Aspects of Personality Traits and Changes in Different Stages of Dementia Disorders

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Abstract Personality change is part of the dementia syndrome. In this chapter, we aim to outline aspects of personality in different stages of the cognitive continuum towards dementia. Research studies suggest that personality traits may be risk/protective factors for dementia. Personality changes have been reported to appear early in the disease progress, even before the first cognitive signs. It may be part of a psychological reaction to dysfunction, but also directly related to neurodegeneration in the brain. Some cognitive disorders are associated with different patterns of personality change. Premorbid personality may be associated with the expression of behavioural and psychological symptoms (BPSD) in later stages of dementia. The decreased symptom insight in dementia leads to methodological difficulties when assessing personality changes. Knowledge of personality alterations in dementia may help relatives to understand these difficult changes and may be important information for clinicians and researchers to identify the early signs and distinguish between dementia disorders.

Keywords Personality · Dementia · Mild cognitive impairment · BPSD · Alzheimer's disease dementia · Vascular dementia · Lewy body dementia · Frontotemporal dementia · Cognition

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The Multifaceted Role of 'Personality' in Relation to Dementia

Cognitive decline – progressing impairment regarding memory, language, visuospatial, attention and executive functions – is a hallmark symptom of dementia. Other dementia-related changes, such as changes in personality and behaviour, are often described as 'non-cognitive' symptoms.

Personality may be described as 'the combination of characteristics or qualities that form an individual's distinctive character' (Oxford dictionary). Regarding dementia and personality, the first thing that comes to mind may be the rather extensive personality changes associated with specific manifest dementia syndromes such as frontotemporal dementia. That is, personality changes as part of the *manifest* dementia stage. However, personality traits and changes also play a role *prior* to disease onset, as there is some evidence to suggest that certain traits may actually function as *risk*- or *protective* factors in relation to dementia development – before the onset of any brain changes. Personality change may also be a possible *early indicator* of an underlying dementia disorder – after the onset of brain changes but prior to a clinically manifest dementia syndrome – and consequently have a potential value in the diagnostic procedure. Furthermore, there has been reports of an association between *premorbid* personality traits and how behaviour is expressed in the later, manifest states of dementia, e.g. 'behavioural and psychological symptoms in dementia' (BPSD). Personality may also affect *other aspects* of the disease, such as early vs late help seeking and how a person copes with receiving a diagnosis. Thus, aspects of personality may have implications for the risk of dementia, as well as for signs in the prodromal phase and coping and expression of the manifest phase of dementia. In this chapter, we aim to outline aspects of personality in different stages of the cognitive continuum towards dementia and to highlight that personality factors may play a role throughout the development of dementia. Knowledge in this area is potentially important to better understand the often complex symptomatology of different dementia disorders, not the least for caregivers who struggle with the changes of their loved one.

Dementia: Short Characteristics

The World Health Organization (WHO) has estimated the worldwide prevalence of dementia to 47 million, with 10 million new cases each year. As the average life expectancy increases globally, so does the occurrence of dementia. Prognoses indicate that the prevalence of dementia will nearly triple in the next 33 years – to 132 million cases in 2050 (World Health Organization, 2012).

Dementia is not a disease in itself, but a syndrome characterized by progressing loss of cognitive functions, which is caused by an underlying disease. Several different diseases lead to a dementia state, and Alzheimer's disease is believed to be

the most common aetiology. The clinical signs of prodromal Alzheimer's disease dementia usually start with a decreased ability to remember recent events – the episodic memory function. Gradually, other cognitive domains such as language, attention, visuospatial and executive functions are also affected. Besides Alzheimer's disease, many other conditions may lead to a dementia state. The International Classification of Diseases (ICD-10) lists no less than 25 different underlying physiological conditions that may lead to a dementia state, although many are very rare. Some of the most common dementia types following Alzheimer's disease dementia are vascular dementia, frontotemporal dementia, Lewy body dementia and Parkinson's disease dementia (refer to chapter "Personality Stability and Change in Alzheimer's Disease and Major Depressive Disorder" of this book for more about Parkinson's disease). There are also mixed forms, such as simultaneous presence of both Alzheimer type and vascular type dementia. Each different underlying disease implicates a different pattern of progression, neurobiologically as well as cognitively and behaviourally. The onset of neural degradation starts in different anatomical areas depending on specific disease, which lead to different expressions of the diseases.

Most dementia forms progress during years, perhaps even decades. There are still knowledge gaps about the actual neuronal causes of the common dementia forms. Dementia research largely focuses on identifying the starting point of the dementia disorders, especially concerning Alzheimer's disease. There is also still no efficient medical cure for dementia, and treatment options are to date still limited to symptom relief. Eventually, all dementia states lead to a complete loss of abilities.

Changes of the personality are undoubtedly a part of the dementia syndrome and seem to progress in a linear fashion alongside the disease progression (Helmes, Norton, & Østbye, 2013). However, the type and temporal onset of personality changes differ for different dementia disorders. In some dementia disorders, personality change may be an important early sign, while in others such changes appear later in the disease progress. Thus, it is not possible to establish only one type of personality change that is specific for dementia. Disease-specific personality changes have been associated with specific degenerative lesions to brain structures in neurodegenerative diseases (Sollberger et al., 2009). For example, interpersonal traits high in 'agency' (a person's assertiveness towards others) have been associated with left dorsolateral prefrontal and left lateral frontopolar regions, whereas interpersonal traits high in 'affiliation' (social/emotional engagement) were in the same study related to right ventromedial prefrontal and right anteromedial temporal regions (Sollberger et al., 2009).

Dementia: A Timeline

According to a model operationalized as the Global Deterioration Scale (GDS) (Reisberg, Ferris, de Leon, & Crook, 1982), the phases leading to dementia can be divided into seven stages. The seven stages are summarized in Fig. 1.

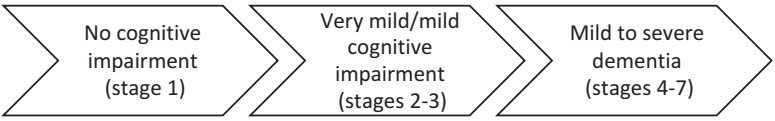


Fig. 1 The progression from healthy to dementia as stages

Stage 1 – *no cognitive decline*. There are no clinical changes, neither subjective nor objective, although neural changes have started for individuals who will develop dementia.

Stage 2 – *very mild cognitive decline*. Neural changes have started, and first cognitive difficulties may be noticeable by the affected individual (subjective cognitive decline) although cognitive tests are still in the normal range.

Stage 3 – *mild cognitive decline.* Decline become gradually more noticeable by neuropsychological tests and family members may begin to notice signs of change. Instrumental activities of daily living such as managing personal finances or meal preparations may be mildly affected.

Stage 4 – *moderate cognitive decline*. Clinical signs are now noticeable by others and can be detected during interview and exam. Instrumental activities of daily living, such as managing finances and personal transportation, are affected. Basic activities of daily living such as maintaining personal hygiene and dressing oneself start to become affected. Social withdrawal is common.

Stage 5 – *moderately severe cognitive decline*. The cognitive and functional problems are now widely spread and affect most parts of everyday activities, such as dressing and bathing. People may have difficulty orientating themselves in time and place and, for example, may forget their own address.

Stage 6 – *severe cognitive decline*. In this stage, people are often incontinent and may also forget the name of loved ones. It is common with delusions, anxiety and agitation. The affected person needs constant care.

Stage 7 – *very severe cognitive decline*. The ability to speak and communicate is lost. Eventually, the affected person can no longer walk.

Aspects of personality are potentially relevant for all seven stages of cognitive decline, in various ways. In the following text, this timeline will be followed to outline different aspects of personality and personality changes related to dementia progression.

Personality Theories

Various different theories and models of personality have been developed during the last century, some driven by psychological or psychobiological theories and other by statistical analyses. An example of the former is Cloninger's psychobiological model of personality which was developed to predict vulnerability to mental disorders proposing that personality is structured in the connection between

neurobiology and temperament (Cloninger, 1986). The 'five-factor model' or 'big-five theory' has perhaps been the most influential model, suggesting that personality may be described as traits that may be more or less occurring in an individual (i.e. dimensions) – as opposed to 'type' – theories that describe personality more in terms of categories.

This chapter is not written from the standpoint of a specific theory or model of personality. The aspects of personality mentioned here rather reflect which models and instruments have been used in related research studies – most often variants of the 'five-factor model'. Thus, we use the term 'trait' throughout the chapter.

Is Personality Stable Across the Lifespan?

