The F.O.T.T. Approach: Functional – Complex – Relevant for Daily Life

Ricki Nusser-Müller-Busch

Contents

R. Nusser-Müller-Busch, K. Gampp Lehmann (eds.), *Facial-Oral Tract Therapy (F.O.T.T.)*,
https://doi.org/10.1007/978-3-030-51637-6_1

When brain damage occurs, it may cause various forms of swallowing disorders and speech dysfunctions. The goal of Facial-Oral Tract Therapy (F.O.T.T.), as developed by Kay Coombes and colleagues, is the integration and coordination of facial-oral functions. This enables the safe coordination of breathing, swallowing, voice, speech, facial expression, eating and drinking, and the efficient use of protective clearing measures, when required. In order to eat and drink safely again, many patients must relearn to adapt their postural control during daily activities, for example, transporting food to their mouths, using the tongue to remove residues from the oral cavity by coughing, swallowing or spitting out, etc.

» Know the normal! (Coombes 2002)

From the moment we get up, our bodies are engaged in activity without even thinking about it. We rarely consider how we get out of bed or what we need to move first to do so. We check our emails casually while eating breakfast. We chew, drink, and swallow without paying particular attention to posture and muscle tone. We drive to work and greet our colleagues, and we do all of this at a pace adapted to our individual phonation-breathing pattern. We could not say how many times we have swallowed or cleared our throat since we woke up.

The facial-oral functions are affected by posture and movement, and work together constantly, in coordination:

- We breathe while chewing, our breathing is paused or interrupted during swallowing, and we resume breathing thereafter.
- We usually swallow (or spit out) after coughing. We swallow after yawning or after spitting out water while brushing our teeth, and at convenient moments such as after a longer period of speaking.
- We even are able to speak when forming a bolus, in the oral phase of the swallowing sequence.
- Facial expressions alter constantly and support our verbal communication.

Note

We all, therapists, doctors, nurses, and relatives perform these movements and functions daily. But we rarely use this implicit, physical experience in our work, when examining and treating dysfunctions of the facial-oral tract.

Knowing the normal means:

- To perceive the occurrence and sequential interaction of breathing, swallowing, speaking, throat clearing, etc. during the course of the day, in ourselves and others.
- To use this neglected source of information as a feedforward potential in therapy to influence the sensorimotor performance in our patients!

1.1 Facial-Oral Functions

Conventional physiological descriptions consider the functions of swallowing, facial expression, speaking, or breathing separately as *acts*. F.O.T.T. provides an integrated perspective of *sequences* where the facial-oral functions interact constantly during the day (Fig. 1.1).

Breathing, swallowing, eating, drinking, and speaking are essential facial-oral functions. Breathing and swallowing work and interact with other facial-oral functions and activities in a coordinated and mostly subcortical way around the clock.

1.1.1 Protective Mechanisms

- Breathing-swallowing coordination: Breathing and swallowing interact reciprocally. Due to brainstem circuits (Bolser et al. 2013), breathing is centrally interrupted during swallowing, usually followed by a brief, reflexive exhalation. This exhalation helps to detect risks in the airway caused by foreign particles and can be called the primary protective mechanism. Afterwards, breathing continues, and a

