis, 2008; Wagner, 2002). Additionally, better problem-solving and abstract thinking, as well as set-shifting and verbal fluency skills appear to be related to greater medication adherence, although how each of these domains may contribute to aspects of adherence are still unknown (Barclay et al., 2007; Ettenhofer et al., 2009; Hinkin et al., 2002, 2004; Woods et al., 2009). In contrast to medication management skills, which demonstrated consistent relationships with both learning and memory, only complex delayed verbal memory, but not learning, showed a consistent relationship with successful ART medication adherence (Barclay et al., 2007; Hinkin et al., 2002, 2004; Wagner, 2002; Woods et al., 2009). This differential pattern of learning versus memory in the prediction of medication management and adherence may reflect the implicit learning skills that are needed when managing a new ART regimen that may be less relevant when remembering to accurately take medications in daily life. Of note, one study examined the nature of such memory-based impairments on cART adherence and found that although HIV+ individuals with both good (i.e., $\geq$90 %) and poor (i.e., <90 %) adherence demonstrated comparably worse verbal encoding abilities compared to HIV− participants, those seropositive individuals with poor adherence displayed significantly worse retrieval abilities than the HIV+ individuals with good adherence. Therefore, this study suggests that it may in fact be HIV-associated retrieval deficits that are driving nonadherence behaviors, rather than encoding or consolidation abilities (Wright et al., 2011). In addition, complex working memory and speeded information processing (Ettenhofer et al., 2009, 2010; Hinkin et al., 2002, 2004; Solomon & Halkitis, 2008; Woods et al., 2009) were also related to better cART adherence, albeit less consistently or strongly across the literature relative to executive functions and delayed memory. Lastly, fine motor skills and learning abilities demonstrated the most inconsistent and generally weakest findings when examined across studies of ART adherence. For example, Ettenhofer and colleagues (2009, 2010) published the only studies that found a relationship between ART adherence and grooved pegboard performance, but not verbal learning, whereas Woods et al. (2009) illustrated a relationship between adherence and learning, but not motor skills.

One novel area of cognitive functioning that may be particularly germane to health care management skills and ART adherence in HIV+ is prospective memory (i.e., "remembering to remember"). Given that one of the necessary cognitive components of successful adherence is remembering to take one's medication at a

designated time, the role for prospective memory in adherence is particularly face-valid and ecologically relevant. For instance, prospective memory is associated with self-reported cART management skills independent of other important factors known to predict medication management (e.g., mood, psychosocial variables, deficits on traditional neurocognitive batteries), and is associated with implementation of ART adherence strategies (Woods et al., 2008). Importantly, global prospective memory abilities demonstrate medium effect sizes with cART adherence (i.e., Contardo, Black, Beauvais, Dieckhaus, & Rosen, 2009; Woods et al., 2009), and appear to be particularly driven by deficits in time-based prospective memory (i.e., remembering to complete a future intention at a particular time), which have been shown to confer a sixfold increase in the risk of cART nonadherence (Woods et al., 2009), particularly in the context of longer delays between the encoding and execution of the intention (Poquette et al., 2013). Counterintuitively, increased frequency of memory-based adherence strategy use is associated with worse event-based prospective memory and poorer actual cART adherence (Blackstone, Woods et al., 2013); taken in the context of what is known regarding prospective memory abilities and adherence in HIV, this finding may indicate that HIV-associated prospective memory deficits impact adherence strategy implementation resulting in poorer actual adherence. Given that prospective memory is conceptualized to encompass aspects of both executive functions (e.g., planning, working memory) and retrospective memory (e.g., remembering previous intention) and that both medication management and adherence are strongly related to executive and memory functions in HIV+ individuals, prospective memory may provide a highly specific and sensitive target for remediation in the context of ART adherence interventions.

Automobile Driving

The ability to drive an automobile is a complex, multifaceted everyday task that is often a primary factor in maintaining functional independence across the lifespan (e.g., Marottoli et al., 2000). Diminished driving ability can be attributed to a variety of state- (e.g., affective distress) and trait-based (e.g., aggressiveness) personal characteristics (e.g., Beck, Daughters, & Ali, 2013) as well as medical conditions (e.g., osteoporosis; Ackerman, Vance, Wadley, & Ball, 2010). Although basic driving is typically a largely automated behavior for experienced drivers (Norman & Shallice, 1986), many aspects of driving require active, complex engagement of both lower- and higher-order cognitive functions. At face value, drivers must be able to visually scan, perceive, and attend to numerous areas of the environment, make rapid decisions, and plan and follow prescribed sequential motor procedures (Marcotte et al., 1999). Prior evidence shows that safe driving requires the contribution of various attention, executive, spatial, and psychomotor functions (e.g., Marcotte et al., 1999). In healthy adults, driving is thought to involve a variety of neural regions, particularly the parietal, occipital, and prefrontal cortices. Extending the neuroimaging findings, neurocognitive impairment is a significant predictor of driving ability across both

healthy (e.g., normal aging, Goode et al., 1998) and clinical populations (e.g., multiple sclerosis; Schultheis, Garay, & DeLuca, 2001).

The research literature estimates that approximately 20 % of individuals with HIV exhibit unsafe driving (Marcotte et al., 2004), with rates of reported accidents higher than those of seronegative counterparts (Marcotte et al., 2006). Although only a handful of studies have examined the impact of HAND on driving, research has consistently shown that global neurocognitive impairment confers a significant risk for diminished driving skills, performance, and safety (e.g., Marcotte et al., 1999, 2004), even when considered alongside other relevant predictors of these outcomes (i.e., demographic characteristics, HIV disease severity, driving history). Numerous measurement strategies and predictor variables have been employed in elucidating the effect of HAND on driving, but the research clearly demonstrates that both neuropsychological testing as well as computer-based driving simulators independently predict real-world driving ability (e.g., on-road driving evaluations, reported number of accidents; e.g., Marcotte et al., 2004, 2006). Consistent with HIV's predilection for disrupting frontostriatal circuitry, the strongest neurocognitive impact on driving across the literature is found in the domain of executive functions, including tests reliant on visual concept formation, novel problem solving, inhibition, complex sequencing, set shifting and speeded word generation abilities. The precise aspects of executive (and supporting) functions driving this relationship remains to be determined, as most prior studies used domain-level summary scores of executive functions defined broadly. For instance, the vast majority of the measures used require performance of executively demanding tasks in the context of speeded visual processing, thus raising the questions of which component(s) of these measures may in fact be impacting the relationship between cognition and driving: executive load, speeded abilities, and/or modality specificity. Future research might determine whether the strategic load of neurocognitive tasks are more influential on driving ability, regardless of sensory modality (i.e., verbal executive tasks), or if the visual component of these tests is uniquely predictive of driving. Furthermore, the multifaceted nature of "executive functions" begs the analysis of other processes often lumped under this umbrella term that are affected in HIV, including multitasking (Scott et al., 2011), visual planning (e.g., Cattie et al., 2012), and decision-making (e.g., Iudicello et al., 2012).

Despite the high prevalence of visually mediated tasks represented in executive functions literature on driving ability in HIV (e.g., Marcotte et al., 1999), there is a dearth of data on more traditional aspects of basic (e.g., detection, recognition, and orientation) and complex (e.g., mental rotation, map navigation, novel route learning) spatial cognition. Two studies observed associations between a speeded test of visual problem-solving (i.e., Block Design) and basic driving simulation (i.e., Foley et al., 2013; Marcotte et al., 1999). Therefore it is plausible that other aspects of spatial cognition are important in automobile driving abilities and safety, especially given the degree to which it is necessary for one to quickly and accurately process and manipulate visual information en route to his destination. Although HAND typically spares brain regions required for basic visual processing (e.g., occipital cortex; cf. Thompson et al., 2005), impairment in higher-order visual abilities have

been observed (e.g., mental rotation; Weber et al., 2010), likely due to white matter damage on tracts connecting the frontal lobes to other visual processing centers (e.g., parietal lobes; Schweinsburg et al., 2012).

Other neurocognitive domains that have been minimally dissected within the HIV driving literature include attention and working memory, which like executive functions are broad and multifaceted constructs. For instance, the primary clinical model of attention specifies a hierarchy of attentional processes that each require greater levels of strategic cognitive resources in order to be effectively carried out (i.e., focused, sustained, selective, alternating, and divided attention; Sohlberg & Mateer, 1989). These different aspects of attention may each have related, but separable roles in automobile driving skills and safety. For example, divided, but not selective, visual attention as measured by the Useful Field of View was associated with higher self-reported traffic accidents (Marcotte et al., 2006), but not with on-road driving evaluations (Marcotte et al., 2004) in HIV. Within working memory, the Paced Auditory Serial Addition Test (PASAT) emerged as a relevant predictor of driving across a few studies (e.g., Marcotte et al., 2006), but this measure of auditory working memory also has strong processing speed demands (Gonzalez et al., 2006) so it is difficult to differentiate whether processing speed or working memory may be driving this relationship. Similarly, many of the "executive" tasks reviewed above are multifactorial and include strong attentional and working memory components, but the specific mechanisms underlying the observed effects on driving ability remain uncertain and await future studies guided by strong cognitive theory and current knowledge regarding the profile of HAND. For instance, in the context of Baddeley's (2003) model of working memory, HIV-associated neurocognitive deficits in working memory are related to difficulties in the central executive system, which is responsible for higher-level processing such as planning, monitoring, and control of cognitive operations (e.g., Law et al., 1994; Woods et al., 2010), rather than the basic sensory slave components (i.e., visuospatial sketchpad; Hinkin et al., 2002). Considered in the context of the executive findings reviewed above, one might hypothesize that HIV-associated deficits in the central executive, but not the slave systems, are important in driving outcomes, which require the prioritization and coordination of cognitive resources to intake, integrate, and make rapid decisions from incoming sensory stimuli.

Across the HIV driving literature, findings were also mixed in regard to several neurocognitive domains that, at face value, one would expect to be highly relevant to driving ability, including information processing speed, fine-motor speed and coordination, and episodic memory. Perhaps most surprisingly, information processing speed evidenced statistically significant relationships in only two out of five studies in which it was examined, which included laboratory-based driving simulator reaction time (Marcotte et al., 1999) and self-reported accidents (Marcotte et al., 2006). Findings regarding the impact of deficits in fine-motor speed and coordination on driving in HIV were similarly mixed across studies and modalities (e.g., Marcotte et al., 1999, 2004). Lastly, most research showed that learning and memory were not associated with driving ability, with the exception of a single study showing that list learning delayed recall predicted self-reported number of accidents

(Marcotte et al., 2006). One aspect of memory that may be worthy of examining in future studies of automobile driving in HIV is procedural learning and memory, aspects of which may be affected in HIV (Gonzalez et al., 2010) and clearly map on to the overlearned, habitual physical and mental aspects of driving.

As has been observed in other real-world functioning domains (e.g., IADLs), a variety of demographic (e.g., age), neuropsychiatric (e.g., substance use), and medical (e.g., hepatitis C coinfection) comorbidities may further increase the risk of poor automobile driving outcomes in HIV. Notable among these factors is older age, which is of particular relevance with the increasing prevalence of HIV-infected older adults who are increased risk of poorer immunovirologic (High et al., 2012), neurocognitive (e.g., Valcour et al., 2004), and real-world outcomes (e.g., Morgan, Iudicello et al., 2012). The impact of HAND on driving behavior may be exacerbated by the normal aging process, which itself is associated with declines in driving ability (e.g., Lee, Cameron, & Lee, 2003). To this end, Foley and Colleagues (2013) recently demonstrated that older HIV-infected adults displayed greater difficulty than their younger HIV-infected counterparts on a driving simulation with relatively few distractors (e.g., pedestrians to avoid). Older HIV-infected adults with HAND evidenced particular difficulty with regard to route finding efficiency and overall completion time, both of which are heavily reliant on information processing speed and visual planning. This may represent the new onset of age-related parenchymal damage and/or the additive effect of aging and its comorbidities (e.g., cerebrovascular disease) on white matter pathways already implicated in HAND. Future studies might examine the role of diminished cognitive control, or intraindividual variability, which may identify fluctuations in attention abilities, and is prevalent in older HIV-infected individuals (e.g., Morgan, Iudicello et al., 2012), and predictive of driving simulator performance in substance users (Morgan et al., 2013).