The risk of developing dementia increases with age. The global prevalence of dementia in 65-year-olds is approximately 1–2% and 29–64% for 90-year-olds, with large variations for different regions of the world (Prince et al., 2013). Normal age changes are therefore important to take into account when examining possible signs and symptoms of dementia. The personality continuity vs change that may be expected in normal ageing is a large separate research area. In short, earlier accounts often described personality traits as generally stable across the lifespan, at least after the age of 30 (Conley, 1985; Costa Jr. & McCrae, 1988), but more recent research has shown that personality actually may change somewhat throughout the lifespan (Allemand, Gomez, & Jackson, 2010; Allemand, Zimprich, & Martin, 2008; Helson, Jones, & Kwan, 2002; Jeronimus, Riese, Sanderman, & Ormel, 2014; Lucas & Donnellan, 2011; Mroczek & Spiro, 2003; Roberts, Walton, & Viechtbauer, 2006). However, considering the many life-changing events that a person goes through during life, personality can still be considered as remarkably stable (Caspi, Roberts, & Shiner, 2005). The theories about which mechanisms cause the degree of continuity span from genetic influence (e.g. McCrae et al., 2000; McGue, Bacon, & Lykken, 1993) to environmental and psychological factors. For example, people develop a psychological maturity over time, which may enhance certain traits such as agreeableness and openness, while, e.g. neuroticism may be reduced. People tend to create, seek out or 'end up' in specific environments that are correlated with their traits ('niche building'), and people commit to certain identities that provide reference points to life decisions, which may also serve the continuity of personality traits. A key point is that life experiences, such as career choices, does not happen randomly – they are to some extent created by people in a fashion that corresponds to their traits, which are thereby further deepened (Caspi et al., 2005). Specific examples from research on personality in old age suggest that neuroticism decreases during adulthood but later increases in the oldest old (Mroczek & Spiro, 2003) and extraversion was seen to decline in another 79-year-old cohort (Mottus, Johnson, & Deary, 2012). Another study on 80 + -year-olds found that extraversion decreased, whereas neuroticism remained stable (Berg & Johansson, 2014). To complicate the

matter of normal age-related changes even further, there also seem to be cohort effects – for example, individuals born around 1900 scored lower on extraversion compared to cohorts born later (Mroczek & Spiro, 2003).

Personality Traits as Risk vs Protective Factors

Most dementia disorders develop gradually and it is not fully understood when, or how, they begin. Therefore, it is an essential topic of dementia research to investigate potential risk factors, which may play a role for the development of the disease, in – or prior to – early disease stages (Fig. 2). Can certain personality traits increase the risk of developing a dementia disorder? Some studies support such an association (Johansson et al., 2014; Low, Harrison, & Lackersteen, 2013; Terracciano, Stephan, Luchetti, Albanese, & Sutin, 2017; Wang et al., 2009; Wilson et al., 2005). A large US population-based study (Terracciano et al., 2017) investigated associations between personality traits and subsequent dementia in a large sample of over 10,000 50 + -year-old participants. The follow-up time was up to 8 years. The results indicated that low conscientiousness, high neuroticism and low agreeableness were significantly and independently associated with higher risk of incident dementia, also after accounting for age and sex, socio-economic status, health behaviours and clinical risk factors. They also investigated the association between personality traits and conversion from healthy to a milder form of cognitive impairment not yet reaching the dementia state ('cognitive impairment no dementia' – CIND). Persons who declined from healthy to CIND scored higher at baseline on neuroticism and lower on conscientiousness compared to those who did not decline cognitively. Similar results were reported from a 2013 meta-analysis of fifteen relevant studies (Low et al., 2013). It was concluded that higher neuroticism was associated with greater risk of subsequent dementia. Considering specific facets, anxiety and vulnerability to stress, rather than depression, were associated with dementia. Extraversion and agreeableness were not associated with dementia risk.

A memory clinic study from 2015 (Ramakers et al., 2015) reported opposite results. Neuroticism-related traits and rigidity were associated with a *decreased* risk of dementia in this study, while no personality traits predicted conversion to dementia. How can we understand these conflicting results regarding the role of the neuroticism trait in relation to dementia risk? It is likely that a major factor has to do

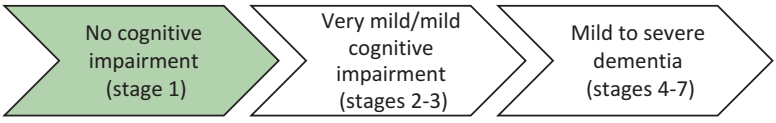


Fig. 2 The current text section highlights aspects of personality/personality changes that may be relevant before or at the stage of 'no cognitive impairment' – that is, prior to clinical symptoms, which corresponds to GDS stage 1

with the type of population in focus. The two most common types of study of dementia risk include on the one hand population-based studies, in which community-dwelling individuals are randomly selected and invited to participate, and on the other hand clinically based studies, which investigate patients who are in the medical health care system because of related health issues – in this case, most frequently memory problems. Dementia disorders are often slowly and gradually developing. The point of help seeking for cognitive problems that could possibly be caused by a dementia disorder largely differs between individuals. Some people do not seek medical help until they are in a manifest dementia state, when they can no longer manage basic activities of daily life. However, memory clinics also frequently see individuals seeking help for very subtle self-perceived cognitive changes, which could potentially be (but often are not) the first cognitive symptoms of a dementia disorder. Subtle memory complaints may be associated to multiple factors – personality is one of them. Once again, a higher level of neuroticism has been associated with an increased prevalence of memory complaints (Comijs, Deeg, Dik, Twisk, & Jonker, 2002). Persons with only subjective cognitive decline still have a somewhat larger risk to develop dementia compared to the general population (Mitchell, Beaumont, Ferguson, Yadegarfar, & Stubbs, 2014). However, studies indicate that the prevalence of depressive symptoms, anxiety and stress is high in this help-seeking group (Eckerstrom et al., 2016; Elfgren et al., 2003), which may be a more plausible cause than an underlying dementia, of their self-experienced cognitive problems. The difference between help-seeking individuals and the general population may explain why population-based studies and memory clinic studies have reported contradicting results. Obviously, high neuroticism is related to a higher tendency to worry and likely also a higher tendency to seek medical care even for very subtle cognitive changes that are less likely to be related to dementia. Therefore, in memory clinic patients, it may be speculated on that high scores on neuroticism may actually be more common in patients who will not decline cognitively.

There are several suggested mechanisms used to describe in what way personality traits induce an increased risk of dementia. Some personality traits may be indirect risk factors, because they increase the probability of the presence of *direct* risk factors for dementia. For example, studies have reported an association between personality traits and the likelihood of cigarette smoking, a sedentary lifestyle and other cardiovascular or metabolic risk factors for dementia (Jokela et al., 2014; Sutin, Ferrucci, Zonderman, & Terracciano, 2011; Terracciano & Costa Jr., 2004). These are known as *mediating factors*. However, the large study from Terracciano and colleagues found that these factors did not fully account for the relation between personality traits and dementia development (Terracciano et al., 2017). An alternative, or perhaps additional hypothesis, is that personality traits modulate dementia through its associations with specific brain changes – whole brain integrity, brain-tissue loss and white matter hyperintensities (Booth et al., 2014). For example, neuroimaging findings have indicated that higher neuroticism is associated with smaller

regional brain volumes and greater decreases in volume with increasing age, while higher conscientiousness is associated with larger regional brain volumes and less decline in higher age (Jackson, Balota, & Head, 2011).

It is also important to acknowledge the methodological challenges associated with studying dementia risk. Dementia is in most cases developed over a long time, with subtle symptoms emerging gradually. This makes it difficult to draw the line between risk factors and symptoms that are more likely to be early manifestations of the diseases. To clarify which factors are actual long-term risk factors, studies need to follow large populations over several decades.

Personality Traits as a Protective Factor Against Dementia

If some personality traits may infer an increased risk to develop dementia, could other sets of personality traits be associated with a decreased risk to develop dementia and thus act as possible protective factors? Higher conscientiousness – referring to being more careful, dutiful, organized and thorough – may be protective against dementia according to some studies (Duberstein et al., 2011; Wilson, Schneider, Arnold, Bienias, & Bennett, 2007). Two studies have pursued to analyse which facets of the conscientiousness trait are specifically related to a decreased dementia risk. Terracciano et al. (2014) found that being *organized*, *responsible*, *disciplined* and *capable* was associated with a lower risk of dementia. Another study reported similar results – high scores on *responsibility* showed the greatest risk reduction, followed by *self-control* and *industriousness* (Sutin, Stephan, & Terracciano, 2017). High scores on these facets were also related to a reduced risk of developing CIND, which is a state characterized by milder cognitive impairment. Higher scores on *openness* have also been associated with a decreased risk of dementia (Low et al., 2013).

What could then be the mechanisms behind this association? As stated previously, one possibility is that certain personality traits during life reduce the risk of engaging in behaviours that are direct risk factors to develop dementia, such as smoking and physical inactivity. However, in the study by Sutin et al. (2017), the association between specific facets of conscientiousness and dementia remained even after accounting for smoking, physical inactivity and low educational attainment. Thus, the complex interrelationship between personality and underlying brain structure may again be part of the explanation for decreased risk. Although several studies have reported an increased or decreased risk for the development of manifest dementia associated with certain personality traits, it is however not clear to what extent personality changes can be directly linked to the underlying neuropathology that is believed to act as the neural basis for dementia disorders. One study based on brain imaging reported that specific regions of the brain were associated with personality-related traits in patients with neurodegenerative disease (Sollberger et al., 2009). Further, the fact that different dementia disorders lead to different patterns of personality change – for example, differences between

temporal and frontal variants of frontotemporal dementia (Rankin, Kramer, Mychack, & Miller, 2003) – implies that there is a relationship between personality and brain structure (Sollberger et al., 2009). However, there are also studies that could not find associations between personality traits and typical dementia pathology (e.g. Wilson, Begeny, Boyle, Schneider, & Bennett, 2011). A possible explanation could be that psychosocial behaviour may modify the association of pathology with cognition (Wilson & Bennett, 2017). In other words, a person with personality traits that, for example, make it more likely to engage in social activities and thus maintain a larger social network may have an increased cognitive resistance to the neuropathological changes.