1

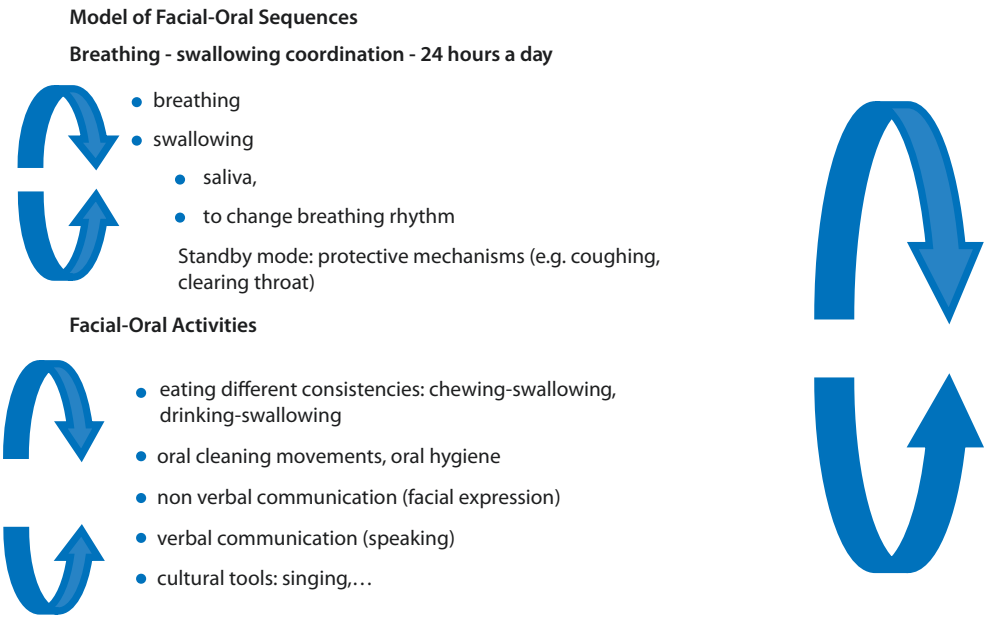

Fig. 1.1 Model of facial-oral sequences. Facial-oral functions alternate in coordination (arrow). They adapt to the context of the respective activity. (© Nusser-Müller-Busch 2019. All Rights Reserved)

change of breathing pattern may follow adapted to a new activity.

Other protective mechanisms may occur if the swallowing process is not successful.

- Subsequent clearing the oral cavity: After swallowing once, the tongue controls and collects residues in the oral cavity, which are swallowed afterwards and breathing continues.
- Clearing the throat: Clearing the throat transports particles upwards from the hypopharynx, necessarily followed by swallowing or spitting out. Then breathing continues.
- Coughing: If penetrated (into the larynx) or aspirated (in the lower airway below the vocal cords) material is sensed in the airway, coughing (after inhalation, forced exhalation, and loud release of air from the lungs due explosive opening of the closed glottis) ejects the residues to the oral cavity again, where they will be swallowed or spat out. After spitting out, usually a swallowing reaction follows and breathing continues.
- Gagging/vomiting: Gagging may be evoked by an object touching the back of the tongue or the back of the throat. The response is a contraction of the soft palate and a bilateral contraction of pharyngeal muscles while breathing is interrupted reflexively. After a moderate gagging, swallowing often occurs. Vomiting moves the stomach content reflexively with a strong expulsion via the pharynx to the oral cavity and/or nose. Afterwards usually a swallowing reaction follows and breathing continues.
- Sneezing: Sneezing removes foreign particles from the nasopharyngeal space by an explosive expulsion of air from the lungs through the nose and mouth. Sneezing also is often followed by a swallow reaction.

Note

Protective mechanisms and also yawning are often followed by a swallowing reaction and subsequent breathing.

Coughing on demand (as it is often used in dysphagia therapy) happens rarely in daily life. It should not be equated with an involuntary, reflexive cough in response to a hazardous irritant in the throat or airway, which is usually followed by a cleansing swallow. The sensorimotor loop is different between voluntary and involuntary coughing.

The assessment of a gag reaction in patients may be unreliable. In a test setting, a relatively large proportion of healthy participants (10% of women and 40% of men) showed no gag reaction (Logemann 1998).

The effectiveness of truly self-protective mechanisms, such as sneezing, coughing, gagging, is difficult to assess, as opposed to an assessment on demand. For example, self-protective gagging occurs only in dire situation and sometimes as a last resort.

Reflex versus Reaction

For decades, the Bobath concept for children (Neuro-Developmental Treatment, NDT, ► https://www.ndta.org/) and F.O.T.T. have referred to the *swallowing reaction* rather than the swallowing reflex, *a cough reaction* rather than a cough reflex, to a *gag reaction* rather than a gag reflex.

The central nervous system (CNS) responds and adapts reactively. Depending on the consistency and quantity, pharyngeal motor responses vary when either swallowing, for example liquid or a piece of bread.

Duysens et al. (1990) concluded that the reflexive/automatic part of the swallowing process changes with adaptation to different consistencies and bolus types. The neurally controlled motor responses become more differentiated in the course of development. Also coughing varies.

The American Speech-Language-Hearing Association (ASHA) also included this terminology in a policy statement, and promotes the term swallowing reaction (Robbins et al. 2008).

Many of the facial-oral functions are genetically determined. While nourishment is received via the umbilical cord, the embryo begins to swallow amniotic fluid from the 12th week of pregnancy. According to Hüther and Weser (2012), these movements are immanent to embryonic development and support the structuring of the body functions via use.

After birth, the newborn has to deal with gravity. Activities (the task-oriented use of functions) will influence the structures, for example the form of the face, teeth and mouth; and the individual prominence of muscles, such as the mentalis or masseter muscles.

» The function determines the form (Castillo Morales 1998)

During lifespan, functional activities become differentiated: from the newborn reflexive sucking of liquid food, to the perfected processing of solid consistencies and coordinated chewing, with its rotational components. This takes place through practice, also via imitation, and through communication with others. These actions are increasingly automated and unconscious. Only in case of an interruption or a problem, for example particularly solid food, choking or spilling liquid, these operations require special attention, which is then given immediately.