Vocational Functioning

Approximately two-thirds of individuals with HIV infection are unemployed, which is six times the unemployment estimates for seronegatives in the USA (CDC, 2010). Across various clinical populations, neurocognition is often cited as an independent predictor of employment status and vocational abilities (e.g., McGurk & Meltzer, 2000; Weber et al., 2012), above and beyond noncognitive predictors (e.g., depression). However, a meta-analysis of the literature on cognition and employment across clinical populations yielded generally small-to-medium effect sizes, suggesting that the magnitude of the association between cognition and employment is modest (Kalechstein, Newton, & Van Gorp, 2003). Indeed, in the HIV literature, the relationship between neurocognition and employment is strikingly less robust than that for other aspects of everyday functioning reviewed in this chapter; more specifically, only three of the five studies published on this topic in HIV showed a significant relationship between global neurocognitive impairment and vocational functioning (e.g., Chernoff, Martin, Schrock, & Huy, 2010; Heaton et al., 2004; Morgan, Iudicello et al., 2012; Rivera-Mindt et al., 2003). The strength

of the relationship between neurocognition and vocational ability is generally consistent across measures of functional capacity (e.g., measurement of work-related abilities) and manifest (i.e., actual real life performance) vocational functioning (e.g., work status).

Nevertheless, the literature reveals an element of domain specificity to the relationship between neurocognitive deficits and vocational functioning in HIV. Consistent with other aforementioned functional domains, executive dysfunction appears to be highly relevant to vocational success across the HIV literature, with all studies that examined this domain reporting statistically significant associations (i.e., Cattie et al., 2012; Chernoff et al., 2010; Heaton et al., 2004; Rabkin et al., 2004; van Gorp et al., 1999, 2007; Woods et al., 2011). According to this literature, the specific executive subcomponents involved include both speeded and non-speeded aspects of executive functions, such as inhibition, perseverative thinking, visual planning (e.g., rule monitoring), verbal fluency, complex sequencing, concept formation, and logical analysis. It appears that such higher-order executive functions play a critical role in governing the implementation and efficiency of lower-order abilities necessary for gainful employment. The consistency of these findings suggests that it may be prudent to examine other aspects of executive functions (e.g., multitasking) as well as other cognitive and neurobehavioral constructs associated with prefrontal functions (e.g., apathy, Kamat et al., 2012) in relation to vocational outcomes.

Beyond executive functions, learning abilities predict vocational outcomes in two-thirds of the studies that examined their relationship (Chernoff et al. 2010; Heaton et al., 2004; Rueda et al. 2011; van Gorp et al., 1999, 2007; Woods et al., 2011). Of note, studies that revealed significant effects were those that used a demanding supraspan word list-learning test (i.e., California Verbal Learning Test), whereas studies that also examined story and/or figure learning were less reliably predictive of employment. In contrast to other domains of everyday functioning in HIV (e.g., medication adherence), delayed episodic memory was largely unrelated to vocational functioning (e.g., Heaton et al., 2004). At first glance, this lack of significant associations was surprising because one would assume that the retention and recollection of events and information would play an important role in many aspects of work. Interpreted in the context of the strong executive findings for employment and the mixed encoding/retrieval profile of HAND (e.g., Gongvatana, Woods, Taylor, Vigil, & Grant, 2007), one might reason that the strategic organization, acquisition, and retrieval of information are the critical elements for day-to-day vocational functioning in HIV. Indeed, one prior study shows a significant relationship between employment and HIV-associated deficits in prospective memory (Woods et al., 2011), a specific form of episodic memory that requires considerable that requires considerable strategic encoding, monitoring, and retrieval demands and relies heavily on intact executive functions (e.g., McDaniel & Einstein, 2000). A similar argument may be made for findings within the attention domain, such that the only study to find a significant relationship (Heaton et al., 2004) used a domain comprising tests primarily related to strategically demanding working memory abilities rather than more basic aspects of

attention. Finally, mostly small and nonsignificant relationships were found for the domains of information processing speed, fine-motor skills, and spatial cognition with vocational functioning.

Although there did not appear to be clear differences in the existing literature regarding the differential impact of cognition on vocational capacity versus manifest employment status, researchers will likely benefit from continued to examination of these questions as the job market and required skills continue to evolve. For example, instruments used to assess vocational capacity (e.g., COMPASS; Valpar International Corporation, 1992) were created and validated prior to the increased reliance on computer-based technology in the workplace. In the modern era, perhaps novel methods of assessing vocational capacity are necessary to capture the intricacies of technologically driven job skills, which may have unique neurocognitive demands. In fact, it is reasonable to assume that the vocational impact different neurocognitive deficits will vary across type and level of job function (e.g., motor skills for manual laborers versus executive functions for corporate executives). Finally, with increasingly encouraging primary health outcomes in HIV during the cART era, many individuals who have been previously unemployed or on disability may consider returning to the workforce. As illustrated in the seminal study by van Gorp et al. (2007), neurocognitive and neuropsychiatric functioning may be particularly relevant moderators of successful return to work in HIV.

Health-Related Quality of Life (HRQoL)

As individuals with HIV infection are living longer in the cART era, there has been increasing interest in identifying the risk and protective factors for health-related quality of life (HRQoL), which is notably reduced in HIV. HRQoL is a multifaceted construct that describes the various ways by which an individual's health impacts his/her perceived level of daily functioning and biopsychosocial well-being (Coons, Rao, Keininger, & Hays, 2000; Hays et al., 2000). One influential conceptual model of HRQoL proposed by Wilson and Cleary (1995) posits a linear relationship whereby physiological/biological factors (e.g., viral load, CD4 counts) influence the expression of symptoms (e.g., opportunistic infections, HAND) that impact everyday functioning (e.g., non-adherence, disability), resulting in altered general health perceptions, and lower overall quality of life. This theoretical framework has been influential in understanding the associations between HRQoL and various health outcome domains and identifying risk factors (e.g., neurocognitive impairment) to target for interventions aimed at improving HRQoL in affected individuals. A considerable body of research conducted during the cART era has demonstrated lower HRQoL in HIV-infected individuals despite effective cART (e.g., Tozzi et al., 2004) and particularly in those with more advanced disease (i.e., symptomatic HIV infection or AIDS; Hays et al., 2000). More specifically, lower HRQoL has been linked to higher HIV viral loads, a greater number of disease-related symptoms (e.g., headaches, nausea/vomiting; Hays et al., 2000), lower CD4 counts (Hays et al., 2000; Jia, Uphold, Wu, Chen, & Duncan, 2005), and ARV failure (Parsons

et al., 2006). Other notable risk factors for poorer HRQoL in HIV include demographic factors (e.g., older age, lower education; Hays et al., 2000; Morgan, Iudicello et al., 2012), comorbid medical (Rodriguez-Penney et al., 2013), psychiatric (e.g., depression; Morgan, Iudicello et al., 2012; Sherbourne et al., 2000; Trépanier et al. 2005), and substance use disorders (e.g., alcohol dependence; Rosenbloom et al., 2007), psychosocial issues, interpersonal characteristics (e.g., social support; Emlet, Fredriksen-Goldsen, & Kim, 2013), and unemployment (Hays et al., 2000). Importantly, the magnitude of association between these aforementioned underlying risk factors of poorer HRQoL may differ to some degree depending on the specific domain of HRQoL assessed (e.g., physical functioning versus emotional well being). For example, an increased number of HIV-associated symptoms and a greater comorbid medical burden have been more closely associated with poorer physical HRQoL, whereas factors such as social support and psychological distress are more closely tied to emotional well-being (e.g., Emlet et al., 2013; Hays et al., 2000; Rodriguez-Penney et al., 2013).

HIV-associated neurocognitive impairment is also a strong, independent risk factor for lower overall HRQoL (e.g., Tozzi et al., 2003, 2004). With regard to specific aspects of HRQoL, HAND has been linked to lower physical functioning, emotional well-being, social functioning, and general health perceptions (Morgan, Iudicello et al., 2012; Tozzi et al., 2003, 2004), even when considered alongside other well-established predictors of HRQoL, such as emotional distress, substance use disorders, and HIV disease severity. At the domain level, the most consistent neurocognitive associations are observed for executive functions (i.e., inhibition, sequencing, and mental flexibility) and complex information processing speed, both of which predict the physical and mental aspects of HRQoL (Doyle, Weber, Atkinson, Grant, & Woods, 2012; Osowiecki et al., 2000; Parsons et al., 2006; Schifitto et al., 2001; Tozzi et al., 2003, 2004). Evidence for the role of fine-motor functioning and episodic memory is spottier across this literature; however, the aforementioned prominence of executive dysfunction in HRQoL raises the possibility that a more detailed examination of the specific cognitive (e.g., executive) components of learning and memory (e.g., executive or organizational strategies such as semantic clustering) may be warranted. For example, Doyle et al. (2012) recently reported that PM was a significant predictor of poorer mental and physical HRQoL in younger HIV-infected adults, even when accounting for depression, substance dependence, and immunosuppression.

Risk Behaviors

Approximately 50,000 adults are infected with HIV annually in the USA, with incidence rates highest among men who have sex with men, injection drug users, and ethnic and racial minorities (Prejean et al., 2011). HIV-seropositive individuals are most likely to transmit the virus to others during the acute and early stage of infection (e.g., Pao et al., 2005), due to high viral loads and delayed awareness of their serostatus. Even beyond this initial period of infection, curbing HIV transmission risk behaviors is an essential aspect of everyday functioning that is not only important to

prevent new infections, but also to enhance HIV health outcomes by preventing superinfection and the transmission of treatment resistant viral strains among seropositives (Ross et al., 2007). Risk factors that precipitated an individual's initial infection with HIV (e.g., unsafe sex and drug use practices) often persist after infection and diagnosis; in fact, it is estimated that one-third of HIV-infected adults continue unsafe transmission practices after they test positive for the virus (see Kalichman, 2000). Public health HIV prevention efforts have largely relied upon psychoeducation approaches regarding safer sex and drug use practices and psychosocial interventions (e.g., motivational interviewing) to reduce HIV transmission risk (e.g., Garfein, Metzner, Cuevas, Bousman, & Patterson, 2010). As observed in the broader social psychological literature (i.e., intention-behavior relations; Sheeran, 2002), the intention to engage in safe practices does not readily translate into actual behaviors. Numerous psychological avenues have been explored to determine potential individually based mediators and moderators of increased transmission risk behaviors, including mood disorders (e.g., depression), personality traits (e.g., narcissism; Martin, Benotsch, Perschbacher Lance, and Green 2013), and substance use (e.g., Kalichman et al., 2000). Moreover, social programs like clean needle exchanges and condom distribution have made strides in alleviating such problems due to lack of access to materials required for healthier behaviors.