Personality Changes as Early Signs of a Dementia Disorder

Dementia research is largely focused on identifying early signs of prodromal dementia, that is, objective but mild signs before the dementia has become manifest (Fig. 3). The medical treatment options for dementia are still very limited, but early identification will likely be increasingly important when efficient treatment is developed. Early identification may also give families more time to plan for the following functional decline. One aspect of personality dementia research concerns the hypothesis that there may be changes in personality preceding a dementia diagnosis – thus, not as a risk factor but rather as an early sign of an already ongoing underlying disease that will progress. Such changes could then be potentially helpful non-cognitive clues when trying to establish the correct diagnosis. The results from studies (Ausen, Edman, Almkvist, & Bogdanovic, 2009; Balsis, Carpenter, & Storandt, 2005; Lykou et al., 2013; Smith-Gamble et al., 2002; Wilson et al., 2007; Yoneda, Rush, Berg, Johansson, & Piccinin, 2017) that have examined personality-related changes as possible early signs of dementia are summarized in Fig. 4. Increased neuroticism has been associated with both a higher risk of converting to dementia and with fulfilling the criteria for mild cognitive impairment – the possible transitional stage between healthy and dementia. Other changes that have been reported before the transition to dementia – e.g. increased stubbornness, apathy, rigidity and irritability – borders what could also be assessed as psychiatric symptoms, for instance, related to depression or anxiety, and also the challenging 'behavioural and psychological symptoms' (BPSD), which we discuss later in this chapter.

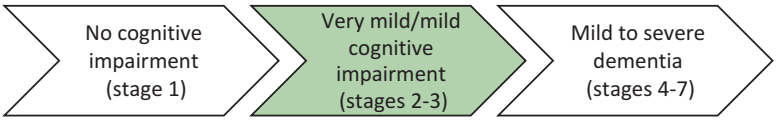


Fig. 3 The current text section highlights aspects of personality/personality changes that may be relevant for the stage of very mild/mild cognitive impairment, which corresponds to GDS stages 2–3

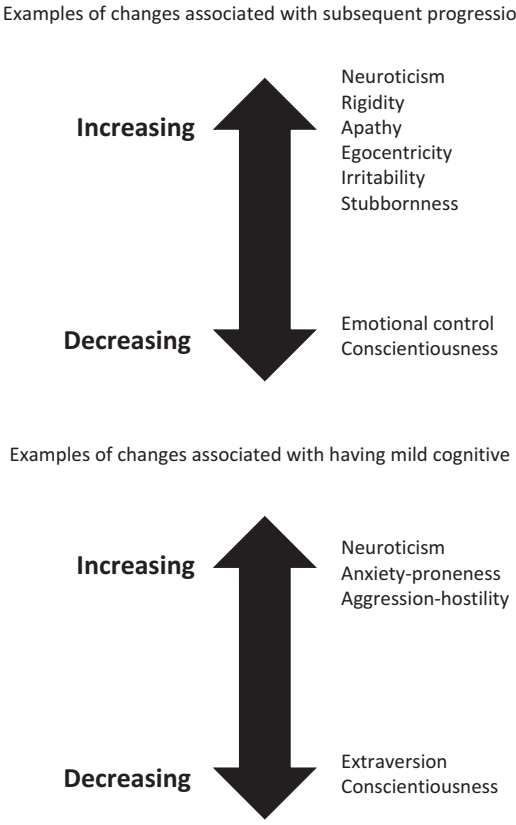


Fig. 4 Personality-related changes as possible early signs of a dementia disorder

Obviously, there is no sharp borderline between changes in personality and long-lasting psychiatric symptoms.

One study also performed post-mortem pathology examinations of the brains of study participants (Balsis et al., 2005). Interestingly, the same pattern of personality changes that was identified in individuals who later progressed to dementia was also frequently occurring in persons who did *not* develop clinical dementia during their lives but who had Alzheimer pathology in their brains (Balsis et al., 2005). These results suggest that personality changes, for some individuals, could emerge even before the cognitive changes, on the progressive continuum towards dementia. However, this is a complicated issue, since it is not possible to know if persons with Alzheimer pathology would remain cognitively intact if they would have lived longer or if they would eventually develop symptoms (Iacono et al., 2009).

Considering extraversion, one study reported that this trait seemed stable in persons who later were diagnosed with dementia (Yoneda et al., 2017), while another study observed that extraversion seemed to decrease, and anxiety proneness seemed

to increase, in persons with mild cognitive impairment (Ausen et al., 2009). In the group with mild cognitive impairment, some but far from all persons will progress to dementia. This clinical group also includes help seekers who have a mild cognitive decline due to other factors than an underlying dementia – such as psychiatric disorders, somatic disease or stress. It is therefore not surprising that individuals with mild cognitive impairment tend to become more socially withdrawn and anxious. Individuals who are close to converting to dementia may already have a slightly decreased insight into their symptoms, which possibly makes it emotionally easier for some individuals to engage in social activities compared to in earlier stages of the disease when symptom insight was at its peak.

Dementia Camouflaged as a Personality Disorder

The process of diagnosing dementia may be hampered when a patient also fulfils a psychiatric disorder that may alter the manifestations of symptoms. For example, presence of a personality disorder may complicate the clinical picture. Researchers often want to include as homogeneous patient samples as possible, to decrease the effects of confounding factors. However, real life is not as simple, and different syndromes often occur simultaneously.

Hellwig, Dykierek, Hellwig, Zwernemann, and Meyer (2012) describe the case of a 61-year-old female patient who presented with a progressive memory impairment. The patient had a medical history of repeated help seeking for symptoms that had generally been assessed as somatoform (psychogenic), as no organic causes could be identified: gastric pain, migraine, psychogenic muscle twitching, limb pain and fluctuating inability of leg movement. Together with other aspects of her behaviour, such as 'theatrical behaviour', inadequate boasting about personal merits, lack of empathy and excessive preoccupation with her physical appearance, she was assessed as fulfilling criteria for a histrionic personality disorder. Consequently, her impaired cognitive performance – which was measured by neuropsychological examination – was initially considered yet another aspect of the somatoform symptomatology. However, subsequent investigations using magnetic resonance imaging, 18F-fluorodeoxyglucose positron emission tomography (^{18}F-FDG-PET), Pittsburgh Compound-B (PiB-PET) and analysis of Alzheimer typical markers in cerebrospinal fluid, showed typical signs of Alzheimer's disease, and deteriorating cognitive deficits helped confirm the diagnosis (Hellwig et al., 2012).

The process of diagnosing dementia is a time-consuming puzzle and often includes several different measures – clinical as well as neuropsychological, brain imaging and neurochemical markers. Furthermore, patients often need to be followed over time to investigate whether the symptoms progress. This case exemplifies the additional difficulties that emerge in cases of personality disorders.

Personality Changes and Expressions of Manifest Dementia

Specific Dementia Disorders and Related Personality Changes

Alzheimer's Disease Dementia

The *manifest* dementia stages (Fig. 5) ranges from 'mild dementia' or 'moderate cognitive decline', which is the first stage of a manifest clinical dementia syndrome, while 'severe dementia' is a term to describe the very last stages of the syndrome, when the abilities to speak, communicate and eventually also to walk, are lost. Dementia of the Alzheimer type is often described as the most common dementia form. The neural changes in Alzheimer's disease include presence of amyloid plaques and neurofibrillary tangles, which lead to neuron malfunction. The typical neural damage associated with Alzheimer type dementia includes atrophy in the temporal and parietal regions of the brain, due to loss of neurons and synapses. Except for a few known genetic mutations, the cause of Alzheimer's disease is still unknown. The brain changes occur for years and perhaps decades before the clinical signs appear. The first symptoms may be merely self-experienced, but will develop into a measurable cognitive decline that often is characterized by a poor ability to recall recent information and events.

Personality changes occur in almost all individuals with Alzheimer's disease dementia and tend to progress alongside the disease (Aitken, Simpson, & Burns, 1999). The changes are often noted even before the clinical diagnosis (Balsis et al., 2005).

The pattern of personality change in Alzheimer's disease dementia has been summarized in a meta-analysis covering nine relevant studies (Robins Wahlin & Byrne, 2011). They outlined four possible different patterns of personality change: (i) an exaggeration of premorbid personality; (ii) the development of a specific Alzheimer disease personality type; (iii) changes that may develop in a stereotypic pattern but still reflect individual variability; and (iv) changes develop without any clear pattern, without reflecting the premorbid personality. However, most researchers seem to argue against the hypothesis of a unified shift in personality that would lead to a converged 'Alzheimer type personality'. Rather, the changes in personality seem to reflect the premorbid personality (Balsis et al., 2005). The most marked change in patients developing Alzheimer type dementia seem to be a decrease in *conscientiousness*. *Neuroticism* is often clearly increased and *extraversion* decreased, while *openness* and *agreeableness* have been observed as modestly

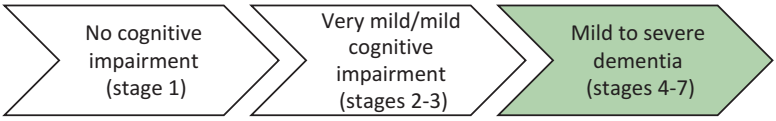


Fig. 5 The current text section highlights aspects of personality/personality changes that may be relevant for the stage of mild to severe dementia, which corresponds to GDS stages 4–7

reduced (Robins Wahlin & Byrne, 2011). Thus, this meta-analysis supported the view of a clear and consistent systematic stereotypic personality change in Alzheimer type dementia, consisting of changes towards a specific direction, but still with maintained individual variability reflecting the premorbid personality. In other words, those who were high on one trait remained high also after disease onset (Robins Wahlin & Byrne, 2011).