1.1.2 Postural Control and Facial-Oral Functions

The entire body is involved in the performance of facial-oral functions and their sequences during all activities (► Sect. 1.3, ► Chap. 4).

► Example

When sitting at the table and preparing to eat (pre-oral phase), we usually orient our eyes, head, and trunk toward the food in front of us. We have already learned to chew food and mix it with saliva; these activities are automated. The following swallowing is not just a "reflex" but also a *reactive response* to the processing of the bolus and its size and consistency. Swallowing of food commonly takes place with the head centered, but in certain situations it

can also be performed with the head turned to the side.

If we take a sip from the cup of coffee while in bed, we automatically change our position in order to swallow safely. If we take a too large sip from the glass and choke, we may bend our upper body forward abruptly, supporting ourselves (*support reaction*), and blow the drink out (*protective reaction*). We hopefully will continue to cough up all residues until the airway is clear and a quiet, rhythmic breathing cycle is restored. ◄

To date, the influence of postural control on facial-oral functions and their coordination have barely been addressed in the scientific literature.

Schultheiss et al. (2015) investigated the effect of three different body positions (90°, 45°, 0°) on swallowing parameters in 21 healthy subjects (= 762 swallows) with a combined EMG/bioimpedance measurement system and a piezoelectric sensor. A change of body position influenced the range of motion and the speed of the laryngeal elevation significantly. The swallowing-breathing patterns (pre-oral and post-swallowing) changed from saliva to solid food of inspiration/swallow/inspiration to expiration/swallow/expiration.

Note

Model of Facial-Oral Sequences

The facial-oral functions alternate continuously during the 24 hours a day and over lifespan. They react and adapt to the specific activity and its context. Swallowing (and subsequent breathing) often occurs after coughing, sneezing, yawning, spitting out, and speaking sequences.

Knowing this, enables therapists and nurses to elicit or facilitate the appropriate motoric reactions.

1.2 Movement Behavior and Motor Learning

» The brain is a problem-solving machine (Mulder 2003)

1.2.1 Prerequisites for Motor Learning

The F.O.T.T. approach is based on further assumptions:

- The newborn is equipped with a large stock of automatic motions (Kandel et al. 2012). These rhythmic movements, for example, the sucking/swallowing, breathing, can be attributed to innate neural networks, so-called *central pattern generators* (CPGs).
- Once activated, CPGs constantly generate task-oriented moving patterns and motion sequences. Postnatally, these movements are repeated and varied thousands of times, for example, the tireless drive of small children learning to stand up from all-fours. This results in automated movements which can then be performed subcortically, rapidly, efficiently, and safely. Then, these movements no longer require cortical initiation (Paeth Rohlfs 2010).
- Movements in activities are always goal oriented. The central nervous system (CNS) enables to achieve goals and adapt our bodies to the respective task and environmental conditions. Incoming signals are weighted, and the specific gravity conditions are calculated, which are necessary for the successful accomplishment of the task in the respective position (standing, lying, sitting, etc.). Calculated accordingly, the impulses then direct the activation of the corresponding antagonists (reciprocal innervations; Horst 2011, Kandel 2007). The intramuscular coordination determines the task-specific recruitment of the corresponding muscle fiber types. Depending on the task, the muscles work concentrically (shortening), eccentrically (giving length), or statically (constant).
- Postural control adapts and optimizes our movements. Incoming information is selected and evaluated through comparison with our existing knowledge and experiences (*feedback*). These experiences serve as the base for the performance not only of comparable

and similar, but also of new movements. *Feedforward* mechanisms use this wealth of experience to anticipate and plan activities and their necessary movements (▶ Chap. 3).

- Humans learn through problem-solving, using the body's own (e.g., proprioceptive, visceral, vestibular) and environmental (e.g., auditory, olfactory, visual, postural) information (Mulder and Hochstenbach 2003). The existence of special neurons in primates, known as *mirror neurons*, suggests that these neurons mirror the behavior of the others, thus enabling the encoding of reactions as though the observers were acting themselves (Rizzolatti and Sinigaglia 2008).
- Contrary to previous assumptions, humans can continue to learn into old age.
- *Neuroplasticity* describes the ability of the CNS to undergo lifelong functional changes through activity-dependent potentiation or depression, axonal sprouting, and other triggers. This allows the brain to compensate for damages, a discovery which revolutionized our knowledge about the functioning of the CNS. Kleim and Jones (2008) identify 10 principles which appear to affect neuroplasticity positively, for example, use it or lose it, use it and improve it, repetition matters, intensity matters, and time matters.
- Factors such as *attention, concentration, cognition, memory, motivation, past experiences, knowledge*, and the environmental context influence the individual performance of tasks. The results are stored, and can be accessed and adapted when similar situations arise (Banduras 1986, Kandel 2007, ▶ Chap. 3).
- All this depends on personal factors such as general condition, constitution, occurrence of diseases, and the environmental factors of the individual.