Although psychosocial interventions used to reduce HIV transmission risk behaviors among infected individuals often contain skills (e.g., decision-making and problem-solving; e.g., Kalichman, Rompa, & Cage, 2005) that rely heavily on intact cognitive functioning, research examining the relationship between neurocognitive impairment and risk behavior has been limited. It is reasonable to hypothesize that higher-order neurocognitive abilities such as episodic memory and executive functions (e.g., inhibition and planning) might play an important role in effectively acquiring, processing, and deploying HIV risk prevention knowledge, skills, and behaviors. For example, impulsivity in sexual behavior may preempt controlled cognitive processes that would be responsible for choosing to use a condom. As such, relative to other areas of everyday functioning in HIV infection, greater scientific inquiry has been made at the level of discrete cognitive abilities (cf. global neurocognitive impairment). At the basic skills level, Malow and colleagues (2012) demonstrated that slowed information processing speed was associated with poorer behaviorally assessed condom use skills, suggesting difficulties with carrying out the actions required of safe sexual practices. With regard to higher-level manifest risk behaviors, Martin et al. (2007) showed a moderately strong relationship between self-reported engagement in sexual risk behaviors and time-based PM, but not with event-based PM, working memory, or retrospective memory, in a mixed cohort of HIV-infected substance users (see also Weinborn et al., 2013). This finding suggests that the ability to remember to perform important aspects of health maintenance behavior is more sensitive to dysfunction of strategically demanding cognitive abilities (e.g., monitoring).

Several studies have indicated that the relationship between neurocognition and risk behaviors is highly complex, perhaps by way of its interaction with other important psychosocial factors. For instance, a study by Gonzalez et al. (2005) reported

that higher levels of sensation-seeking were associated with engagement in risky behaviors only among HIV-infected persons with intact decision-making. Similarly, Wardle, Gonzalez, Bechara, & Martin-Thormeyer (2010) found that intact decision-making abilities strengthened the relationship between psychological distress and risk behaviors. This relationship has also been demonstrated in the inverse, such that greater spontaneous safe sex-related associations were related to condom use among men with better working memory ability (Grenard, Ames, & Stacy, 2013). These studies suggest that neurocognitive impairment may disrupt the pathways that would typically link important psychological predictors to engagement in risk behaviors, or at a more basic level, between behavior intention and behavior action.

HIV-Associated Everyday Functioning Across Cultures

Assessment of HIV disease-related disability across cultures is essential, as HIV infection is a worldwide epidemic with some of the highest rates of infection in resource-limited settings outside of the USA. Although research has begun to delineate the neurocognitive consequences of HIV infection across countries, the functional and behavioral impact of HAND is less clear. Rates of neurocognitive impairment appear to differ somewhat depending on the country of interest; for example, HIV+ individuals in China demonstrated similar rates and profiles of impairment to those in the USA (i.e., mild-to-moderate impairments across about 40 % of the cohort; Cysique et al., 2007; Heaton et al., 2008), whereas studies in sub-Saharan Africa illustrate a higher prevalence of the most impaired classifications of HAND (i.e., HIV-associated dementia identified in up to 30 % of African cohorts versus <10 % in US-based studies; Heaton et al., 2011; Joska, Fincham, Stein, Paul, & Seedat, 2010; Wong et al., 2007). Given the differential trajectory and impact of HIV infection by the country (e.g., in China, the HIV epidemic was first introduced in rural areas associated with blood product collection whereas in India, the first reported cases of HIV infection were in female sex workers; Heaton et al., 2008; John, Babu, Jayakumari, & Simoes, 1987), such differences in the expression of HAND may be anticipated. Additionally, there may be differential influences to consider when examining real-world functioning versus neurocognition across cultures. For example, the sociocultural context in which HIV infection occurs may differ by country thereby impacting stigma of disease, access to healthcare resources and ART treatment, value of employment, or expression of distress (e.g., Atkinson, McCurdy, Williams, Mbwambo, & Kilonzo, 2011; Jin et al., 2006), to name a few, all of which may have important effects on functional outcomes for HIV+ individuals.

In the past decades, there have been concerted efforts to create appropriate normative data in order to account for cultural and racial differences on neurocognitive functioning which may be applied to individuals with HIV (e.g., Heaton et al., 2004; Norman et al., 2011), yet relatively fewer studies have examined HIV-associated everyday functioning outcomes across cultures both within and outside of the USA. Within the USA, Rivera-Mindt et al. (2003) created a Spanish version of a performance-based functional battery and found that individuals with

HIV-associated neurocognitive impairment performed worse than neurocognitively intact individuals therefore supporting the construct validity of the battery and implicating the role of global neurocognition on everyday functioning for Spanish-speaking HIV+ individuals in the USA. Additionally, in China, HIV+ individuals evidenced greater cognitive complaints, IADL dependence (most commonly in finances, shopping, housekeeping, and cooking), and higher rates of unemployment than seronegative controls, and these functional difficulties were also associated with poorer global neuropsychological performance (Cysique et al., 2007; Heaton et al., 2008). On the other hand, in contrast to some studies in the USA, reported antiretroviral adherence levels are relatively high across countries internationally (i.e., 62 and 57 % reported adherence rates over 95 % in Africa and Brazil, respectively; Pinheiro, De-Carvalho-Leite, Drachler, & Silveira, 2002; Potchoo et al., 2010). Although neurocognition was not examined in these studies, the authors noted that memory complaints, lower adherence self-efficacy, greater perception of negative affective and physical concerns, regimen complexity, and lower educational attainment were all significant predictors of nonadherence (Lawler et al., 2011; Pinheiro et al., 2002; Potchoo et al., 2010). Lastly, again though not examined in the context of neurocognition, poorer HRQoL is consistently reported among HIV+ individuals in India, and is associated with lower current CD4, female gender, marital status, lower educational attainment and income (Nirmal, Divya, Dorairaj, & Venkateswaran, 2008; Subramanian, Gupte, Dorairaj, Periannan, & Mathai, 2009; Wig et al., 2006). Taken together, these studies begin to delineate the important impact of HIV infection on everyday functioning across cultures, yet the role of neurocognition on these outcomes is less well understood, but represents an important future direction for neuroAIDS investigators worldwide.

Summary and Future Directions

Although the health status of persons living with HIV infection has improved dramatically over the past 15 years, HIV is still associated with a variety of adverse real-world outcomes. HIV-associated declines in real-world functioning are multifactorial, but the considerable body of literature reviewed in this chapter suggests that neurocognitive impairment is a unique risk factor for dependence in ADLs, cART non-adherence, unemployment, automobile driving accidents, lower HRQoL, and engagement in HIV transmission risk behaviors. Executive dysfunction, primarily operationalized by measures of cognitive flexibility and novel problem solving, emerged as the most robust neurocognitive risk factor for nearly all of the real-world outcomes reviewed. Delayed episodic memory, and to a slightly lesser extent, learning/acquisition were also strong predictors of real-world outcomes, most notably for IADL declines and cART adherence. Somewhat surprising was the relatively weaker ecological relevance of deficits in information processing speed and motor skills, although this may be due to the reduced prevalence of impairments in these ability areas in the cART era (Heaton et al., 2011). Also striking was the lack of hypothesis-driven research examining the domains of attention and spatial

cognition, both of which might play a role in certain real-world outcomes, such as automobile driving. Moreover, the vast majority of this literature has utilized standard indices from well-validated clinical tasks (e.g., learning trials total score), which sets the stage for future hypothesis-driven work to examine the underlying component processes of these associations (e.g., semantic clustering indices). Future studies might also examine other so-called "integrative" constructs, paying particular attention to the conceptual match between the demands of the real-world task and the cognitive and functional capacities under study (e.g., social cognition as a predictor of social and emotional HRQoL).

In-depth examination of the role of neurocognition per functional outcome is critical given the variability observed across type and severity of cognitive impairment in this relationship. The real-world outcomes most strongly (and broadly) related to neurocognitive functioning were IADLs, cART adherence, medication management, and HRQoL, whereas the relationships with automobile driving, risk behaviors, and employment, while clearly present, were nevertheless more variable across neurocognitive domains. A relevant next step for the field might be to examine more specific manifest ADL domains affected in HIV (e.g., cooking, cleaning, shopping) rather than global ADL functioning, which may be differentially impacted by (or impervious to) HIV-associated neurocognitive impairment. NeuroAIDS researchers might also consider expanding the range of real-world outcomes to include other ecologically relevant aspects of the daily lives of persons infected with HIV (e.g., psychosocial functioning). For example, the everyday functioning independence of individuals living with HIV infection is increasingly dependent on navigation of the Internet to engage medical (e.g., pharmacy and health information), household (e.g., shopping and banking), and even psychosocial (e.g., social networking) resources. As such, the development of web-based capacity (e.g., Internet navigation skills) and manifest (e.g., electronic health record utilization) functioning may be increasingly relevant to health outcomes (Goverover & DeLuca et al., 2015). It will also be important to examine cofactors that may modulate the observed relationships between neurocognitive functioning and real-world outcomes in HIV, as we know little about the influence of motivation, awareness, actual real-world demands, and compensatory strategies (see Fig. 10.1).

Considering the prevalence and real-world impact of HAND, the development, validation, and clinical deployment of effective cognitive, behavioral, and pharmacological treatments to improve cognitive health outcomes is a clear priority (Weber, Blackstone, & Woods, 2013). To date, pharmacological (including cART and non-ART approaches) have shown limited effectiveness on HAND (Al-Khindi, Zakzanis, & van Gorp, 2011) and none to our knowledge have examined the trickle down effects of cognitively targeted therapies on real-world outcomes. Only three studies have been published to date on cognitive rehabilitation in HIV (see Weber, Blackstone, & Woods, 2013), all of which have used a restorative approach. Only one study has examined the benefits of cognitive rehabilitation on functional outcomes in HIV. In 2012, Vance et al. reported that a 10-h restorative processing speed intervention was associated with modest improvements in two functional skills tasks (i.e., timed IADLs and Useful Field of View) in a small HIV-infected cohort, but its impact on

manifest real-world outcomes remains to be determined. Given the consistency of executive dysfunction and episodic memory as predictors of functional skills and real-world outcomes across the HIV literature, targeting these ability areas for restoration and/or compensatory rehabilitation may be particularly beneficial. For example, the use of cueing paradigms (e.g., alarms) may improve self- and environmental-monitoring of safe driving behaviors (e.g., checking for appropriate speed) and assist in breaking periods of inattention or distracted driving. Additionally, qualitatively, themes such as having a "stable base" (e.g., home and community resources) and "finding and maintaining balance" (e.g., adjusting daily routines according to physical and cognitive symptoms), have been identified as important aspects of successful daily functioning among HIV+ individuals (Bedell, 2000). Therefore, in order to successfully address the functional difficulties observed, it may be important to not only address those neurocognitive factors that may be contributing to declines, but also the important psychosocial domains and comorbidities that may contribute to the global picture of functioning in HIV infection. Viewed in the context of our guiding conceptual model, improving HIV-associated neurocognitive and functional impairment may subsequently improve real-world functioning, which may in turn enhance general health perceptions and overall quality of life.

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Disability and Public Policy in America

11

Senator Robert Menendez

The purpose of the Americans with Disabilities Act is to provide a clear and comprehensive national mandate to end discrimination against individuals with disabilities and to bring persons with disabilities into the economic and social mainstream of American life; to provide enforceable standards addressing discrimination against individuals with disabilities, and to ensure that the Federal government plays a central role in enforcing these standards on behalf of individuals with disabilities.

This is how a report issued by the Senate Committee on Labor and Human Resources describes the intent and function of the Americans with Disabilities Act, the landmark civil rights legislation signed into law on July 26, 1990. While the passage of this law is the product of decades of struggle by the disabilities community to gain the rights and recognition they deserve, it by no means represents the entire story of the struggle of persons with disabilities for full acceptance into the social and economic fabric of the American society. Congress and the courts continually revisit the issue of discrimination against those with disabilities, while businesses, employers, and communities around the country work to be more accepting and accommodating towards those with disabilities.

The History of Disability Rights in America

The story of the disabilities rights movement is the story of how a few determined individuals, through their tireless work and dogged efforts, were able to overcome long-standing prejudices in the fight for equal rights. Just as the African-American civil rights movement found leadership and inspiration from people like Rosa Parks

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and Martin Luther King, Jr., the disabilities rights movement has leaders such as Ed Roberts, Bob Burgdorf, and a host of others who helped open our society to recognize and include people with disabilities.