Recent studies have focused on the associations between neurochemical Alzheimer disease biomarkers and premorbid personality. Findings have suggested that there is an interaction between personality traits and Alzheimer pathology, which predicts cognitive functioning (Tautvydaite et al., 2017). Possibly, personality traits may affect cognitive reserve (resistance to brain damage), but more studies are needed.

Vascular Dementia

Vascular dementia is the second most common form of dementia (Roman, 2003). It is related to reduced blood flow to the brain which may be caused by a large incident such as a stroke or narrowing and/or blockage of the small blood vessels. Common symptomatology includes, e.g. slowness of thought, difficulties with planning and organizing (executive functioning), depression, gait disturbance, restlessness, confusion and emotional lability. The literature on the vascular dementia phenotype is limited compared to the Alzheimer type, possibly due to debated and unclear boundaries between these two syndromes. Five-factor personality traits in relation to vascular dementia have seldom been investigated. Some findings have suggested that white matter lesions, which are a common finding in vascular dementia, are related to reduced conscientiousness and increased neuroticism (Duron et al., 2014). Early accounts describe personality as ‘relatively preserved’ in vascular dementia, compared to Alzheimer’s disease dementia. For example, relatively preserved personality was listed as a criterion in the Hachinski Ischemic Score (Hachinski et al., 1975), which was previously frequently used to identify vascular dementia. However, contradicting findings suggest that personality traits do in fact change to a similar extent in vascular dementia and dementia of the Alzheimer type (Verhey, Ponds, Rozendaal, & Jolles, 1995). Furthermore, ‘personality and mood changes’ are listed as clinical criteria in the frequently used diagnostic criteria for vascular dementia: the National Institute of Neurological Disorder and Stroke-Association Internationale pour Recherche et l’Enseignment en Neuroscience (NINDS-AIREN) (Roman et al., 1993; Roman, Erkinjuntti, Wallin, Pantoni, & Chui, 2002). These contradicting accounts of personality within the literature on – and criteria for – vascular dementia forms likely have to do with terminology. An increase in emotional lability is a well-established symptom of the vascular dementia phenotype (O'Brien, 2003). That is, changes that could be described as ‘increased neuroticism’ are rather described as ‘increased emotional lability’, and the conceptual boundaries between personality traits and emotional expression are unclear. Taken together, vascular dementia undoubtedly is associated with changes that are likely to be perceived as a change of personality by loved ones, often related to the person's emotional expression.

Lewy Body Dementia

Lewy body dementia (LBD) is often described as the third most common dementia disorder, after Alzheimer type dementia and vascular dementia. The related pathology known as Lewy bodies (after neurologist Frederic Lewy) – consisting of abnormal levels of the protein alpha-synuclein – was observed already in the early 1900s. The disease was not described until much later and the diagnosis was not fully established until the mid-1990s. This is a plausible reason for the, to date, relatively limited amount of studies focusing on this specific disorder. The cognitive symptomatology and brain pathology in LBD is somewhat overlapping with e.g. Alzheimer's disease dementia in many patients, which complicates the diagnostic procedure (Galvin, 2003). However, the clinical picture of LBD frequently displays other specific characteristics. Memory impairment is generally the primary symptom of Alzheimer's disease dementia, but LBD is rather characterized by fluctuations in cognitive functioning. One typical symptom related to early signs of LBD is vivid dreaming, which often is physically acted out by movements during sleep. Another hallmark symptom is visual hallucinations, often in the form of living creatures such as people or animals. Hallucinations in LBD are non-psychotic, as the affected individuals generally are not delusional but are aware that the visions are not real. LBD also includes severe medical sensitivity, which may potentially be life-threatening if patients are misdiagnosed and, for instance, medicated with antipsychotic drugs. These can induce neuroleptic malignant syndrome in patients with LBD, which may lead to kidney failure. Furthermore, LBD is closely associated with Parkinson's disease dementia, both regarding brain pathology and the typical motor symptoms including e.g. gait disturbance and stiffness. The only established clear difference between LBD and Parkinson's disease dementia involves the order of symptoms – cognitive symptoms should present earlier than motor symptoms in LBD, but vice versa in Parkinson's disease. The aspects of personality in relation to LBD are not thoroughly described in research studies. Clinical experience suggests that the personality in patients with LBD is often largely intact for a relatively long time into the disease progress. However, one study (Galvin, Malcom, Johnson, & Morris, 2007) observed some aspects of personality that separated between LBD and Alzheimer's disease dementia patients. Personality-related factors that distinguished LBD were diminished emotional responsiveness, relinquishing hobbies, growing apathy and purposeless hyperactivity. They also found that these changes were associated with presence of visual hallucinations, but not associated with Parkinsonism.

Frontotemporal Dementia (FTD)

The term frontotemporal dementia (FTD) is inconsistently used and debated in the literature, but has previously often been divided into three specific phenotypical syndromes: a behavioural variant (bvFTD) and two temporal variants – semantic dementia and primary-progressive non-fluent aphasia (Neary et al., 1998). Since

2011, new criteria have been published in which the language variants are more distinctly separated from FTD (Gorno-Tempini et al., 2011; Rascovsky et al., 2011) and described as primary-progressive aphasia with three main variants. The age of onset is relatively low – typically at 45–65 years. Neuropathologically, dementia disorders within the FTD spectrum comprise atrophy in the frontal and/or anterior temporal cortex (Neary, Snowden, & Mann, 2005), with atrophy in the right lobe being associated with far more pervading personality changes compared to left lobe atrophy (see Mychack, Rosen, and Miller (2001) for case studies).

The frontal area of the brain, especially the prefrontal area, is central for executive functions such as planning, control, complex attention and impulse inhibition. The prefrontal cortex is usually regarded as the most important neuroanatomical structure for the development of personality. Consequently, neurodegeneration in this area leads to extensive personality alterations, which is also known as a hallmark symptom of bvFTD. One study reported that 50% of patients with bvFTD showed behaviours that could be classified as 'misdemeanours' – especially shoplifting and physical threats (Diehl et al., 2006). The other dementia syndromes related to frontotemporal lobar degeneration – primary-progressive aphasia and subtypes – include atrophy in the temporal region which primarily leads to the specific symptomatology of impaired ability to find and understand words (semantic dementia) or to pronounce words and use correct grammar (primary-progressive aphasia).

Frontotemporal Dementia: Behavioural Variant

Personality change is a core criterion of bvFTD (Neary et al., 2005), and changes related to all five-factor model traits have been reported, e.g. Mahoney, Rohrer, Omar, Rossor, and Warren (2011). Abnormal social behaviour is common. Personality changes appear early in the disease and are often much more pronounced than the cognitive deficits. A person with FTD generally has very reduced insight into these changes (Salmon et al., 2008) which differentiates them from persons with Alzheimer type dementia who generally show more self-awareness regarding personality dimensions (Rankin, Baldwin, Pace-Savitsky, Kramer, & Miller, 2005). Not surprisingly, many persons who are later diagnosed with FTD start out as patients in psychiatric care, because their symptoms are poorly understood (Wittenberg et al., 2008).

A case study published in Military Medicine (Faber, Hill, & Kim, 2003) describes the progression of bvFTD in S.C., a 51-year-old former US air force officer. Previously, S.C. had maintained 'impeccable standards of personal presentation and behaviour necessary for an officer of that rank'. During a 9-year period, his behaviour and personality went through dramatic changes. The first signs, according to retrospective accounts by family members, were subtle but inadequate behaviours – such as hanging up the telephone in the middle of a conversation without warning. During the subsequent years, his behaviour became increasingly impulsive and socially unacceptable: he developed an excessive interest in pornography;

he attended a family wedding unwashed and physically abused one of the guests and suddenly left abroad for a 3-year contract without giving notice to his family. These incidents were typically accompanied by a total lack of remorse or empathy from S.C.'s part. His eating habits became unhealthy consisting of soft drinks and candy, leading to a weight gain of 88 kg. Eventually, the changes led up to a divorce from his wife and discharge from the army. He was not able to hold down even simpler jobs, such as working at a fast food restaurant. Prior to inevitable hospital admission, his behaviours developed to the extreme, including defecating in inappropriate places (even though he was not incontinent). Despite these extensive behavioural changes, S.C.'s memory functions, as well as comprehension, reading, spelling and calculating, were intact. He scored 30 of 30 on the Mini-Mental State Examination (MMSE). He declined having any suicidal or homicidal thoughts or any auditory or visual hallucinations. His insight into his problems was poor, and his behaviour during medical and psychological evaluation was characterized by restlessness, inattention, distractibility and occasional inappropriate personal questions.

Frontotemporal Dementia: Temporal Variants

Dementia characterized by atrophy in the predominantly left temporal brain regions often leads to a deterioration of language functions, with three different but overlapping main variants as described within the diagnostic concept of primary-progressive aphasia: non-fluent/agrammatic variant, semantic variant and logopenic variant (Gorno-Tempini et al., 2011). In short, these three variants are characterized by impairments in grammar and motor speech (non-fluent/agrammatic variant), single-word comprehension and object/people knowledge (semantic variant), repetition (logopenic variant), confrontation naming and reading/spelling (semantic and logopenic variants) and sentence comprehension (logopenic and agrammatic variants) (Gorno-Tempini et al., 2011). Changes in personality traits may appear in the different primary-progressive aphasia variants (Multani et al., 2017), but to a much lesser extent compared to right-sided bvFTD (Mesulam, 2013). The semantic variant has been associated with a decline in warmth, extraversion, agreeableness, openness and dominance and an increase in neurotic traits (Mahoney et al., 2011; Sollberger, Stanley, et al., 2009; Sollberger, Neuhaus, et al., 2011).