1.2.2 Changes Following Brain Damage

Brain damage can dramatically change motor behavior and motor learning. The disturbed movement patterns in patients with tetra- /hemiparesis, hemiplegia, and ataxia have been described in the original work of Berta and Karel Bobath (1977a, b, 1990). The concept and treatment principles have been further developed by Davies (1994, 2000), Paeth Rohlfs (2010), and Bassoe Gjelsvik (2012). Vaughan-Graham et al. (2009, 2015) and WHO (2012) provided new insight into the clinical practice of the concept and put it in context with the International Classification of Functioning (ICF, WHO 2012).

Secondary Problems

Many patients with impaired postural control lose balance. In order to keep balance, muscles with slowly twitching – (Type I, *tonic fibers*) try to stabilize the body by shortening concentrically.

Note

Stiffness as a secondary or compensatory phenomenon can be caused by postural instability, lack of movement, immobilization, and confinement to bed (bedridden state). Stiffness hinders the face, mouth, throat, larynx, and esophagus from moving adapted to the task.

It does not matter to the brain whether the inputs are physiological or pathological in nature: When the brain no longer receives the usual physiological inputs after damage, movements and behavior change, and ultimately malfunctions occur. This can hinder the patients from acting and moving independently. As a result, patients depend on the help and competence of caregivers to regain lost skills and cope with life.

Note

The brain operates 24 hours a day and learns at all times!

Also, pathological movement patterns can be learned and acquired permanently.

Swallowing is performed by movement – speaking is performed by movement!

Recognizing facial-oral dysfunctions (also) as *movement disorders* is a key to evaluate and treat the movements of swallowing (in dysphagia) and speech (in dysarthria).

1

1.3 Conceptual Considerations

» Give help for a better life, not exercises. (Berta Bobath)

What to do
- If the impaired sensorimotor system produces pathological movement patterns?
- If posture and movement are primarily altered by paralysis or dysfunctions in tone, but also secondarily, due to stiffness, anxiety, and stress?
- If the body is not able to compensate?

1.3.1 Bobath Concept

» First look at what the patient can do in his daily life; afterwards record their deficits and begin treatment, in order to find out why the movement pattern is dysfunctional. (B. Bobath, quoted by Biewald 1999)

According to the International Bobath Instructors Training Association (IBITA), "the Bobath concept is the most widely used neurorehabilitation approach worldwide, and considers the impact of the neurological condition on the whole person within her/his individual context. The clinical application focuses on movement analysis with respect to selective movement, postural control and the role of sensory information to develop a movement diagnosis guiding treatment and evaluation" (ibita.org 2019).

Orientation toward Potential and Solutions

According to Berta Bobath (1907–1991), the goal of diagnostic assessment is not to establish the dysfunction, but to assess the problems which patients face in their daily life, what they are still able to do, and how their *potentials* be utilized best (▶ Chap. 11). Bobath's conclusions were based on the systematic observation and knowledge of childhood learning. As a physiotherapist, she did not aim to strengthen certain muscles, but rather improve the coordination of posture and movement, and to obtain an adapted tone in activities of daily living (ADL). Her therapeutic focus emphasized the individual/patient in their surroundings and daily routine. In this way, activities (and their movement patterns) learned earlier may be remembered and potentially accessed. Therapeutic work in the context of daily living also offers greater potential for variation and repetition than any exercise program. Current approaches also propagate that *task-oriented* movement therapy is more effective than abstract exercises (Wulf 2007, Horst 2011, ▶ Chap. 3).

At the time, her approach to the person and her/his environment, which acknowledged the experiences, feelings, expectations, and particularly the attitude for learning, was unusual. This comprehensive approach which takes account of an individual's context, meets the standards of the International Classification of Functioning, Disability and Health (ICF; WHO 2012). Alongside specific *personal* and *environmental factors, activity* and *participation* in social life should be included in any assessment of the functionality of an affected person, as well as in the subsequent therapy.