Ed Roberts was born in California in 1939. In 1953, just two years before Dr. Jonas Salk developed the vaccine for polio, Roberts was diagnosed with the disease. He spent a year and a half in the hospital and upon returning home was confined to an iron lung for upwards of 18 h a day. The machine, which was vital to keeping him alive, was also a prison that kept him isolated from the rest of the world both physically and mentally. As time wore on, Roberts became increasingly isolated and depressed, seeing himself as nothing more than a "helpless cripple" who would never have a meaningful or fulfilling life. However, as his health started to improve and he was able to leave the iron lung during the day, Roberts returned to high school and attended classes in person during his senior year. He found education to be empowering, and allowed him to realize that just because he looked different, his body did not function like the other students' and he was in a wheelchair, he should not be treated any differently than others.

After nearly being denied his high school diploma because he did not have the required driver's education or gym credits, Roberts continued to defy his doctors and counselors who did not think he was capable of living a normal life by going to college. After completing two years at a small community college Roberts applied to the University of California at Berkeley, with the intent to study political science. However, Roberts needed to overcome the prejudices of both the California Department of Rehabilitation—which refused to pay for his tuition, despite covering those costs for other less-severely disabled students—because they thought it was "infeasible" that he could ever work, since the administration at Berkeley had "tried [admitting] cripples before and it didn't work." After winning the support of several administration officials at the school, he was admitted to study. It was at this point that he faced yet another hurdle in the seemingly endless line of obstacles that stood in between him and his goals. Now that he was admitted to study, he needed to find a place on campus to live. This was not only a challenge because of the dorm buildings lacked sufficient ramps to accommodate wheelchairs, but he needed the space and the structural support that could also accommodate the 800 pound iron lung he still needed to be in while sleeping. He evenutally found a home in the school's on-campus hospital, turning it into a "one man dormitory." Thanks to Roberts' standard brand of willpower and determination, he was able to settle into campus life and have a rich, fulfilling college experience.

This being Berkeley in the 1960s, Roberts was in the epicenter of the political movements that would define the era and shape his generation. In 1967, as Roberts finished his Masters and started working on his doctorate, the campus disabled community had grown to twelve full-time students. Calling themselves the "Rolling Quads," this group of friends, all of whom ended up living in the hospital wing first established as a dorm when Roberts moved in, started to build a political identity and began strategizing on ways to make Berkeley a more inclusive and accommodating place for those with disabilities. In one of their first victories, they were successful in lobbying the city of Berkeley to include wheelchair accessible curb

cuts to the city's sidewalks as part of a street renovation project near the campus. This was a milestone—not only in gaining legitimate political clout, but also in gaining an increased sense of independence and self-reliance.

Organized Advocacy for Persons with Disabilities Begins in America

Focusing on empowerment, independence, and self-reliance, Roberts and the Rolling Quads founded the Physically Disabled Students' Program (PDSP) with the help of a federal grant from the then-Department of Health, Education and Welfare (HEW). The PDSP served as a one-stop shop for students with disabilities, offering services that ranged from attendants to help prepare meals, to a workshop to repair wheelchairs and even retrofit cars and vans to be wheelchair accessible. The PDSP was run by students with disabilities, for students with disabilities. It was the first of its kind and a truly empowering enterprise, not just for those who worked there but for those who came to rely on the services provided.

The key to this empowerment was in the radical new way Roberts and the PDSP thought about disabilities. Up until that point, social services and medical providers looked at disabilities as a limiting factor in the person's life: what they could not do as a result of their particular disability. Roberts turned that philosophy around and saw the person with a disability in terms of what he or she *could* do: what level of independence was this person able to achieve and how the PDSP could help foster that independence. With this paradigm shift, the independent living movement was born. This movement empowered people with disabilities to take full control of their lives and know that they, too, could fulfill their dreams of an education, a career, and a fulfilling life.

The PDSP quickly became a popular and much sought after resource for students and non-students alike. As the demand for PDSP services grew, especially among the non-student disabled community, Roberts realized that his work had outgrown the limited space of the Berkeley campus and he needed something devoted to the larger community. In 1972, the Center for Independent Living (CIL) was founded, based on the model established by the PDSP. It was managed by people with disabilities and focused on ensuring those with disabilities were afforded the opportunity to live independent lives. The CIL is still active in the Berkeley-San Francisco Bay area today.

Over the course of the intervening 40 years, the CIL and organizations born in its image have been on the forefront of the fight to expand opportunity and civil rights for those with disabilities. The CIL and Roberts' notion that people with disabilities are defined not by their disabilities but by their capabilities has helped to transform the nation's understanding of disability and breakdown the social, economic, and cultural barriers that relegated those with disabilities to a second-class status for far too long. This started with the seemingly small victory of requiring curb cuts in the sidewalks of their hometown, grew to organizing the passage of first federal statute providing broad civil rights protections for individuals with disabilities in 1973, and finally helped build the groundswell of public support necessary for the enactment of the landmark Americans with Disabilities Act in 1990.

Legislative History

Prior to 1973, the inclusion of the rights of persons with disabilities within the broader category of civil rights was just an idea, with no basis in federal law. There was nothing in federal law that recognized this simple truth. That changed when President Richard Nixon signed the Rehabilitation Act of 1973 into law. However, what is now seen as a fundamental reformulation of the way the federal government approached disabilities rights, was actually somewhat of an afterthought at the time.

In the years following World War II, Congress began focusing attention on providing those with disabilities access to education and health care. With the rise in the need to both address veterans with disabilities returning from war and the advancement of medical treatments that allowed children born with disabilities to live much longer lives, it was no longer possible to ignore or isolate those with disabilities. Advocacy groups were formed to lobby lawmakers on issues of importance for those with disabilities, often focusing on the specific needs of those with specific disabilities or illnesses. Such advocacy groups typically evolved from ad hoc groups of family members and friends of those with disabilities.

Up until this point in time the diagnosis of a disability, often as a young child, meant being seen by society as Ed Roberts once saw himself: a "helpless cripple" with no chance of leading a fulfilling, independent life. This typically meant being shipped to an institution, away from family, and denied a real opportunity for a better existence. As the second half of the twentieth century began, medical science advanced quickly and our scientific and cultural understanding of disability began to evolve. Parents of children with disabilities started demanding a proper education for their children. This meant that they were not only unwilling to send their children to an institution, but they also demanded that their children be integrated into the regular school system. This movement of concerned parents seeking to provide their children with the education and life experiences afforded children without disabilities formed the foundation that would help push Congress to establish the first federal agency devoted to the support of the handicapped in 1966. By 1970, Congress was appropriating funds specifically targeted at both training special education teachers and developing learning materials specifically designed for children with disabilities.

The Rehabilitation Act of 1973, however, was the first federal law to fully recognize that disabilities rights are indeed civil rights. Following in the footsteps of other pioneering civil rights legislation such as the Equal Pay Act of 1963, the Civil Rights Act of 1964, the Voting Rights Act of 1965 and the Fair Housing Act (as part of the Civil Rights Act of 1968), the Rehabilitation Act codified that it was illegal for a entity which received federal funding to discriminate against an otherwise qualified individual solely on the basis of their disability. This included universities, government agencies, and the US Postal Service specifically. Within the larger piece of legislation was Sec. 504, the first federal statute to explicitly guarantee basic civil rights to persons with disabilities. While Sec. 504 was limited in jurisdiction to only certain programs affiliated with the federal government, it formed the foundation upon which the American with Disabilities Act was later built.

Looking back, Sec. 504 was an instrumental piece of civil rights law that established the basis upon which all disabilities rights laws are built. However, at the time it was hardly noticed. The legal concept of disabilities rights as civil rights was not something for which advocate groups heavily lobbied or something on which lawmakers spent countless hours debating. In fact, it remains unclear how the provision made it into the Rehabilitation Act in the first place.

Seen as primarily a bill to provide funding for disability-related grants, the Rehabilitation Act was not recognized at the time as a vehicle for sweeping social change. The protections outlined in Sec. 504 were lifted directly out of the Civil Rights Act of 1964, altering the language previously used to protect against discrimination based on race, color, or national origin to now protect individuals on the basis of a disability. This sweeping new protection was never once subject to a Congressional hearing or debate, a fact that might have eased the passage into law but which seemed to hamper the writing of the regulations that would give it practical applicability. The administration of President Gerald Ford, when examining Sec. 504, estimated that it would cost billions of dollars—taxpayer dollars—to implement and enforce. As a result, the regulation writers at the HEW dragged their feet, delaying the issuance of formal regulations and preventing Sec. 504 from fully taking effect. When President Carter came to office in 1977, after highlighting the implementation of Sec. 504 as an issue during his campaign, his administration quickly worked to finalize the necessary rules and regulations.

However, a new president and a new approach to disability rights does not always ensure a smooth path towards victory. The newly installed Secretary of the Department of Health, Education and Welfare, Joseph Califano, a Harvard-trained lawyer and former staffer at the Department of Defense and the LBJ White House, realized the same potential hazards as his predecessors. That is, in addition to the potential costs of compliance there was the more pressing issue of the political backlash that could result if alcoholics, drug abusers or homosexuals were able to claim protection under Sec. 504. Despite the assurances of HEW officials that this was not the case and such individuals would not qualify for protection, Califano continued to delay the implementation of the regulations.[1]

Advocates for disabilities rights, who were relatively unaware of the impact of Sec. 504 at the time it was passed by Congress, were now fully engaged in ensuring its provisions were implemented. And they wanted them implemented quickly. Adopting a more direct lobbying strategy, citizen-lobbyists in wheelchairs even took to holding demonstrations and vigils outside Califano's home. These actions had little impact on the HEW's movement towards final issuance of the Sec. 504 regulators, but they did have a clear effect on emboldening disability rights advocates across the country.

[1] Secretary Califano has a long and distinguished career as a lawyer, author and public servant. Despite these initial hesitations about people suffering from substance abuse issues and homosexuals, he was an advocate on their behalf. He is the founder of The National Center on Addiction and Substance Abuse at Columbia University and in 1979 was the driving force behind HEW eliminating homosexuality as a "mental disease or defect."

Taking tactical queues from their anti-Vietnam War predecessors, these activists started occupying the HEW offices in Washington, DC, and in satellite offices throughout the country. An especially effective demonstration took place at the HEW protests in the San Francisco regional office. The San Francisco Bay Area, where political demonstrations were a way of life and had been honed to a fine art, was the stage for one of the more epic battles in the struggle to implement Sec. 504.

Garnering the attention of the national media, the protestors in the San Francisco HEW offices were able to rally increased popular support for their cause, even if the HEW officials against whom they protesting were not so quick to back down. After several days of protesting and occupying the HEW offices, surviving on food and support donated by local businesses and supporters since the HEW officials refused to provide those necessitates, Congressional officials held a field hearing in the occupied building to explore the grievances of the protestors.

The protests continued. For several more weeks advocates occupied the HEW offices and demanded the justice they knew they deserved. Eventually Califano gave in to their demands and certified the Sec. 504 regulations, along with those for the Education for All Handicapped Children Act. This brought an end to the protests and a beginning of the march towards full equal treatment under the law for people with disabilities.

Implementation

While this signaled the end of the battle to ensure Sec. 504 obtained the full force of the law, the war for disabilities rights was far from won. As the regulations went into effect, businesses, aided by publicity in the news media, started complaining about the costs that would be incurred by having to retrofit their buildings to accommodate those with disabilities. With some estimates showing upwards of $15 billion as the cost of compliance to universities alone, the backlash to the implementation of Sec. 504 started to grow. This posed a unique problem for the disabilities rights movement. With prior advances in civil rights, such as those afforded to African-Americans, there was no dollar amount associated with compliance: it did not cost a dime to allow a black man to use an already existing facility to which he was previously barred from using. In contrast, providing equal access to those with disabilities often required building ramps, widening doorways, installing elevators, etc. In some small rural towns there were complaints that facilities would have to spend enormous sums to accommodate wheelchairs, when in fact nobody in town used one. These sensational stories are often spread nationwide and caused high-profile, but short-lived scandals. As is often the case, the reality is far less severe than assumed beforehand.