Differences Between Different Dementia Disorders

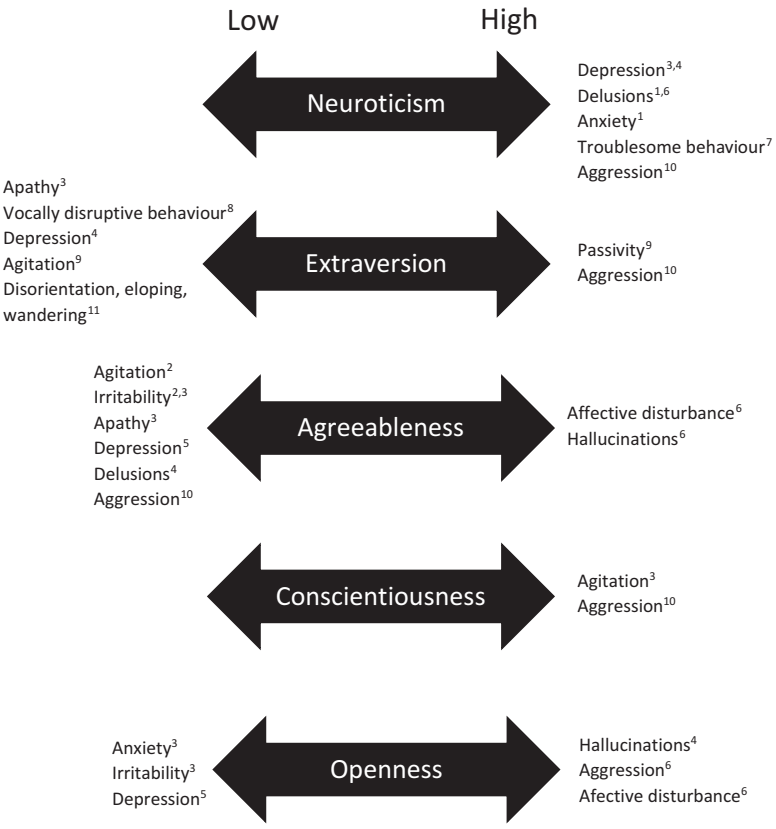
Is it possible to distinguish different dementia disorders by different patterns of personality changes? There are still only a limited number of studies, although some have addressed this specific issue, e.g. between frontotemporal dementia, Alzheimer type dementia and mild cognitive impairment (Lykou et al., 2013); Lewy body dementia and Alzheimer type dementia (Galvin et al., 2007); Alzheimer type

dementia, head injuries and stroke (Golden & Golden, 2003); and bvFTD, primary-progressive aphasia and Alzheimer type dementia (Sollberger et al., 2011; Torrente et al., 2014). The most specific patterns of personality change are generally observed in cases of frontotemporal dementia and can give a clear early indication of that specific dementia diagnosis. For instance, a lack of warmth has been reported as the clearest difference between frontotemporal dementia forms and Alzheimer type dementia (Sollberger et al., 2011). However, for other dementia disorders, the boundaries are generally not as clear, and most dementia disorders are associated with some degree of, e.g. increased apathy, social withdrawal and emotional lability – even if these symptoms may present earlier in vascular dementia forms. Increased neuroticism is a recurrent theme across dementia disorders. However, as personality traits have been associated with specific underlying neural networks (Sollberger et al., 2009), it is reasonable to assume that there are more specific personality differences in dementia disorders that still remain to be identified by research studies. Many studies have so far only reported the broader personality traits/domains such as 'neuroticism' and 'extraversion'. Personality assessment would perhaps provide more information that is useful considering the differential diagnostic procedures if studies would further pursue in-depth study of specific facets.

BPSD: Behavioural and Psychological Symptoms in Dementia

'Behavioural and psychological symptoms in dementia' (BPSD) is a term describing a heterogeneous group of non-cognitive symptoms and behaviours occurring in dementia (Cerejeira, Lagarto, & Mukaetova-Ladinska, 2012). These include symptoms such as irritability, insomnia, agitation, hallucinations, wandering, screaming, paranoid delusions and depressive symptoms/anxiety, with great individual variability considering the severity of symptoms. The prevalence of BPSD in old age cognitive impairment (occurrence of at least one symptom) was recently reported as 66% in persons with mild cognitive impairment, 86% in mild dementia and 91% in moderate dementia (Boccardi et al., 2017). For most types of dementia, BPSD is most common in later phases. The distinction between what should be considered a 'change of personality' and what is better described as BPSD symptoms is not clear (von Gunten, Pocnet, & Rossier, 2009). Both are matters of behaviour, and it is likely not possible to establish any clear-cut boundaries. The complex relationship between personality and BPSD can be described as 'pathoplastic' (von Gunten et al., 2009), meaning that personality has an effect on how the symptoms develop and thus may partly explain why individuals who are diagnosed with the same disease may display variations in symptoms.

Needless to point out, BPSD symptoms induce very difficult challenges for caregivers as well as immense suffering for both the affected individuals and family members. Knowledge of how personality, as well as cognition, emotion and behaviour, may change during dementia, is likely important to help family members cope with these challenges.



1. (Strauss, Lee, & DiFilippo, 1997); 2. (Archer et al., 2007); 3. (Tabata et al., 2017); 4. (Chatterjee, Strauss, Smyth, & Whitehouse, 1992); 5. (Wilson, Arnold, Beck, Bienias, & Bennett, 2008); 6. (Low, Brodaty, & Draper, 2002); 7. (Meins, Frey, & Thiesemann, 1998); 8. (Holst, Hallberg, & Gustafson, 1997); 9. (A. Kolanowski & Litaker, 2006); 10. (A. M. Kolanowski, Strand, & Whall, 1997); 11. (Song & Algase, 2008).

Fig. 6 Premorbid personality traits in relation to BPSD symptoms

Figure 6 shows summarized results from 11 studies on the subject of personality traits (using only five-factor traits) in relation to BPSD symptoms. Clearly, even across this limited number of studies, a complex pattern of relationships between personality traits and challenging non-cognitive behaviours emerges.

The most marked associations appear to be evident between BPSD symptoms and high premorbid levels of neuroticism, low premorbid levels of extraversion and agreeableness. Additionally, *low* premorbid levels of neuroticism and conscientiousness were not associated with any BPSD symptoms.

A review (Osborne, Simpson, & Stokes, 2010) included 18 studies published between 1992 and 2008 that investigated the relationship between premorbid

personality and challenging behaviour in dementia. Most studies (n = 14) used informant report as a measure of behaviour, and the four remaining used observational methods. All studies used informant report to assess personality traits, mostly in accordance with the NEO five-factor model. Five studies reported that there were no significant relationships between premorbid personality traits and challenging behaviours, which could perhaps partly be explained by low sample sizes. The remaining 13 studies reported significant relationships between challenging behaviours and premorbid personality. The most frequently reported relationships included aggressive behaviour (aggression, irritability, agitation) and mood-related behaviour (depression, passivity, apathy), which were positively associated with higher neuroticism. Two studies reported that agreeableness was negatively related to aggression-related behaviours. Two studies focused on wandering behaviour, which was significantly associated with 'extraversion', although in two opposite directions.

One such case was described by Poletti and Bonuccelli (2011), focusing on the relation between personality disorders – the pathological expression of personality – and dementia. They present the case of U.C., a 73-year-old retired chemical engineer.

Throughout adulthood, he had displayed several characteristics typical for a narcissistic personality disorder. During decades, he prepared thousands of lawsuits and studied law textbooks to denounce individuals and institutions who he thought were guilty of misconduct. Further, he wrote an erotic version of a best-selling novel. He described himself as having a superior intelligence. The authors describe that his behavioural pattern was also compatible with a paranoid personality disorder, given his extensive distrust and suspiciousness of others. At the age of 72, his wife reported that his behaviours changed to include new patterns, such as hypersexuality, disinhibition and verbal aggression. Brain imaging using MRI revealed leukoencephalopathy, and ^{18}F FDG-PET showed a bilateral prefrontal hypometabolism, which was marked on the right side, and a less marked mesial temporal hypometabolism especially on the right side. His clinical symptoms as well as the imaging findings were compatible with a diagnosis of FTD.

Methodological Challenges When Studying Personality in Dementia

It is well known that the level of awareness of cognitive functioning and insight into disease gradually declines during dementia development. This process may begin even before the dementia is manifest, even though the pattern of how and when awareness is affected may differ for different dementia disorders. In later stages, anosognosia – decreased awareness of one's own disability – is inevitable in all dementia disorders. The reduced insight also affects the persons' ability to assess their own behaviour accurately and consequently also when asked to rate their own

personality traits (Robins Wahlin & Byrne, 2011). Persons with dementia may tend to report on their former personality traits rather than their current traits, which makes it difficult to investigate possible personality changes (Rankin et al., 2005). Consequently, in studies including persons with manifest dementia, self-assessment is not possible, or of very limited value (von Gunten et al., 2009). A few studies have been based on materials in which personality was assessed prospectively, before disease onset (e.g. Ausen et al., 2009; Berg & Johansson, 2014; Yoneda et al., 2017). However, in most studies, researchers have had to use retrospective informant-reported personality measures as a second-best alternative, which undoubtedly gives rise to questions of validity. Although there is evidence of a high correlation between informant-reported and self-rated personality (Bagby et al., 1998), it is not certain whether retrospective informant-reported assessment is valid (Low et al., 2013). When a family member rates the patient's personality, what is actually assessed? Personality consists of both a person's view of herself and of behaviour. In informant-based personality rating, the self-viewing perspective will inevitably be lost. The methodological problem of assessing personality retrospectively has been highlighted by several researchers (Balsis et al., 2005; Osborne et al., 2010; Robins Wahlin & Byrne, 2011). Investigating self-reported personality traits in relation to dementia would require large and longitudinal prospectively collected data sets, which is rare.