1.3.2 Ingredients for Therapy: Input – Activity – Variability – Relevance – Context

» Without activity there is no input, without input there is no adaptation, and without adaptation survival is impossible. Input, activity and adaptation are therefore the basic ingredients of recovery (Mulder and Hochstenbach 2003)

In neurosciences and movement sciences, input, activity, adaptation, and variability in a meaningful context are factors that determine our development and survival. These are the basic principles of motor learning and rehabilitation following peripheral or central damages. Mulder and Hochstenbach (2003) describe three prerequisites for optimal learning (▶ Overview 1.1).

Overview 1.1 Prerequisites for Optimal Learning
- Optimally adapted sensory information
- Variability of tasks
- Task-oriented training related to context

In terms of both quality and quantity, training must be tailored to the patient's needs and capabilities. Patients are trained individually to perform increasingly difficult tasks to help them utilize their full potential. It is necessary to provide a diverse and expanding range of sensory inputs under varying conditions (shaping). To avoid overburdening the patient, learning steps and difficulty levels should be cautiously increased and adapted to the desired goal.

1.3.3 Intensity of Therapy – Rest Periods

Robbins et al. (2008) stated that time-consuming training is not synonymous with effectiveness. Nurses and therapists in rehabilitation clinics sometimes encounter patients who endure an overly full, daily therapy marathon.

The necessity and importance of resting periods for the patient were already recognized by Berta Bobath and are currently the subject of investigation in medical training therapy. Studies from the sports sciences and learning sciences show that breaks help to learn more effectively.

Seidl et al. (2007) found evidence that particularly in the early phase of rehabilitation, learning capacity can be exhausted quickly. A decrease in the rate of swallowing was observed following a 60-minute treatment, which only normalized after a recovery period of 90 minutes (Seidl et al. 2007). Patients receiving additional therapies, for example, physiotherapy and occupational therapy, immediately after the swallowing treatment, may not be able to access more capacity due to exhaustion. The authors assume that rest breaks are necessary to enable the brain to process new information. However, further research is needed to establish the benefits of rest periods in neurorehabilitation.

Note

Rest breaks are essential for physical recovery. Comparing rehabilitation therapy with hard, physical labor, it can be surmised that the CNS requires time to process the stimuli and impressions it has experienced.

Further studies are needed to confirm the hypothesis that rest breaks are necessary for central processing.

1.4 F.O.T.T. Areas

Four main areas are concerned: nutrition (eating, drinking, and swallowing), nonverbal communication, breathing, voice and speech and oral hygiene.

1.4.1 F.O.T.T. Area: Nutrition – Eating, Drinking, and Swallowing

» Along with nutrition and pleasure, eating and drinking provides an opportunity for meeting day to day with our fellow human beings, and cultivating social contacts! (Müller ▶ Chap. 5)

When people meet and communicate, it is often in conjunction with a meal. This provides an opportunity to show appreciation, care, affection, and hospitality. Eating and drinking are an important part of human culture and a form of human communication on many different occasions, for example birthdays, marriages, funeral receptions. These facts also shape the F.O.T.T. view and approach.

Swallowing Sequence according to Coombes

The swallowing sequence (Coombes 1996) consists of four phases:

1. Pre-oral phase
2. Oral phase
   - Bolus formation
   - Bolus transport
3. Pharyngeal phase
4. Esophageal phase

Coombes emphasizes the significance of the *pre-oral phase* in assessment and treatment.

The pre-oral phase is a state of *sensorimotor readiness*, of planning the following activities. It involves anticipatory saliva production and possibly swallowing, in response to seeing and smelling. Postural control

allows for an optimal alignment of head, shoulders, and trunk, promoting a stable foundation for manual dexterity, eye-hand coordination, arm movement, and coordinated adapted jaw opening, in any position. These operations "set the scene" (Mayston 2001) for phases such as the oral phase and influence timing and coordination of the pharyngeal phase.

Therapists must pay careful attention to the entire sequence of an activity, including the way it is initiated, for example: What happens in the pre-oral phase, *before* swallowing? What occurs *after* coughing or swallowing? Do patients breath in or breath out after swallowing? Do patients swallow after coughing, yawning, or is there no reaction? Techniques such as the F.O.T.T. tactile oral stimulation (▶ Sects. 1.5.3 and 6.2.4) are used to increase the quality and frequency of tongue movements and improve swallowing competence.

1.4.2 F.O.T.T. Area: Nonverbal Communication

Body language and facial expressions reveal much about humans. Feelings such as affection, fear, acceptance, or rejection are perceived without a spoken word. Anyone who has experienced the phenomenon of "love at first sight" will know. From infancy and childhood onward, learning is culture dependent, for example, how to interpret the nonverbal signs of others, how to respond through facial expressions, or to communicate feelings (▶ Chap. 7).