The Labor Department, in a study on the costs of compliance to Sec. 504 five years after the regulations were finalized, showed that costs were “no big deal” and that most of the changes necessary to accommodate people with disabilities were minimal and often carried no costs at all. As such, businesses, university administrators and other who were required to comply with the requirements of Sec. 504 were quick to come around.

While the 1970s saw significant progress in the advancement of disabilities rights, the 1980s got off to a slow start. When Ronald Reagan was elected president in 1980, he did so on a platform that consisted of reviewing all regulations deemed over burdensome or onerous to both businesses and government agencies alike. Clearly the Sec. 504 regulations were in the crosshairs, and for the next several years the advancement of the rights of those with disabilities significantly slowed. But there was one thing the anti-regulation minded Reagan administration could not stop, and that was the new generation of children being raised in a world that included not only the acknowledgement of their basic civil rights as outlined in Sec. 504 of the Rehabilitation Act, but also the access to an education afforded them in the Individuals with Disabilities Act (then known as the Education of All Handicapped Children Act, which is discussed in further detail below).

The first class of students protected under these two federal laws started graduating in the late 1970s and early 1980s. Entering a new world where private companies and other institutions that were not required to provide equal treatment, the disabled students-turned adults began to demand equal protection in all aspects of society. These were, for the first time, members of a generation raised in world of opportunity, where their disabilities did not determine the full course of the life they would lead. The growing numbers of people with disabilities who were no longer content to live a quite, subjective life on the sidelines of society became more vocal in their calls for full protection under the law. No longer was it sufficient for the laws to protect them only when they were in school or dealing with a government entity. The basic rights and protections afforded to all minority populations needed to be extended to include those with disabilities. This included private sector businesses, publicly available accommodations and services, transportation and telecommunications. With this in mind, the seeds of the landmark Americans with Disabilities Act were sown.

Within the Reagan administration was a group of relatively young, conservative staffers working at the then-obscure National Council on Disability (NCD; formerly known as the National Council on the Handicapped, which was created as part of the 1973 Rehabilitation Act). The NCD was elevated to the status of an independent agency in 1984, having spent the previous decade housed inside the Department of Education. The NCD was given a broad mandate to evaluate how federal laws impacted people with disabilities, including how they foster community integration and independence for individuals with disabilities.

Americans with Disabilities Act

One of the staffers working at the NCD under President Reagan was a not-quite middle-aged attorney named Bob Burgdorf. Having a paralyzed arm and personal experience with discrimination in his life as a result of his disability, Burgdorf was not content to use his position within the NCD to maintain the status quo. He was determined to make a significant impact on the disabilities rights movement through a comprehensive federal approach to ending disabilities-based discrimination. The Americans with Disabilities Act was his brainchild.

Burgdorf had a draft of a bill, one that would be used to extend federal protection to all people with disabilities and would seek to ensure everything was accessible—every building, bus and train station—within two short years after enactment. This was a somewhat radical, yet fully comprehensive, way to achieve their goals of total accessibility and inclusion in society. At the end of Reagan's second term in office, the bill was introduced in Congress. Despite garnering 124 cosponsors in the House of Representatives and 26 in the Senate, the bill saw virtually no official action.

As 1989 began, with the start of the new 101st Congress and the swearing in of President George H.W. Bush as the 41st President, the ADA was given new life. With the help of disabilities rights advocate Patricia Wright—a political powerhouse who led the lobbying arm of the disabilities rights movement—the bill garnered the attention of two powerful Senators with an interest in civil and disability rights: Edward Kennedy of Massachusetts and Tom Harkin of Iowa. For the first months of the 101st Congress, they rewrote Burgdorf's original vision of the ADA to be more moderate and acceptable to the business community. In an ironic turn of events, these three liberals were putting together a bill far more conservative than the one Burgdorf and his Reganite colleagues had previously written. However, this more moderate shift in tone was not an abandonment of principle or a sign of a reduced dedication to disabilities rights. Rather, it was an understanding of the politics necessary to ensure the bill's legislative success.

As was the case a decade before with the Sec. 504 regulations, there was substantial opposition to the ADA, based on the potential financial hardship any new regulations would bring on businesses and communities. Again, expanding the rights of those with disabilities carried with it something laws expanding the rights of minorities and women did not: financial commitments. The potential costs to businesses and communities were a major hurdle to overcome and the new draft of the ADA addressed this issue head-on. For example, in a departure from the original draft, only newly built or renovated buildings would have to be made accessible, ensuring that costs would not be overly burdensome to businesses, that is, when done in the course of a larger project, these accomodations would add negligible costs. However, as is almost always the case when drafting legislation of this scope and impact, attempts at moderation to make it more politically acceptable had its negative consequences. Specifically, proponents became anxious that too much ground was being conceded while opponents remained concerned their views still are not being properly taken into consideration. Thankfully, this is exactly what the legislative process is designed to address and overcome.

The Americans with Disabilities Act was introduced in the Senate on May 9, 1989, with a bipartisan group of 33 Senators as original cosponsors. Congress highlighted four main policy goals it aimed to achieve with this legislation: (1) equality of opportunity, (2) full participation in society, (3) independent living, and (4) economic self-sufficiency. These four goals were consistently identified over the years by the constant work of the disabilities rights advocacy community, meaning the advocates were able to set the agenda in Congress through efforts to highlight the persistence of discrimination and unequal access to the basic things those without disabilities take for granted. Over the course of the next week, the Senate Committee on Labor and Resources and its Subcommittee on Handicapped held

several hearings that explored the need for this comprehensive legislation. Included as witnesses were a wide range of key stakeholders, including disabilities rights advocates, business leaders and even Senator Bob Dole, the then-Senate Minority Leader, and Richard Thornburgh, then-Attorney General of the United States.

Throughout the course of these hearings, the Committee heard testimony outlining the historic patterns of discrimination facing people living with disabilities. Coupled with outside reports compiled by groups like the National Council on Disability and the Civil Rights Commission, the Committee realized that the same core issues remained: individuals with disabilities have lived in isolation from the larger society; discrimination against people with disabilities is prevalent in the key areas of private sector employment, public services and accommodations, transportation, and telecommunications; the laws, both on a state and federal level, were inadequate to protect against this type of pervasive discrimination; people with disabilities occupy a significantly lower status in most aspects of society, including socially, educationally, and economically; and, that as a result of all this, people with disabilities are denied equal opportunity. The need for comprehensive legislation addressing these persistent inequities was made abundantly clear.

Defining the ADA

In order to fulfill the four main goals of the legislation, it was broken into three major components, or titles. The first dealt with *discrimination in employment*. In order to address the blatant discrimination many individuals with disabilities were facing when it came to finding jobs—jobs for which they are qualified and can successfully do—the law requires that potential employers would no longer be able to discriminate when it comes to applying, being hired, being promoted or being fired because of their disabilities. This includes requiring an employer to make what is known as a "reasonable accommodation" to the work environment that will allow a qualified person to perform the functions of their job. Examples of this could include modifying work schedules or getting office equipment or a translator to allow for full communications. An example that was often cited in the past, although outdated in today's world, is that of a deaf secretary. If the main duties of a secretary are answering phones and filing documents, then a reasonable accommodation would be to have a hearing secretary work the phones while the secretary with the hearing disability focused solely on filing. In today's office environment, with the advancement in technology, it is easier than ever to find reasonable accommodations for employees with disabilities, and at an ever-decreasing cost.

The second title of the bill deals with *ensuring equal access to all public facilities, including public transportation*. This includes all state and local government agencies and entities, such as a state department of motor vehicles, the police and fire departments, and government employment. This is a departure from the previous Sec. 504 regulations, which were only applicable to agencies of the federal government. This section also includes public transportation systems that were owned or operated by the state or local governments. Transportation is an undeniably important aspect of life, and without access to reliable transportation it becomes

nearly impossible to maintain employment or live an independent life. Recognizing this, the ADA specifically requires that all public transportation be made accessible to those with disabilities. During the debate on this provision, many were concerned with the costs this would impose on local transit authorities. A compromise was reached that only new buses, trains, and other vehicles be made accessible. This prevented the need for existing vehicles to be retrofitted to ensure accessibility, which if even structurally possible, would have proven to be overly expensive. However, in order to ensure those with disabilities did not have to wait for their local buses to be upgraded—something that could have taken years—transit authorities were required to immediately provide "paratransit" options, such as accessible vans, to those who could not otherwise access the public transportation.

The third title of the bill, and perhaps the most transformative part of the law for those with disabilities in America, was the requirement that *all "public accommodations," commercial facilities and facilitates related to occupational or educational purposes be made fully accessible to people with disabilities*. The range of facilities impacted includes publicly accessible places like restaurants, hotels, shopping centers, laundromats, doctors' offices, hospitals, theaters, libraries, parks, zoos, day care centers, and bowling alleys. As with the public transportation section of the law, concerns were raised about how these entities, especially the smaller businesses, would be able to afford the renovations to their facilities to ensure accessibility. In a similar manner, compromises were made that required only new buildings and those undergoing renovations to be required to be fully accessible. Existing buildings were still required to make efforts to remove any barrier, if such an effort was readily achievable. In this way accessibility was significantly increased and improved for those with disabilities.

The final major provision of the ADA addresses the critical issue of *telecommunications*. This section required all telecommunications companies to provide functionally equivalent services to persons with disabilities affecting their hearing and speech and represents a groundbreaking advancement for affected individuals. As a result of this requirement, telecom providers established the TTY (teletypewriter), TDD (Telecommunications Device for the Deaf), TRS (Telecommunications Relay Services), and VRS (Video Relay Services), which have allowed millions of Americans to more easily communicate. With the advancement in communications made possible through the internet, this functionality far exceeds the expectations of those in the late 1980s when the ADA was being drafted.

Within 14 months of the bill's introduction in the Senate, which is a noticeably quick timeframe for a bill to move through the legislative process, the Americans with Disabilities Act was signed into law by President George H.W. Bush on July 26, 1990.

The Individuals with Disabilities Education Act (IDEA)

While the ADA is the more widely known disability law, it is not the only major disabilities law to use the Rehabilitation Act of 1973 as the precursor. In 1975, the Education for All Handicapped Children Act (P.L. 94-142), now known as the Individuals with Disabilities Education Act (IDEA), was signed into law to

guarantee children with a disability are able to receive a free public education.[2] Prior to the enactment of IDEA most disabled children were denied access to public school. In fact, many states had laws in place explicitly forbidding them from attending school. Most children facing discrimination were those with developmental disabilities and emotional disorders, however states routinely denied access to regular public schools for blind and deaf children, as well.

It is important to point out that the history of civil rights in America was in large part the story of the struggle for equal education. Some of the major milestones in the history of advancing civil rights include the Supreme Court's *Brown v. Board of Education of Topeka Kansas* ruling on segregated classrooms, and school integration. Civil rights pioneers like James Meredith, the Little Rock Nine and Ruby Bridges (who is the subject of a Norman Rockwell painting currently hanging in the White House) were simply students seeking equal access to the fundamental right of an education. And of course the story of Ed Roberts' struggle to attend the University of California, a struggle that helped spawn the disabilities rights movement, was also undertaken in order to gain the right to an education.

As outlined in the law, the IDEA is designed "to ensure that all children with disabilities have available to them a free appropriate public education that emphasizes special education and related services designed to meet their unique needs and prepare them for further education, employment, and independent living … to ensure that the rights of children with disabilities and parents of such children are protected; and … to assist states, localities, educational service agencies, and Federal agencies to provide for the education of all children with disabilities." In this respect IDEA serves two roles: one is a law that grants the authority to provide funding; while the other is, like the ADA, to act as a civil rights law.