Another methodological difficulty concerns what comprises the concept of personality and its complex associations with emotion, behaviour and cognition. What is a change of personality? When is the change best described as a personality change, and when is it a change of behaviour and emotion that is an inevitable consequence of decreased functioning? To what extent are the personality-related changes direct effects of damage to neural circuits, or indirect effects of cognitive impairment and dysfunction in everyday life? Plausibly, early changes may be more related to coping and reactions to the emerging dysfunction, and later changes are likely to be related to the progressing neurodegeneration of the brain.

Implications of Personality Research in Dementia

Dementia disorders gradually deprive affected individuals of their functions and lead to extensive changes in cognition, emotion and behaviour – essential aspects of what a person is. It is a painful journey for friends and family members to see a loved one be gradually broken down until there is not much left of what characterized them previously in life. Not seldom, spouses of patients with mild dementia find it very difficult to deal with the changes of personality and behaviour, which may lead to irritability and conflicts within affected families. The knowledge of that these personality changes partly are caused by underlying brain changes may help relatives to accept these changes as a part of the disease itself and not as a matter of choice. Knowledge of personality changes and related emotional/behavioural changes are also potentially useful in the planning of interventions and health care.

For clinicians and researchers, evidence suggesting that personality changes may help differentiate between different dementia disorders and that personality changes often appear in an early stage – perhaps even earlier than the first cognitive signs – are important as part of the complex process of identifying early signs of dementia. Not least for clinical drug trials, the identification of early signs is a key issue.

Personality is a complex phenomenon and the clinical usefulness and possibilities are limited. Studies on personality traits and changes tend to be primarily descriptive. More in-depth studies into associations and mechanisms between personality and dementia-related brain changes are needed. Nevertheless, the procedure of diagnosing dementia is a puzzle, and aspects of personality change may be one useful piece of that puzzle.

References

Aitken, L., Simpson, S., & Burns, A. (1999). Personality change in dementia. *International Psychogeriatrics, 11*(3), 263–271.

Allemand, M., Gomez, V., & Jackson, J. J. (2010). Personality trait development in midlife: Exploring the impact of psychological turning points. *European Journal of Ageing, 7*(3), 147–155. https://doi.org/10.1007/s10433-010-0158-0

Allemand, M., Zimprich, D., & Martin, M. (2008). Long-term correlated change in personality traits in old age. *Psychology and Aging, 23*(3), 545–557. https://doi.org/10.1037/a0013239

Archer, N., Brown, R. G., Reeves, S. J., Boothby, H., Nicholas, H., Foy, C., … Lovestone, S. (2007). Premorbid personality and behavioral and psychological symptoms in probable Alzheimer disease. *The American Journal of Geriatric Psychiatry, 15*(3), 202–213. https://doi.org/10.1097/01.JGP.0000232510.77213.10

Ausen, B., Edman, G., Almkvist, O., & Bogdanovic, N. (2009). Personality features in subjective cognitive impairment and mild cognitive impairment--early indicators of dementia? *Dementia and Geriatric Cognitive Disorders, 28*(6), 528–535. https://doi.org/10.1159/000255104

Bagby, R. M., Rector, N. A., Bindseil, K., Dickens, S. E., Levitan, R. D., & Kennedy, S. H. (1998). Self-report ratings and informants' ratings of personalities of depressed outpatients. *The American Journal of Psychiatry, 155*(3), 437–438. https://doi.org/10.1176/ajp.155.3.437

Balsis, S., Carpenter, B. D., & Storandt, M. (2005). Personality change precedes clinical diagnosis of dementia of the Alzheimer type. *The Journals of Gerontology. Series B, Psychological Sciences and Social Sciences, 60*(2), P98–P101.

Berg, A. I., & Johansson, B. (2014). Personality change in the oldest-old: Is it a matter of compromised health and functioning? *Journal of Personality, 82*(1), 25–31. https://doi.org/10.1111/jopy.12030

Boccardi, V., Conestabile Della Staffa, M., Baroni, M., Ercolani, S., Croce, M. F., Ruggiero, C., … Re, G. A. L. s. g. (2017). Prevalence and correlates of behavioral disorders in old age subjects with cognitive Impairment: Results from the ReGAl Project. *Journal of Alzheimer's Disease*. https://doi.org/10.3233/JAD-170494

Booth, T., Mottus, R., Corley, J., Gow, A. J., Henderson, R. D., Maniega, S. M., … Deary, I. J. (2014). Personality, health, and brain integrity: The Lothian birth cohort study 1936. *Health Psychology, 33*(12), 1477–1486. https://doi.org/10.1037/hea0000012

Caspi, A., Roberts, B. W., & Shiner, R. L. (2005). Personality development: Stability and change. *Annual Review of Psychology, 56*, 453–484. https://doi.org/10.1146/annurev.psych.55.090902.141913

Cerejeira, J., Lagarto, L., & Mukaetova-Ladinska, E. B. (2012). Behavioral and psychological symptoms of dementia. *Frontiers in Neurology, 3*, 73. https://doi.org/10.3389/fneur.2012.00073

Chatterjee, A., Strauss, M. E., Smyth, K. A., & Whitehouse, P. J. (1992). Personality changes in Alzheimer's disease. *Archives of Neurology, 49*(5), 486–491.

Cloninger, C. R. (1986). A unified biosocial theory of personality and its role in the development of anxiety states. *Psychiatric Developments, 3*, 167–226.

Comijs, H. C., Deeg, D. J., Dik, M. G., Twisk, J. W., & Jonker, C. (2002). Memory complaints; the association with psycho-affective and health problems and the role of personality characteristics. A 6-year follow-up study. *Journal of Affective Disorders, 72*(2), 157–165.

Conley, J. J. (1985). Longitudinal stability of personality traits: A multitrait-multimethod-multioccasion analysis. *Journal of Personality and Social Psychology, 49*(5), 1266–1282.

Costa, P. T., Jr., & McCrae, R. R. (1988). Personality in adulthood: A six-year longitudinal study of self-reports and spouse ratings on the NEO personality inventory. *Journal of Personality and Social Psychology, 54*(5), 853–863.

Diehl, J., Ernst, J., Krapp, S., Forstl, H., Nedopil, N., & Kurz, A. (2006). Misdemeanor in frontotemporal dementia. *Fortschritte der Neurologie-Psychiatrie, 74*(4), 203–210.

Duberstein, P. R., Chapman, B. P., Tindle, H. A., Sink, K. M., Bamonti, P., Robbins, J., … Franks, P. (2011). Personality and risk for Alzheimer's disease in adults 72 years of age and older: A 6-year follow-up. *Psychology and Aging, 26*(2), 351–362. https://doi.org/10.1037/a0021377

Duron, E., Vidal, J. S., Bounatiro, S., Ben Ahmed, S., Seux, M. L., Rigaud, A. S., … Martel, G. (2014). Relationships between personality traits, medial temporal lobe atrophy, and white matter lesion in subjects suffering from mild cognitive impairment. *Frontiers in Aging Neuroscience, 6*, 195. https://doi.org/10.3389/fnagi.2014.00195

Eckerstrom, M., Berg, A. I., Nordlund, A., Rolstad, S., Sacuiu, S., & Wallin, A. (2016). High prevalence of stress and Low prevalence of Alzheimer disease CSF biomarkers in a clinical sample with subjective cognitive impairment. *Dementia and Geriatric Cognitive Disorders, 42*(1–2), 93–105. https://doi.org/10.1159/000448326

Elfgren, C., Gustafson, L., Vestberg, S., Risberg, J., Rosen, I., Ryding, E., & Passant, U. (2003). Subjective experience of memory deficits related to clinical and neuroimaging findings. *Dementia and Geriatric Cognitive Disorders, 16*(2), 84–92. doi: 70680.

Faber, R., Hill, V. M., & Kim, B. J. (2003). Frontotemporal dementia affecting a U.S. air Force officer. *Military Medicine, 168*(4), 333–336.

Galvin, J. E. (2003). Dementia with Lewy bodies. *Archives of Neurology, 60*(9), 1332–1335. https://doi.org/10.1001/archneur.60.9.1332

Galvin, J. E., Malcom, H., Johnson, D., & Morris, J. C. (2007). Personality traits distinguishing dementia with Lewy bodies from Alzheimer disease. *Neurology, 68*(22), 1895–1901. https://doi.org/10.1212/01.wnl.0000263131.80945.ad

Golden, Z., & Golden, C. J. (2003). The differential impacts of Alzheimer's dementia, head injury, and stroke on personality dysfunction. *The International Journal of Neuroscience, 113*(6), 869–878. https://doi.org/10.1080/00207450390200927

Gorno-Tempini, M. L., Hillis, A. E., Weintraub, S., Kertesz, A., Mendez, M., Cappa, S. F., … Grossman, M. (2011). Classification of primary progressive aphasia and its variants. *Neurology, 76*(11), 1006–1014. https://doi.org/10.1212/WNL.0b013e31821103e6

Hachinski, V. C., Iliff, L. D., Zilhka, E., Du Boulay, G. H., McAllister, V. L., Marshall, J., … Symon, L. (1975). Cerebral blood flow in dementia. *Archives of Neurology, 32*(9), 632–637.