Many neurological patients have facial disturbances, especially during physically strenuous activities or multitasking:

- The facial expression is often rigid, and therefore appears unwelcoming.
- Facial movements are slow and often lacking in distinction.
- Asymmetry of the facial features, caused by facial paresis, is often intensified during action.
- The mouth may be open, causing a continuous flow of saliva, so-called drooling.
- Tongue protrusion causes saliva to be transported out of the mouth, rather than backwards into the throat.

All these symptoms affect communication-negatively, often with social consequences.

Impairments of Facial expression should not be considered or treated in Isolation

Often the facial expression of a patient, for example, with constantly raised eyebrows, is part of an abnormal body pattern, which also includes a retracted jaw, "shortened neck"; weak, flexed trunk; and fixed posterior pelvic tilt. Working on facial movements alone and in a sitting position may perpetuate this body pattern. Sitting demands considerable postural control from the patient, potentially reducing the capacity for selective facial movements.

Changing the position by choosing a more appropriate position for treatment may indicate whether the raised forehead is part of an overall, compensatory pattern.

A more *supportive starting position*, such as side lying, is advantageous for many patients, as the weight of the head and trunk can rest on the supporting surface. The attention and capability of the patient can then be fully directed toward sensing and performing facial movements.

A *(supported) standing position* may be an option for some patients. Standing upright allows for a more physiological position of the neck and head ("long neck") – and helps the patient to deal with gravity again (▶ Chaps. 4, 7, and 8).

1.4.3 F.O.T.T. Area: Breathing, Voice, and Speech

This F.O.T.T. area encompasses breathing, voice speech, and essential intermittent swallowing. Influencing/optimizing posture and tone enables more efficient breathing and speaking (▶ Chap. 8).

Central brain damage causes dysphagia and dysarthria (central disorders of respiration, phonation, and speech), either individually or in combination. As a result of pathological movement patterns and impaired postural control, the ability to perform selective movements is limited or distorted. The biomechanics often change in a compensatory manner. When patients with ataxia speak, often their head (usually punctum stabile) is in motion. The lower jaw (usually punctum mobile) is fixed and thus compensates for stabilization (▶ Chap. 4).

Note
Swallowing also occurs when speaking!

1.4.4 F.O.T.T. Area: Oral Hygiene

» The field of oral hygiene offers a therapeutic approach to problem analysis and the preparation of a treatment plan, in order to develop the most physiological movement patterns possible. (Daniela Jakobsen, personal communication)

The cleaning of the oral cavity and removal of oral residues is important for the safety of the patient, for example, to prevent aspiration pneumonia and to gain experience in the mouth area during the course of the day (▶ Chap. 6).

Note
Structured and therapeutically performed oral hygiene is optimal to elicit and facilitate the swallowing sequence in an ADL, for example, after spitting out water, by repetition and variation. Inputs are set clearly and in a structured manner.

The aim is also to develop the swallowing–breathing coordination and to deal with the occurrence of protective reactions.

The approach, the methods, and techniques are also appropriate for patients requiring long-term care, suffering from dementia, or receiving palliative care (Penner et al. 2010, German guidelines palliative care for patients with incurable cancer 2015).

1.4.5 F.O.T.T.: Tracheostomy Tube Management (TTM)

For many reasons, patients at risk of aspiration and mechanical ventilated patients are dependent on a cuffed tracheostomy tube (TT). The cuff of the TT may prevent these patients from aspiration-related complications, for example, pneumonia. The airflow bypasses the larynx and enters and exits through the TT opening.

Due to protection of the lower airway, a tube with an inflated cuff initially is a blessing! But the tube can become a curse for a variety of reasons. In therapy, we have to deal with several negative effects of the TT:

- A changed path of the airflow during breathing
- Altered protective mechanisms, for example, coughing
- Sometimes noticeable decrease in swallowing frequency
- Limitations on communication
- Complications such as tracheal stenosis, which may manifest later, even weeks after decannulation

A cuffed TT and/or a feeding tube may impede swallowing mechanically.

Overview 1.2 Prerequisites in Tracheostomy Tube Management

- Knowledge and fundamental skills relating to the effective care and management of the patient with TT, for example, suction techniques, changing of tube, care of the tracheostoma.

- The expertise of therapeutic skills: knowledge of airway changes and impacts on facial-oral functions, when using a tube. Facilitation of facial-oral movements and efficient clearing procedures during therapeutic-structured weaning, using speaking valves.
- Monitoring, observation, and evaluation of parameters, for example, oxygen saturation in the blood.