Congress determined four main issues that necessitated a law be passed to ensure children with disabilities had access to public education. *First and foremost was an increase in awareness that this need existed*. In an eye opening report by the then-Bureau for the Education of the Handicapped it was shown that of the estimated eight million children in the country with a disability at the time, less than half were receiving an "appropriate" education, while an additional 1.75 million had no educational services at all. The report also showed that 2.5 million children with disabilities were actually receiving "inappropriate" educational services. These statistics spurred significant debate in Congress about the need to remedy "the failure to provide a right to education to the handicapped children," because "education is basic to equal opportunity and is vital to secure the future and prosperity of our people."

The second issue Congress noticed, as a result of several court rulings, was that *denying children with disabilities access to public schools was a violation of the children's constitutional rights*. In what seemed like a growing judicial movement, courts across the country were ruling to affirm a child's right to a free and equitable public education and stating that state laws excluding them from the public schools and denying them the ability to argue for that right were in direct violation of the

[2] For the sake of simplicity and consistency, the Education for All Handicapped Children Act will be referred to by its current name, the Individuals with Disabilities Education Act or IDEA.

Constitution. In one case[3] the court stated that children with disabilities who were statutorily prohibited from attending public school "established a colorable constitutional claim" that their rights were being infringed. In a case that followed,[4] the court found that children who had been determined to have emotional disturbances, mental retardation or were hyperactive, and were subsequently expelled from school without a hearing or any appeals process had their due process rights violated. Together these two rulings set the stage for further action to ensure that children were guaranteed both the right to attend school, and a process to appeal any denial of that right. By the time Congress was debating IDEA, dozens of similar cases had worked (or were then working) their way through the legal system, all with the overwhelming view that excluding children with disabilities from the classroom was a violation of Constitutionally protected rights.

While ruling that it was unconstitutional to deny children access to the classroom, the courts did recognize *the question of funding and the ability of school systems to provide the necessary services to these children* as the third issue necessitating legislative action. As a result, the third reason Congress determined that IDEA was necessary was to provide schools with the resources they needed so the question of adequate financial resources would no longer prove a valid excuse for denying these children a proper education.

As frequently happens during debates on education, the debate centered heavily on the role of the federal government when it comes to the predominantly local issue of education. In the end the proponents of federal action prevailed, arguing that the need to provide an education to this population of children—as well as the growing judicial consensus that denying them such access was unconstitutional—was so great that *only* the federal government could ensure the schools were provided with the resources they needed to provide the free and adequate public education.

The fourth issue Congress recognized was both politically practical as well as socially beneficial. In what might seem an anachronistic way of seeing the issues, it was argued that *providing children with disabilities an education would afford them the skills and opportunity to become productive members of society* rather than spending their entire lives as a "burden" on others. This notion was not new; as Ed Roberts recognized from early on that an education was the key to successful independent living. The evidence at the time also bore out this theory, showing that an education and equal opportunity for success decreased the need for institutional care and thus, a decrease in the costs associated with those institutions.

Together these for main issues—(1) an increase in awareness of the need to provide an education to children with disabilities, (2) a growing consensus in the courts that an education was a constitutional right, (3) the need to provide funding to schools so they could provide an adequate education to this population, and (4) the long-term benefits that an education provides—were enough to push the IDEA legislation through Congress and signed into law.

[3] *PARC v. State of Pennsylvania, 343 F.Supp. 279 (E.D. Pa. 1972).*

[4] *Mills v. Board of Education of the District of Columbia, 348 F. Supp. 866 (D.D.C. 1972).*

As with the ADA, the IDEA significantly advances the cause of disabilities rights through the simple concept of acknowledging the need to protect the rights of the disabled. Prior to these laws, those with disabilities—ranging from children being denied access to schools, adults being discriminated against by employers, and those of all ages facing difficulties in accessing transportation and communications—were seen as burdens on society, outcasts, and preordained to live unfulfilled lives of solitude and neglect.

Defining Disability

One of the more important aspects of any civil rights law is how to define the individuals it seeks to protect. This is especially true for groundbreaking laws for which there does not exist any legal precedent. In setting out to define "disability" as it would apply in law, the authors of the Americans with Disabilities Act sought to find a definition that would be inclusive as well as understanding the sensitivities surrounding the terminology historically used to describe those with disabilities. However, the specifics of how disability would be defined in the ADA was critical for an additional reason, which would not be fully realized for several years after it was signed into law: reinterpretation of its meaning by the Supreme Court.

Throughout history we have assigned terms or phrases to certain groups of people as a way to categorize society. At times this can be a relatively harmless practice, such as deeming those with darker hair as "brunettes." However, and unfortunately more frequently, this practice is used to marginalize, subjugate and oppress those who do not easily fit into the general norms of society. For example, terms have been used to categorize people based on their race, gender, ethnicity, sexual orientation, and for those with a physical or mental disability.

As scholars have noted,[5] the general definition of "disability" carries a unique characteristic: it is defined as a predominantly medical term. On one hand, keeping this term within the realm of the medical has meant that the medical establishment has worked on ways to improve the conditions and wellbeing of those with disabilities, a decidedly positive outcome. However, this definition has also lead to disabilities and people with disabilities being seen as something that can be "treated" or even "cured." This can lead to a focus on the disability at the expense of the individual, and the individual at the expense of society-wide issues that lead an individual with disabilities to have different life experiences. As a result, this interpretation of the word could be used to categorize certain people with "fixable" traits or characteristics which broader society deems abnormal or even deviant. The failure to fix or obscure the disability, therefore, is a reflection on the individual and their own lack of effort, not on a lack of available medical remedies or the inherent social bigotry against those with disabilities.

The terms "disability" and "individual with a disability" are the currently accepted terms in both public policy and general society. This represents an

[5] Linton, Simi. Reassigning Meaning—The Disabilities Studies Reader.pg.224 et seq.

evolution from the previous terminology "handicapped," which fell out of use towards the latter part of the twentieth century, as well as the more derogatory term "crippled." (For example the National Council on the Handicapped was renamed the National Council on Disabilities in 1988.) To this end, the ADA updates the definition used in the Rehabilitation Act of 1973 and the Fair Housing Act—along with the subsequent regulations issued from these laws—by changing "handicapped" to "disabled" and "individual with handicaps" to "individuals with disabilities." This seemingly superficial change to the law's language signified an advancement in the understanding of disabilities and disabilities rights previously unseen in federal law. The academic debate about the inherent meaning behind the word aside, when it comes to making federal law, the adoption of the word "disability" marks progress in how the law recognizes, and interacts with, the disability community.

The change from "handicap" to "disability" was done explicitly and expressly because "Congress has been apprised of the fact that [for] many individuals with disabilities the terminology applied to them is a very significant and sensitive issue."[6] By adopting the phraseology preferred by the disabilities rights advocates and doing away with the previously used, and well ensconced, term "handicapped," the ADA indicated a shift in attitude and understanding that in itself can be considered a victory for disability rights.

As the final language in the ADA states, the definition of an individual with a disability hinges on three key factors:

1. A physical or mental impairment that substantially limits one or more of the major life activities of such individual;
2. A record of such impairment; or
3. Being regarded as having such an impairment.

On the practical side, it is impossible to specify every single disability or iteration of a disability that one might have and which could be protected under this law. As such, the first prong of the definition of "physical or mental impairment" is designed to allow for both flexibility as well as limitations. For example, variations in hair color would not satisfy the definition, but a condition such as epilepsy or being infected with HIV would. Additionally, the first prong of the definition requires that the disability "substantially" limit one or more major life activities, further defined as caring for one's self, performing manual tasks, walking, seeing, hearing, speaking, breathing, learning, and working. The limitations one faces in performing these daily life activities is a critical component of the law that is later visited by the Supreme Court in ways Congress did not originally intend.

As explained in the ADA's accompanying committee report "a person who is paraplegic will have a substantial difficulty in the major life activity of walking; a deaf person will have a substantial difficulty in hearing oral communications and a person with lung disease will have a substantial limitation in the major life activity of

[6] Committee Report on ADA pg 21.

breathing." However, the law is careful not to include things that could be considered fleeting or otherwise trivial impairments, such as a broken finger or an infection.

The second prong of the definition—that an individual have a record of such impairment—was included to protect those who might have "recovered" or successfully treated a condition that had caused substantial limitation in the performance of major life activities. Additionally, this section of the definition protects against those who have been mischaracterized as having a disability. For example, if someone is successfully treating their depression with medication and/or therapy, or if someone has been mischaracterized as having a developmental disability, then they are afforded the same protections against discrimination under the law.

Finally, the third prong of the definition takes a rather novel approach in that it also covers someone who is regarded as having a covered impairment. That is, it is not necessarily required that a disability substantially limit one's major life activities if the *perception* is that it does. This is also the case when a disability would not limit life activities if it were not for social limitations placed on the individual as a result of the disability. This is the crux of a comprehensive civil rights law: protecting against discrimination not just for those who were discriminated because of the presence of a disability, but also to those who were discriminated against because of perception of disability.

As mentioned above, the intervening years after this definition became federal law saw several legal challenges to the ADA mount, including 20 cases decided by the Supreme Court. In this series of rulings, in which the Court tended to focus more on who qualified as "disabled" and less on the discriminatory acts they faced, the Court significantly limited the scope of the definition of disability and thereby the reach of the law's protections. These rulings forced Congress to pass the ADA Amendments Act in 2008, which further clarified the original congressional intent and ensured that the Court could not continue reducing the law's impact and reach.

In 1999, less than a decade after the ADA became law, the Supreme Court ruled in three cases addressing the definition of disability and which individuals were considered disabled. In *Sutton v. United Airlines,* and some related cases, the Court ruled that determining whether or not a person is disabled has to take into account the availability of mitigating circumstances, such as whether or not that person can control the effects of the disability with medication or other therapies. As the Court reiterated in its opinion, it found that under the ADA's definition, "'a disability' exists only where an impairment 'substantially limits' a major life activity, not where it 'might,' 'could,' or 'would' be substantially limiting if mitigating measures were not taken." In effect, this stated that if a person is able to lessen the impact of their disability's effect on their major life activities, then they do not qualify as protected under the ADA and are therefore not protected against discrimination on the basis of that disability. This determination, in conjunction with the Court's interpretation of the ADA's "findings" section that there were 43,000,000 people in the USA (in 1990) living with a disability, resulted in the Court finding that Congress "did not intend to bring under the statute's protection all those whose uncorrected conditions amount to disabilities." Further, in the case *Toyota Motor Manufacturing of Kentucky v. Williamson*, the Court unanimously ruled that the law's requirement

that a disability "substantially limit" major life activities meant that those disabilities which are only "minor" in nature do not qualify an individual for protection under the ADA. This is an unfortunate interpretation of a civil rights legislation. Imagine if the Court ruled that protection under the Civil Rights Act hinged more on proving you were a racial minority and not whether or not you were forced to sit at the back of the bus or use a separate water fountain?

In order to correct this serious misinterpretation the American's with Disabilities Act Amendments Act (ADAAA) explicitly reversed the Courts findings in these cases and reasserted that the original intent of the Americans with Disabilities Act was to be as comprehensive and inclusive as possible. As stated in the Committee Report, "the [ADAAA] intends to lessen the standard of establishing whether an individual has a disability for purposes of coverage under the ADA, and to refocus the question on whether discrimination on the basis of disability occurred."[7] This ensures that people facing discrimination as a result of their disabilities no longer have to fight to prove their sufficiently disabled, a move that shifts the burden back to where it belongs: on those who discriminate to prove they are not being discriminatory.