Hellwig, S., Dykierek, P., Hellwig, B., Zwernemann, S., & Meyer, P. T. (2012). Alzheimer's disease camouflaged by histrionic personality disorder. *Neurocase, 18*(1), 75–79. https://doi.org/10.1080/13554794.2011.556125

Helmes, E., Norton, M., & Østbye, T. (2013). Personality change in older adults with dementia: Occurrence and association with severity of cognitive impairment. *Advances in Aging Research, 2*(1), 27–36.

Helson, R., Jones, C., & Kwan, V. S. (2002). Personality change over 40 years of adulthood: Hierarchical linear modeling analyses of two longitudinal samples. *Journal of Personality and Social Psychology, 83*(3), 752–766.

Holst, G., Hallberg, I. R., & Gustafson, L. (1997). The relationship of vocally disruptive behavior and previous personality in severely demented institutionalized patients. *Archives of Psychiatric Nursing, 11*(3), 147–154.

Iacono, D., Markesbery, W. R., Gross, M., Pletnikova, O., Rudow, G., Zandi, P., & Troncoso, J. C. (2009). The Nun study: Clinically silent AD, neuronal hypertrophy, and linguistic skills in early life. *Neurology, 73*(9), 665–673. https://doi.org/10.1212/WNL.0b013e3181b01077

Jackson, J., Balota, D. A., & Head, D. (2011). Exploring the relationship between personality and regional brain volume in healthy aging. *Neurobiology of Aging, 32*(12), 2162–2171. https://doi.org/10.1016/j.neurobiolaging.2009.12.009

Jeronimus, B. F., Riese, H., Sanderman, R., & Ormel, J. (2014). Mutual reinforcement between neuroticism and life experiences: A five-wave, 16-year study to test reciprocal causation. *Journal of Personality and Social Psychology, 107*(4), 751–764. https://doi.org/10.1037/a0037009

Johansson, L., Guo, X., Duberstein, P. R., Hallstrom, T., Waern, M., Ostling, S., & Skoog, I. (2014). Midlife personality and risk of Alzheimer disease and distress: A 38-year follow-up. *Neurology, 83*(17), 1538–1544. https://doi.org/10.1212/WNL.0000000000000907

Jokela, M., Elovainio, M., Nyberg, S. T., Tabak, A. G., Hintsa, T., Batty, G. D., & Kivimaki, M. (2014). Personality and risk of diabetes in adults: Pooled analysis of 5 cohort studies. *Health Psychology, 33*(12), 1618–1621. https://doi.org/10.1037/hea0000003

Kolanowski, A., & Litaker, M. (2006). Social interaction, premorbid personality, and agitation in nursing home residents with dementia. *Archives of Psychiatric Nursing, 20*(1), 12–20. https://doi.org/10.1016/j.apnu.2005.08.006

Kolanowski, A. M., Strand, G., & Whall, A. (1997). A pilot study of the relation of premorbid characteristics to behavior in dementia. *Journal of Gerontological Nursing, 23*(2), 21–30.

Low, L. F., Brodaty, H., & Draper, B. (2002). A study of premorbid personality and behavioural and psychological symptoms of dementia in nursing home residents. *International Journal of Geriatric Psychiatry, 17*(8), 779–783. https://doi.org/10.1002/gps.697

Low, L. F., Harrison, F., & Lackersteen, S. M. (2013). Does personality affect risk for dementia? A systematic review and meta-analysis. *The American Journal of Geriatric Psychiatry, 21*(8), 713–728. https://doi.org/10.1016/j.jagp.2012.08.004

Lucas, R. E., & Donnellan, M. B. (2011). Personality development across the life span: Longitudinal analyses with a national sample from Germany. *Journal of Personality and Social Psychology, 101*(4), 847–861. https://doi.org/10.1037/a0024298

Lykou, E., Rankin, K. P., Chatziantoniou, L., Boulas, C., Papatriantafyllou, O., Tsaousis, I., … Papatriantafyllou, J. D. (2013). Big 5 personality changes in Greek bvFTD, AD, and MCI patients. *Alzheimer Disease and Associated Disorders, 27*(3), 258–264. https://doi.org/10.1097/WAD.0b013e31826e5504

Mahoney, C. J., Rohrer, J. D., Omar, R., Rossor, M. N., & Warren, J. D. (2011). Neuroanatomical profiles of personality change in frontotemporal lobar degeneration. *The British Journal of Psychiatry, 198*(5), 365–372. https://doi.org/10.1192/bjp.bp.110.082677

McCrae, R. R., Costa, P. T., Jr., Ostendorf, F., Angleitner, A., Hrebickova, M., Avia, M. D., … Smith, P. B. (2000). Nature over nurture: Temperament, personality, and life span development. *Journal of Personality and Social Psychology, 78*(1), 173–186.

McGue, M., Bacon, S., & Lykken, D. T. (1993). Personality stability and change in early adulthood: A behavioral genetic analysis. *Developmental Psychology, 29*, 96–109.

Meins, W., Frey, A., & Thiesemann, R. (1998). Premorbid personality traits in Alzheimer's disease: Do they predispose to noncognitive behavioral symptoms? *International Psychogeriatrics, 10*(4), 369–378.

Mesulam, M. (2013). Primary progressive aphasia: A dementia of the language network. *Dement Neuropsychol, 7*(1), 2–9.

Mitchell, A. J., Beaumont, H., Ferguson, D., Yadegarfar, M., & Stubbs, B. (2014). Risk of dementia and mild cognitive impairment in older people with subjective memory complaints: Meta-analysis. *Acta Psychiatrica Scandinavica, 130*(6), 439–451. https://doi.org/10.1111/acps.12336

Mottus, R., Johnson, W., & Deary, I. J. (2012). Personality traits in old age: Measurement and rank-order stability and some mean-level change. *Psychology and Aging, 27*(1), 243–249. https://doi.org/10.1037/a0023690

Mroczek, D. K., & Spiro, A., 3rd. (2003). Modeling intraindividual change in personality traits: Findings from the normative aging study. *The Journals of Gerontology. Series B, Psychological Sciences and Social Sciences, 58*(3), P153–P165.

Multani, N., Galantucci, S., Wilson, S. M., Shany-Ur, T., Poorzand, P., Growdon, M. E., … Tartaglia, M. C. (2017). Emotion detection deficits and changes in personality traits linked to loss of white matter integrity in primary progressive aphasia. *Neuroimage Clinical, 16*, 447–454. https://doi.org/10.1016/j.nicl.2017.08.020

Mychack, P., Rosen, H., & Miller, B. L. (2001). Novel applications of social-personality measures to the study of dementia. *Neurocase, 7*(2), 131–143. https://doi.org/10.1093/neucas/7.2.131

Neary, D., Snowden, J., & Mann, D. (2005). Frontotemporal dementia. *Lancet Neurology, 4*(11), 771–780. https://doi.org/10.1016/S1474-4422(05)70223-4

Neary, D., Snowden, J. S., Gustafson, L., Passant, U., Stuss, D., Black, S., … Benson, D. F. (1998). Frontotemporal lobar degeneration: a consensus on clinical diagnostic criteria. *Neurology, 51*(6), 1546–1554.

O'Brien, J. (2003). Behavioral symptoms in vascular cognitive impairment and vascular dementia. *International Psychogeriatrics, 15*(Suppl 1), 133–138. https://doi.org/10.1017/S1041610203009098

Osborne, H., Simpson, J., & Stokes, G. (2010). The relationship between pre-morbid personality and challenging behaviour in people with dementia: A systematic review. *Aging & Mental Health, 14*(5), 503–515. https://doi.org/10.1080/13607861003713208

Poletti, M., & Bonuccelli, U. (2011). From narcissistic personality disorder to frontotemporal dementia: A case report. *Behavioural Neurology, 24*(2), 173–176. https://doi.org/10.3233/BEN-2011-0326

Prince, M., Bryce, R., Albanese, E., Wimo, A., Ribeiro, W., & Ferri, C. P. (2013). The global prevalence of dementia: A systematic review and metaanalysis. *Alzheimers Dement, 9*(1), 63–75 e62. https://doi.org/10.1016/j.jalz.2012.11.007

Ramakers, I. H., Honings, S. T., Ponds, R. W., Aalten, P., Sebastian, K., Verhey, F. R., & Visser, P. J. (2015). The effect of psychological distress and personality traits on cognitive performances and the risk of dementia in patients with mild cognitive impairment. *Journal of Alzheimer's Disease, 46*(3), 805–812. https://doi.org/10.3233/JAD-142493

Rankin, K. P., Baldwin, E., Pace-Savitsky, C., Kramer, J. H., & Miller, B. L. (2005). Self awareness and personality change in dementia. *Journal of Neurology, Neurosurgery, and Psychiatry, 76*(5), 632–639. https://doi.org/10.1136/jnnp.2004.042879

Rankin, K. P., Kramer, J. H., Mychack, P., & Miller, B. L. (2003). Double dissociation of social functioning in frontotemporal dementia. *Neurology, 60*(2), 266–271.