Knowledge about TTs and decannulation are becoming more widespread. However, simply deflating the cuff of a TT will not automatically lead to improvements in swallowing due to risk of aspiration. Seidl et al. (2002) showed that the combination of redirection of the expiratory airflow through the larynx, for example using a speaking valve and tactile oral stimulation significantly increased the swallowing frequency.

TTM focuses on the assessment and treatment of the altered posture and facial-oral sequences due to a TT. ▶ Chapters 9 and 10 illustrate the impairment of physiological processes and methods for their restoration.

1.5 F.O.T.T.: Approach – Principles – Methods – Techniques

1.5.1 F.O.T.T. Approach and Principles

F.O.T.T. is based on the Bobath concept and incorporates aspects of the Affolter model (Affolter and Bischofberger 1993) as well as current aspects of neurosciences.

Through clinical reasoning, the interprofessional team (e.g. physiotherapists, occupational therapists, speech therapists, nurses, doctors) provide targeted, therapeutically structured support in daily life (▶ Sect. 1.7.2). Relatives are welcomed, guided, and trained if they wish to be involved in the therapeutic way of supporting the patient. Principles are summarized in ▶ Overview 1.3.

Overview 1.3 The F.O.T.T. Approach and Principles

F.O.T.T. is

- Tailored to the individual patient and their environment
- ADL-oriented and concomitant with daily life
- Integrated into a 24-hour approach
- Interprofessional

The entire body is involved in the performance of facial-oral functions and activities.

F.O.T.T. starts as early as possible after brain injury, to enable patients to use their facial-oral functions as efficiently and effectively as possible.

1.5.2 Methods

In F.O.T.T., methods like activation, shaping, repetition, and variation are used in ADL to influence motor learning.

Activation

Different forms of activation are used:

- *Mobilization*: The patient moves or is moved within a postural set or into another postural set, passively or with facilitation/support. Depending on the task, the goal is to achieve adapted postural control, to gain more/different sensorimotor input, and a higher range of motion (ROM).
- *Facilitation*: It is a therapeutic method helping the patient to initiate, continue, and complete functional tasks. Various types of input (tactile/proprioceptive, visual, vestibular, somatosensory, and acoustic information) can be used to stimulate the motor system, for example, functional movements in the facial-oral tract. Facilitation is an active learning process, helping a person to overcome inertia and can be used, when the patient has inadequate motor behavior, lack of postural control, or problems to perform selective movements.

- *Elicitation*: Evoking of a movement, a function, behavior pattern, or an activity by an appropriate task or environment design. Elicitation is using position, support, and/or situation ("setting the scene") to draw out a functional response or reaction from the patient.
- *Guiding*: The therapist physically guides the patient's body and hands in problem-solving related to ADL, for example, dressing or having something to drink. Goals are to provide tactile/proprioceptive information to the patient, about the position of his/her body in the environment and the activity, and to improve the organization of perceptional processes in the brain (Affolter 1991).

Shaping

Shaping: Systematically increasing the level of difficulty of the tasks in order to achieve the optimal performance without overtaxing the patient.

Repetition and Variation

Repetition with variation means replicating an activity in another context. *Random practice* results in more effective motor learning and neural correlates (▶ Sect. 3.1).

1.5.3 Techniques

Techniques are procedures to facilitate a task by using the visual, proprioceptive, auditory, and vestibular input systems (Horst 2011).

Tactile Stimulation

Tactile, proprioceptive procedures make it possible to work with patients with reduced vigilance and problems in language comprehension.

Hands-on techniques and handling

Hands-on techniques can be implemented to support postural control and improve the biomechanical situation. These techniques aim to restore "the patient's sense of posture and movement," during handling and positioning (Bobath, quoted by Biewald 1999).

▶ Example

The patient lies on his left side for an hour.

Therapy begins with the alteration of this position (method: mobilization, technique: hands-on transfer). Using clear, tactile-proprioceptive, and vestibular input, the patient is moved onto his right side.

If any oral movements or signs of swallowing occur during the activity, transfer will be interrupted with the idea to elicit swallowing. The mandible will be stabilized by the jaw support grip. The lower jaw (biomechanical: punctum stabile) provides a stable reference for the tongue (punctum mobile) to initiate the tongue retraction movement for swallowing (Sticher and Gampp 2017).