Another example of the Court's narrow interpretation of the ADA is a case brought by a Michigan woman with cerebral palsy, *Holt v. Grand Lake Mental Health Center, Inc*. In its decision, the Court determined that because the cerebral palsy only affected speech, eating and chewing, and getting dressed, but did not affect all other manual tasks, it was insufficient to qualify as a disability under the ADA. Again, the Court took this case as an opportunity to further limit the law's protections by making it harder to qualify for those protections. Again, in order to reverse the Court's misinterpretation of the law, the ADAAA made it explicitly clear that the law only requires a disability to affect *one* major life activity, not *all* major life activities.

When looking at the Individuals with Disabilities Education Act, however, we see the need for an entirely different approach to defining the population covered under the law. The ADA includes what is called a functional definition. That is, the definition relates to what actions an individual with a disability can or cannot do, the limitations on their major life activities. Under IDEA, however, the law provides for a categorical definition that encompasses children in need of special educational or related services.

The law states that a child with a disability is one with "mental retardation, hearing impairments (including deafness), speech or language impairments, visual impairments (including blindness), serious emotional disturbance … orthopedic impairments, autism, traumatic brain injury, other health impairments, or specific learning disabilities." The definition goes on to require that if a child is in one of these categories they must also be, as a result, "in need of special education and related services." Further regulations issued after IDEA became law expanded on this definition to include things such as chronic or acute health impairments like

[7] ADAAA Committee Report Pg. 7.

asthmas, attention deficit disorder or attention deficit hyperactivity disorder, and Tourette syndrome.

In another contrast to the ADA, the court's ruling on the definition of a covered child in IDEA have not necessarily focused on who qualifies as disabled, but rather on whether or not there is an actual need for special educational services. The case of *L.I. v. Main School Administrative District No. 55* found that a child with Asperger's Syndrome, as well as some additional social and emotional disorders, was considered in need of special educational services even though she was highly intelligent and a had high academic achievements. The court found that under the definition in IDEA a child's disability was not required to "significantly impact educational performance" to necessitate special educational needs. This important distinction ensures that a child's disability need not prevent them from high academic achievement, making the sky the limit for children seeking to attain an education and fulfill all their hopes, dreams and aspirations of a successful life.

Future Considerations

The generation of children with disabilities who grew up after IDEA demanded equality in larger society, which resulted in the ADA. In the same way today's generation has grown up in a post-ADA world with more accessible public spaces, full access to transportation, and unprecedented ease in telecommunications. However, they are still struggling towards seeing total equality of opportunity, full participation in society, independent living and economic self-sufficiency. While our nation's infrastructure is readily accessible, the job market has been persistently resistant towards equality of access. Even with the passage of the ADA and IDEA, there is still no significant improvement in the employment data for people with disabilities. In fact, data show that less than 1 in 3 disabled people participate in the work force. This means only a third of working age individuals with disabilities are either employed or seeking employment, compared to 80 % of the non-disabled population. This ongoing disparity is the next big obstacle to overcome on the road to full equality for people with disabilities.

While there is no disputing the fact that there is a disproportionately high unemployment rate among the disabled population, there is less agreement on why this is the case and what we can do to get closer to full employment for people with disabilities.

The Great Recession that started in the late 2000s, while deeply affecting all aspects of our economy, was particularly devastating for workers with disabilities. At the height of the recession's impact, workers with disabilities were leaving the labor force at an astonishingly high rate of five times that of non-disabled workers. By December 2010 the disabled workforce decreased by more than 10 %, seeing more than 600,000 people out of work. And this is not for a lack of desire on the part of this population to get back into the workforce. Studies have consistently shown that fully 80 % of the people with disabilities surveyed want to work, to be productive and contributing members of society. There are a number of potential solutions to help spur employment opportunities to the disability community, including

prioritizing disability-owned businesses for government contracts, establish programs that will help improve supports and services for young adults with disabilities as they enter the workforce, incentivize states and local entities to build the infrastructure in long-term support that people with disabilities will need to have a stable, productive life.

Congress is working on developing legislation to address this issue that builds off the successes and advancements in disabilities rights that started with the Rehabilitation Act, the Individuals with Disabilities Education Act and the Americans with Disabilities Act. The passage of these landmark laws brought with them not only legal recognition, but also the understanding that our country would no longer tolerate the bigotry of the past. It is often difficult when examining the history of social progress to determine if social progress changes the law or a law forces social progress to be made. Either way, it is safe to say that we as a country have made significant progress in recognizing the rights, capability, hopes and aspirations of those with disabilities. The next step towards full workforce integration, a complex and difficult task to achieve, is not impossible. All we need is the political courage, social pressure and the underlying will to continue fighting for what is right, to stand up and declare that inequality of any kind is not going to be tolerated, and to further strive towards the more perfect union. Our nation's history is built on a record of expanded rights, increased equality, and a continuation of opening up to ensure all people have a chance at fulfilling their hopes and aspirations.

Living After Brain Changes: From the Patient's Perspective

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Compiled by Nancy D. Chiaravalloti,
Written by Meg Balter, and Bob McGee

Life with Multiple Sclerosis

Meg Balter

I am a 54-year-old woman who has had MS for 33 years. I was diagnosed at age 21, in the prime of my life. Life has taken me through many challenges, but this was not a challenge I was ready to take, not one I was not prepared for at the age of 21. I was a recent graduate of nursing school and was at my first job as a Registered Nurse in a large suburban hospital. I traveled, skied, rode a motorcycle, played softball for the hospital, and was generally glad to be living life. I had my own apartment … was on my own … life was good. All I ever wanted to be was a nurse—my friends were jealous, I knew what I wanted out of life.

I was the second oldest of six children in a close Catholic, Italian, Irish, German, Polish family! My mother had Lupus most of my life so I knew what responsibility was at an early age. I knew that I wanted to be a nurse.

While working at the hospital I met my husband David, a Pharmacist. He is a patient and loving man. While we were dating I was diagnosed. He was there from day 1. We were playing tennis and I could not feel my legs, they went numb…the more we played, the worse it got. He knew there was something grossly wrong.

This chapter is a compilation of vignettes from various patients living with neurological illness and injury. It is included to afford the patient or caregiver an opportunity to hear of the challenges faced by others and how they overcame many of these challenges. We hope this chapter will motivate patients and caregivers to work to maximize their functioning and live the highest possible quality of life. Most of all, we hope this chapter helps persons living with brain illness and injury to not lose hope.

–Nancy D. Chiaravalloti

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First we went to an orthopedist, then a neurologist, to a specialist in New York City, more tests, and finally a diagnosis, Multiple Sclerosis. Back then there were no MRIs or CAT scans, it was lumbar punctures and myelograms.

Given the prognosis, David married me, knowing what might come.

The first year of marriage was bliss, until paresthesia from the waist down. How does this work? Not fun. With time it resolved. We went through genetic research for future plans for children, we were told to go ahead. With God's help we had three beautiful boys, the pregnancies were good. With David's help at midnight feeding's we made it through. I still had numbness, spasticity, fatigue. I had exacerbations and remissions. I was an assistant coach for little league baseball and soccer, taught CCD for 17 years. I still work on a local access Cable TV show for "A Dominican Way," participated in all the elementary and high school duties and kept to my workout routine.

David was always researching to find ways to make my life easier, to find answers and minimize the impact it had on our lives.

MS has changed my life. I set out to be a nurse. I was a charge nurse at a hospital until I could no longer function at a safe capacity for my patients. Memory impairment halted my career. Leg pain and incoordination ended my career.

I studied very hard and I really hate the fact that a disease ended my aspirations for a fulfilling career in nursing.

But here I am now, happily married 29 years with three grown men. My children and my husband know me well. At times I confuse words, numbers and often I do not realize this. My family is supportive of my "style of speaking" and my "style of memory" (DO NOT ask me about the checkbook incident when I was so sure all the numbers ADDED UP!)

Through involvement in research, I learned techniques that help me with daily living. I can now remember more of what I need from the grocery store because my son knows to say "I need super foamy shaving cream because I have a class picture tomorrow" instead of saying "I need shaving cream."

I can ask him ten times if he has homework tonight and not remember. It is just as frustrating for him as for me!

Life has changed because of fatigue. I have learned to pace my day and take needed rests. I almost never stay out late; it makes the next day a disaster for me. David and I will go to a party and if it starts getting late we leave, whether dinner was served yet or not. I do not go on any thrilling rides at Disney, or watch scary movies, it only makes me tingly and weak for a few days; it is not worth it. Avoiding heat can be a challenge, but it absolutely is a must. No hot tubs, baths, or long days on the beach. If I am out in the sun during the summer I am in the pool or the ocean.

Life has changed because even though I am a chatterbox, I am quiet in crowds or at meetings because I cannot express what I want to say, my words come out mixed up and people look at me strangely.

I may be in that exercise class at the gym, I may be giving it my all, but thanks to supportive friends and instructors, they look the other way when I am doing half. Hey, it is MY best!

Meditation, biofeedback, and self hypnosis, all help with pain control. I learned them from a doctor in NYC and they have all helped me at various times in my life, especially during labor and delivery. I could not have an epidural, so without these tools, it would have been a whole different experience.

Through over 30 years of having MS, it is a challenge finding a balance. There are sometimes new scientific findings that could impact my life … what to do, what not to do … what to eat, what not to eat … how to take vitamins or the newest cure or remedy. I have found that the best for me is to stay on a balanced low fat diet, exercise, rest and to try to minimize stress. Reducing stress is not always easy with a household full of boys, but it is a fun house none the less.

Someone once told me never stand if you can sit, never sit when you can lie down, and when you see a bathroom, use it!

When I get symptoms, I shut down! If I do not, the symptoms worsen and I know from past experience that means medication, physical therapy, and an alteration of my life.

My goals have definitely changed since I was 21, overcoming difficulties is definitely a challenge, but the joy of life is present every day, in the faces of my husband David, and my sons Christopher, Evan, and Brett.

Life After Stroke

Bob McGee

On July 17th, 2009 I was chasing my small dream. I was trying to win the club championship at my golf club. I arrived at the course "juiced" to say the least. I had lost a very close match the year before and I was determined not to let that happen again this year. I had practiced all week even going so far as to take a lesson from my local pro. I arrived at the first tee literally shaking from nerves and anticipation. I was determined to win. I got off to a shaky start, going, one down fairly early in the match. By the sixth hole, I had completely reserved my fortunes and was now one up. Because of the format of the match this was the eighteenth hole on the golf course and fortunately for me it was right next to the clubhouse. I putted out on 18 and pulled the flagstick for another gentleman in our foursome.

It was at that moment that I felt as if I had stuck my finger in a light socket. My entire left side felt as if it were buzzing. I felt no pain at all, I heard the someone say "OK you can move away from the hole now" I didn't know where I was. I was buzzing and totally disoriented. I walked under my own power to the golf cart some 50–100 yards away. I became aware of the fact that my left eye wasn't blinking. It was as though it was wide open and there was nothing I could do to shut it. I sat down in the cart in the seat usually occupied by the driver. When my partner came to get in the cart he asked me to move over, I tried but I couldn't move. I felt as though my left side were a block of granite. He literally shoved me over so that he could get into the cart. I was then brought to the clubhouse. Paramedics were summoned. They sat me down in a large chair in the Pros' office and gave me water to drink and began to towel me down. I was sweating profusely. I was starting to feel weak and my left eye was wide open and would not blink. I could hear sirens.