Rascovsky, K., Hodges, J. R., Knopman, D., Mendez, M. F., Kramer, J. H., Neuhaus, J., … Miller, B. L. (2011). Sensitivity of revised diagnostic criteria for the behavioural variant of frontotemporal dementia. *Brain, 134*(Pt 9), 2456–2477. https://doi.org/10.1093/brain/awr179

Reisberg, B., Ferris, S. H., de Leon, M. J., & Crook, T. (1982). The global deterioration scale for assessment of primary degenerative dementia. *The American Journal of Psychiatry, 139*(9), 1136–1139. https://doi.org/10.1176/ajp.139.9.1136

Roberts, B. W., Walton, K. E., & Viechtbauer, W. (2006). Patterns of mean-level change in personality traits across the life course: A meta-analysis of longitudinal studies. *Psychological Bulletin, 132*(1), 1–25. https://doi.org/10.1037/0033-2909.132.1.1

Robins Wahlin, T. B., & Byrne, G. J. (2011). Personality changes in Alzheimer's disease: A systematic review. *International Journal of Geriatric Psychiatry, 26*(10), 1019–1029. https://doi.org/10.1002/gps.2655

Roman, G. C. (2003). Vascular dementia: Distinguishing characteristics, treatment, and prevention. *Journal of the American Geriatrics Society, 51*(5 Suppl Dementia), S296–S304. https://doi.org/10.1046/j.1532-5415.5155.x

Roman, G. C., Erkinjuntti, T., Wallin, A., Pantoni, L., & Chui, H. C. (2002). Subcortical ischaemic vascular dementia. *Lancet Neurology, 1*(7), 426–436.

Roman, G. C., Tatemichi, T. K., Erkinjuntti, T., Cummings, J. L., Masdeu, J. C., Garcia, J. H., et al. (1993). Vascular dementia: Diagnostic criteria for research studies. Report of the NINDS-AIREN international workshop. *Neurology, 43*(2), 250–260.

Salmon, E., Perani, D., Collette, F., Feyers, D., Kalbe, E., Holthoff, V., … Herholz, K. (2008). A comparison of unawareness in frontotemporal dementia and Alzheimer's disease. *Journal of Neurology, Neurosurgery, and Psychiatry, 79*(2), 176–179. https://doi.org/10.1136/jnnp.2007.122853

Smith-Gamble, V., Baiyewu, O., Perkins, A. J., Gureje, O., Hall, K. S., Ogunniyi, A., … Hendrie, H. C. (2002). Informant reports of changes in personality predict dementia in a population-based study of elderly african americans and yoruba. *The American Journal of Geriatric Psychiatry, 10*(6), 724–732.

Sollberger, M., Neuhaus, J., Ketelle, R., Stanley, C. M., Beckman, V., Growdon, M., … Rankin, K. P. (2011). Interpersonal traits change as a function of disease type and severity in degenerative brain diseases. *Journal of Neurology, Neurosurgery, and Psychiatry, 82*(7), 732–739. https://doi.org/10.1136/jnnp.2010.205047

Sollberger, M., Stanley, C. M., Wilson, S. M., Gyurak, A., Beckman, V., Growdon, M., … Rankin, K. P. (2009). Neural basis of interpersonal traits in neurodegenerative diseases. *Neuropsychologia, 47*(13), 2812–2827. https://doi.org/10.1016/j.neuropsychologia.2009.06.006

Song, J. A., & Algase, D. (2008). Premorbid characteristics and wandering behavior in persons with dementia. *Archives of Psychiatric Nursing, 22*(6), 318–327. https://doi.org/10.1016/j.apnu.2007.10.008

Strauss, M. E., Lee, M. M., & DiFilippo, J. M. (1997). Premorbid personality and behavioral symptoms in Alzheimer disease. Some cautions. *Archives of Neurology, 54*(3), 257–259.

Sutin, A. R., Ferrucci, L., Zonderman, A. B., & Terracciano, A. (2011). Personality and obesity across the adult life span. *Journal of Personality and Social Psychology, 101*(3), 579–592. https://doi.org/10.1037/a0024286

Sutin, A. R., Stephan, Y., & Terracciano, A. (2017). Facets of conscientiousness and risk of dementia. *Psychological Medicine, 48*, 1–9. https://doi.org/10.1017/S0033291717002306

Tabata, K., Saijo, Y., Morikawa, F., Naoe, J., Yoshioka, E., Kawanishi, Y., … Yoshida, T. (2017). Association of premorbid personality with behavioral and psychological symptoms in dementia with Lewy bodies: Comparison with Alzheimer's disease patients. *Psychiatry and Clinical Neurosciences, 71*(6), 409–416. https://doi.org/10.1111/pcn.12511

Tautvydaite, D., Kukreja, D., Antonietti, J. P., Henry, H., von Gunten, A., & Popp, J. (2017). Interaction between personality traits and cerebrospinal fluid biomarkers of Alzheimer's disease pathology modulates cognitive performance. *Alzheimer's Research & Therapy, 9*(1), 6. https://doi.org/10.1186/s13195-017-0235-0

Terracciano, A., & Costa, P. T., Jr. (2004). Smoking and the five-factor model of personality. *Addiction, 99*(4), 472–481. https://doi.org/10.1111/j.1360-0443.2004.00687.x

Terracciano, A., Stephan, Y., Luchetti, M., Albanese, E., & Sutin, A. R. (2017). Personality traits and risk of cognitive impairment and dementia. *Journal of Psychiatric Research, 89*, 22–27. https://doi.org/10.1016/j.jpsychires.2017.01.011

Terracciano, A., Sutin, A. R., An, Y., O'Brien, R. J., Ferrucci, L., Zonderman, A. B., & Resnick, S. M. (2014). Personality and risk of Alzheimer's disease: New data and meta-analysis. *Alzheimers Dement, 10*(2), 179–186. https://doi.org/10.1016/j.jalz.2013.03.002

Torrente, F., Pose, M., Gleichgerrcht, E., Torralva, T., Lopez, P., Cetkovich-Bakmas, M., & Manes, F. (2014). Personality changes in dementia: Are they disease specific and universal? *Alzheimer Disease and Associated Disorders, 28*(3), 261–268. https://doi.org/10.1097/WAD.0000000000000030

Verhey, F. R., Ponds, R. W., Rozendaal, N., & Jolles, J. (1995). Depression, insight, and personality changes in Alzheimer's disease and vascular dementia. *Journal of Geriatric Psychiatry and Neurology, 8*(1), 23–27.

von Gunten, A., Pocnet, C., & Rossier, J. (2009). The impact of personality characteristics on the clinical expression in neurodegenerative disorders--a review. *Brain Research Bulletin, 80*(4–5), 179–191. https://doi.org/10.1016/j.brainresbull.2009.07.004

Wang, H. X., Karp, A., Herlitz, A., Crowe, M., Kareholt, I., Winblad, B., & Fratiglioni, L. (2009). Personality and lifestyle in relation to dementia incidence. *Neurology, 72*(3), 253–259. https://doi.org/10.1212/01.wnl.0000339485.39246.87

Wilson, R. S., Arnold, S. E., Beck, T. L., Bienias, J. L., & Bennett, D. A. (2008). Change in depressive symptoms during the prodromal phase of Alzheimer disease. *Archives of General Psychiatry, 65*(4), 439–445. https://doi.org/10.1001/archpsyc.65.4.439

Wilson, R. S., Barnes, L. L., Bennett, D. A., Li, Y., Bienias, J. L., Mendes de Leon, C. F., & Evans, D. A. (2005). Proneness to psychological distress and risk of Alzheimer disease in a biracial community. *Neurology, 64*(2), 380–382. https://doi.org/10.1212/01.WNL.0000149525.53525.E7

Wilson, R. S., Begeny, C. T., Boyle, P. A., Schneider, J. A., & Bennett, D. A. (2011). Vulnerability to stress, anxiety, and development of dementia in old age. *The American Journal of Geriatric Psychiatry, 19*(4), 327–334. https://doi.org/10.1097/JGP.0b013e31820119da

Wilson, R. S., & Bennett, D. A. (2017). How does psychosocial behavior contribute to cognitive health in old age? *Brain Sciences, 7*(6). https://doi.org/10.3390/brainsci7060056

Wilson, R. S., Schneider, J. A., Arnold, S. E., Bienias, J. L., & Bennett, D. A. (2007). Conscientiousness and the incidence of Alzheimer disease and mild cognitive impairment. *Archives of General Psychiatry, 64*(10), 1204–1212. https://doi.org/10.1001/archpsyc.64.10.1204

Wittenberg, D., Possin, K. L., Rascovsky, K., Rankin, K. P., Miller, B. L., & Kramer, J. H. (2008). The early neuropsychological and behavioral characteristics of frontotemporal dementia. *Neuropsychology Review, 18*(1), 91–102. https://doi.org/10.1007/s11065-008-9056-z

World Health Organization. (2012). Dementia - a public health priority. Retrieved from the WHO website October 2017.

Yoneda, T., Rush, J., Berg, A. I., Johansson, B., & Piccinin, A. M. (2017). Trajectories of personality traits preceding dementia diagnosis. *The Journals of Gerontology. Series B, Psychological Sciences and Social Sciences, 72*(6), 922–931. https://doi.org/10.1093/geronb/gbw006