As the ambulance pulled up I could hear people speaking in a very hurried fashion, doors opening and slamming shut I heard more sirens, police were arriving now. Paramedics came in with their first aid kits. One paramedic sat down in front of me and asked me to smile. I struggled to do so but the left side of my face wouldn't cooperate. He then asked me to shrug my shoulders again my left side wouldn't move much. He then asked me to squeeze his hand, which I did, quite weakly. I had no strength in my left hand. I recall being put on the stretcher and loaded into the ambulance. As we rode to the hospital, I could see out the back of the ambulance and I remember thinking,

> *"of all these people out here, why me? I had been doing all the right things. I had lost 25lbs since 2001. I was working out at least three days a week. I was playing golf two-three days a week. I hadn't had a drink or a drug in 18 years. I hadn't smoked in 16 years. My eating habits had improved over the years. Why me?"*

In the ambulance I was totally aware of my surroundings. The first thing I remember was when the paramedic inserted the needle in my left hand. The gravity of the situation began to overcome me and the feelings of helplessness and hopelessness began to set in. I asked the paramedic if I was having a stroke. He told me to lay back and relax. I took that as a yes. Isn't that what they always tell you when you are in deep trouble? The anger began to set in. Why couldn't I just get in my car and go home and be among the masses of people fighting the traffic on this otherwise beautiful July day? The Paramedics were communicating with the hospital. I began to hear things like "blood pressure 220 over 110. No involuntary responses left side" My heart sank, would I die?

I thought of my beautiful girlfriend Rona, if ever I needed her, it was now. I had never "needed" her until this moment. I had met her only 21/2 months prior. I made sure the paramedics had her number. I thought of my children. I had left them and their mother only months prior. I thought of my mother and that little smile she would don, to try and convince me she was going to be okay in the months leading up to her death, she never did succeed in convincing me. I smiled at the memory of her feeble attempt to help me through the process. When they wheeled me into the hospital I was still aware that my eye wasn't functioning, not having blinked in some time it was becoming sore from the dryness. I was wheeled up to a large intake area. I could see the paramedic was growing impatient. Finally I heard him say in an irritated fashion "What do you want me to do with this stroke" A very attractive Asian woman dressed in green scrubs, wheeled around and with a look of both horror and incredulity asked "That's a stroke?" She then ordered the paramedics to bring me in to a room not far from the intake area. People came in and began to remove my clothes, which was difficult because my body was soaked with sweat. I remember them taking off my golf shoes.

I must have lost consciousness soon after this point. I spent 10 days in ICU, I remember some very brief glimpses of people. I remember seeing my brother very briefly with tears in his eyes, which moved me quite deeply because my brother is quite stoic. I also remember my good friend visiting and joking about how many strokes he wanted from me when we hit the golf course after I got better. I remember

the day Rona came in and needed to know the numbers on the keypad of my car because the battery had died and no one could get in it. I remember someone shoving a toothbrush in my mouth and hitting my teeth and being very rough. I recall some sort of skullcap with soap being applied to my head to wash my hair.

From ICU I was transferred to rehabilitation. I was given a room on the brain injury unit. Early on I was in a diaper because I could not control my bladder or my bowels. They would shower me on a gurney lying down. I remember being wheeled in to the shower room and seeing myself for the first time in a mirror, my eye was still not closing. It was alarming to say the least to see myself as such. I had come been in fairly good physical shape prior to my stroke, but now my body was lifeless with no muscle tone. I was angry and irritated to say the least. I was not at all happy to be alive. I wished that I hadn't survived, not wanting to deal with any of this. At times I would think about ways that I could commit suicide. I would dwell on it at times. Although I was forced to do therapy I had no interest in participating in my recovery at all. My mind and body were ravaged by this event I wanted to die or at least sleep. But the aides would come in early in the morning and would pull the curtains back, which sounded like a flock of screeching sea birds, That is how the day would begin and at the onset the fear and sadness would begin. Psychologically, it was hell.

I was what they call a hemi. Apparently so much damage had occurred in the right frontal lobe that my left side had a severe deficit. I couldn't sit up without falling over. I was literally like jello. I had no control to hold myself up at all. I would flop to the side when they put me on the mat in therapy; they couldn't leave me unattended. The first day I remember sitting in a wheel chair in the therapy room waiting for my therapist to come get me and I started to topple over nearly coming out of the wheelchair, I could feel myself falling. I started to bang on my wheelchair and began yelling, afraid I would wind up on the floor. My therapist was able to save me, catching me in time as I was headed downward. I was terrified. The next day I was put on the antianxiety medication. I don't recall ever being as agitated and fearful in my life. The medicine seemed to help. I started to feel somewhat calm, my mind started to clear up as well, up till this point my brain seemed very foggy. It was brought to my attention later that I wasn't looking at people on my left side at all. Though I could read I wasn't scanning the page at all to the left. So these were the things they began to work on in therapy.

At some point I began to turn around. I went from being negative and irritable to willing and cooperative and much of that I owe to the incredible therapists who continually pushed me when I didn't want to be pushed. Many told me I could do it when I doubted I could. I went from an outlook of sorrow and pity to gratitude and appreciation. As I started really participate in my own therapy I realized how fortunate I really was. I would see people in the therapy room who were so much less fortunate than I was. I knew I would at some point get out of my wheel chair and walk again, there were so many that wouldn't. I realized how fortunate I was to not have lost my speech or my cognitive ability.

There were times when I thought that I would never regain my ability to control my bodily functions. Fortunately that was not the case. I was taught to dress myself. I dreaded my therapists appearance at 8:00 AM every morning when she would

come in to show me how to get dressed; it was one of the most difficult things I ever did, but certainly one of the most valuable. After I left rehabilitation I went to live with my girlfriend Rona. I remember the day she brought me home, it was cold and rainy and I was in an old wheelchair that she had obtained from someone she knew. To get to her apartment from the parking lot we had to go down a steep hill. Rona was literally slipping out of her shoes. I thought we would both topple over. I was terrified.

The first couple days in her home were difficult. She would go off to work and I would get up with her. I would move to the living room and usually sleep for several more hours. My brain and body were beat up. I was tired. I was scared. Her apartment was very remote. I felt if anything were to happen no one would get to me in time. Rona had just started a new job about ten miles east of where we were living. Rona would leave food for me, which she would make the night before. She was always very helpful with my medication and making sure I had the right pills at the right time. She would also run around and pick up prescriptions for me. At times it would wear on her however. While I was in rehab, Rona would complain about how much she had to do and how time consuming it was and how she was ignoring her own life. She would speak often about needing to do things for herself and how she needed her space. It was a constant struggle for both of us. Rona is an extremely bright woman with a terrific and at times "stinging" sense of humor. Since the stroke I became more sensitive. My inability to not feel slighted by comments she claimed were made to be humorous was a source of difficulty for us and the relationship suffered.

My confidence was not what it had been before the stroke. I could hardly walk. My body was out of shape due to my inability to participate in any kind of exercise. I suffered some strange effects from the stroke. I would laugh or cry uncontrollably at times, depending which emotion happened to be prevalent at that particular time. This made me feel strange, adding to my low self esteem. At times Rona would even mock my laughter which made me feel worse. No doubt caretakers face tremendous difficulties especially because of the dependency of the ill person, which places a tremendous burden on the caretaker.

It seems to me, that any emotion I feel is intensified as a result of the stroke. Anger seems to be an emotion that raises its ugly head quite frequently, accompanied by frustration. I tend to get confused quite easily. My memory is noticeably affected. I forget where I put things. I forget to return phone calls. I forget appointments unless I write them down. I have constant tinnitus. I find myself depressed quite a bit and engage in self-pity. Although, I would say that my attitude toward recovery is good. I am determined to get better and am willing to work hard toward that goal. I try to stay busy. I engage in a lot of social events. I stay very close to my friends, go to the movies and out to concerts. I go to a lot of AA meetings and Al-anon. I have joined a professional networking group. I feel quite a bit of stress now, wondering if I will have another stroke at some point. It is also more difficult to handle my daily activities such as bill paying, cooking, and cleaning. My girlfriend and I are no longer together, which is difficult emotionally. I live alone and that is challenging in terms of keeping my life organized. I feel quite stressed with regard to the future. Prior to the stroke I was in sales, but I have no interest in going

back to that line of work, nor do I have an idea of what it is I would like to do. Though I am collecting a monthly disability check. I worry if I will have enough money. I wonder if I will ever be 100 % physically and emotionally. I hope to go back to driving in the coming weeks and that is a source of concern for me.

The questions that we all face seem more immediate as I recover. I feel quite a bit of pressure in my life. I improve physically but emotionally and mentally I am not as confident. I have trouble speaking in a group I don't feel as confident as I used to. I have a degree of insecurity that I didn't have prior to the stroke. Every time I feel a slight bit off kilter I worry. If every I feel any pain in my head I immediately worry that a stroke is imminent. I don't know if I have another recovery in me. I don't believe I could summon the courage or the strength to go through this again.

Epilogue: Where Do We Go from Here?

It is clear from the various chapters included in this volume that disruptions to everyday life are common across multiple neurological diseases. A careful reading of each chapter shows various difficulties in daily life including challenges maintaining a household, decreased participation in social activities, impaired ability to drive, and difficulty shopping. These daily life challenges lead to decreased independence and a decrease in an individual's overall quality of life, as is evidenced from both research studies and patient report (Chap. 12).

The study of everyday life activities is significantly limited by several factors, most notably (1) the lack of reliable and sensitive measures of everyday life functioning and (2) the lack of a body of research that directly associates commonly observed clinical symptoms with daily life activities. It is thus extremely difficult for clinicians and researchers to offer recommendations to facilitate improved daily life functioning. Importantly, these are factors that can be addressed in future research. The populations we work with are best served by the design of methodologically vigorous studies that seek to systematically address the issues that we remain faced with today.

The lack of reliable and sensitive measures of everyday life functioning makes it virtually impossible to accurately assess daily life functioning in patient populations. Many reliable and valid measures of cognitive functioning, brain function, and mobility exist and are used for both clinical and research purposes in daily practice. However, substantially less attention has been paid to the assessment of a person's daily life and the impact of neurological illness and injury on daily life functioning. This is likely due to the need to address the most threatening aspects of a disease first. As clinical care evolved, initial attention was paid to the medical aspects of the disease. Whether it be injury survival after TBI or stroke, the slowing of disease progression in MS or dementia, or the maintenance of healthy living in normal aging, the initial focus has always appropriately been on maximizing health. As time went on and medical science progressed, we have had the luxury of attending to other aspects of symptom management that are not necessarily related to immediate survival—cognitive functioning, balance, emotional functioning, and

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motor functioning. We have made substantial gains in our ability to assess and manage such symptoms, but what we still lack is an ability to reliably assess and treat difficulties with daily life functioning. Commonly used tests of daily functioning today include the Functional Independence Measure (FIM), the Instrumental Activities of Daily Living (IADL; Lawton & Brody, 1969), and performance-based measures such as the Executive Function Performance Test (EFPT), or the Assessment of Motor and Process Skills (AMPS). These performance-based tests represent substantial advances over our previous assessments (i.e., FIM or the IADL scale). In addition, as cognitive rehabilitation protocols continue to be developed, we are focusing our efforts on increasing generalization of the treatment effect to impact daily life abilities and in some cases administering treatment in daily life environments using new, cutting edge technologies such as Virtual Reality. We are now thinking more creatively and this is certain to result in an improvement in our existing measures of daily life functioning and an increased ability to focus treatment on improving functioning in daily life.

The second limiting factor in regard to our knowledge of daily life activities is the lack of a body of work that directly associates commonly observed clinical symptoms with daily life activities. This is true across disease entities and substantially reduces our ability to evaluate and understand the impact of neurological injury or illness on daily life. Most certainly, an improvement in available measures to evaluate daily life activities will enable a greater understanding of the relationship between symptom profiles and a person's ability to function independently in their daily life. Progress in this realm should thus directly flow from the previous one. We are on the horizon of progress, and continued dedication to increasing our understanding of daily life will certainly lead to an improvement in our ability to help our patients function optimally in daily life environments.

In conclusion, we have shown substantial progress in our recognition of the impact of neurological illness and injury on daily life and the acknowledgement that it is everyday life functioning that is most important to the patients. As we continue to focus efforts on measure development and the development of therapeutic interventions, it is essential that we continue to recognize the importance of daily life and maintain the improvement of daily life functioning as the ultimate goal in rehabilitation.

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