Afterwards the transfer will be continued. Facial-oral work is continued once the patient has been positioned on his right side. ◀

F.O.T.T. stimulation: Tactile oral stimulation

Tactile oral stimulation aims to trigger a swallowing reaction via the subcortical path, for example, when the CNS perceives the saliva in the oral cavity and not because a therapist demands it (via the cognitive path). F.O.T.T. tactile oral stimulation involves structured tactile stimuli within the oral cavity, which vigilance-impaired or comatose patients and patients in palliative conditions are unable to produce themselves with their tongue, through speech movements or eating movements. The therapist's finger temporarily substitutes for the intraoral stimulation. This will often trigger an involuntary motor response, even an occasional swallow, without it being explicitly requested (▶ Sect. 6.2.4). The intention is to prevent sensory deprivation on one hand, and on the other hand these inputs can trigger motor responses, movements of the jaw, tongue, or even cause swallowing reactions.

Results of studies with transcranial magnetic stimulation show excitation potentials in the brain of healthy subjects during chewing and other facial-oral activities, and during F.O.T.T. tactile oral stimulation (Böggering 2008; Mütz 2009). Further studies are required to evaluate the effectiveness of these procedures.

Visual Stimulation

» Be a visual model Kay Coombes (personal communication)

Mirror neurons seem to decode observed activities of others without the aid of mind or language (Rizzolatti and Sinigaglia 2008). Although the theory of mirror neurons has been questioned (Pascolo et al. 2010), the phenomenon appears to play a role in child development, in how children learn by imitating. Also, the mental image of an action can produce an evoked potential in the CNS of the observer and activate neurons which help in the planning and performance of motor activity (Jeannerod 1997).

Therapists interact nonverbally by their facial expression, gesture and demonstrating, for example, the desired tongue motions, to make it easier for the patient to imitate and adopt the movements. Experience shows that in severely affected patients, imitating movements often leads to more success than following verbal instructions.

Verbal Stimulation

In terms of motor learning, studies suggest that a verbal instruction produces better results, if an *external focus* rather than an *internal focus* is provided. Wulf (2009 and Wulf et al. 2016) demonstrated that focusing attention on the goal to be reached (*what to do*) led to better results than consciously directing attention to the exact performance of a movement sequence (*how to do*) in golf players as well as patients with Parkinson's Syndrome. Different and more brain areas are activated and cross-linked by goal-directed tasks rather than by performing abstract movements.

Verbal instruction using an *external focus* conforms both to the ADL-oriented approach of F.O.T.T. and to current knowledge of motor learning (► Sect. 3.2.3).

Feedback – Timing

Depending on the patient's learning potential, we also must decide which kind of therapeutic feedback to the patient's performance should be provided – general or specific, qualitative or quantitative. This feedback can be verbal, visual (demonstration), or physical support (Muratori et al. 2013).

It is inappropriate to apply too many stimuli simultaneously, for example, verbal instructions plus guiding or facilitating.

Also, timing is important. After the task, patients must have time to evaluate their performance themselves, before therapeutic feedback is applied (Wulf 2007).

1.6 Challenges at Different Stages of Rehabilitation

» Meet the patients on their own terms! (Anonymous)

Emergency care and rehabilitation following a life-threatening incident has improved dramatically in recent years. Nowadays more people survive severe brain injuries. This creates new responsibilities and challenges for the medical and therapeutic professions. Also, the premorbid conditions and functional limitations of patients vary greatly, making it impossible to define a single, therapeutic procedure for all patients.

1.6.1 Intensive and Acute Phase

» Without information subjects are severely hindered in mastering novel tasks. This is an important point, particularly in the first stages of the rehabilitation process when, due to neurological damage, the person often can no longer trust his internal information. Failure to provide information will lead to markedly degraded learning, or to no learning at all. The therapist then becomes the most important source of external information. (Mulder and Hochstenbach 2003)

Thanks to the emergency care network used in many countries, patients are transferred to an intensive care unit (ICU) or stroke unit by ambulance or a rescue helicopter. Intensive care measures, such as long-term ventilation, tracheostomy, and sedation affect vigilance (alertness), protective airway mechanisms, nutrition, and communication capabilities. Nutrition in patients at nihil per os (NPO) must be defined, for example parenteral, enteral, via nasogastric tubes or PEG tube. The lack of physiological facial-oral input can lead to sensory deprivation, loss of movement initiation, and performance and secondary complications, such as biting reactions.

Warning

Swallowing frequency in sedated ICU patients is reduced. If this fact is ignored, it may cause the patient's lungs to fill with saliva within a short period after extubation. Recannulation and mechanical ventilation may then be a matter of life and death. The criteria for protection of the lower airway must be considered (◘ Fig. 9.8).

Early onset therapy

Eating and drinking is often not indicated in the early stage. In the acute phase, the primary concern of the therapist is to avoid sensory deprivation and adverse reactions in the facial-oral tract (Nusser-Müller-Busch 2013). Early onset of F.O.T.T. enables severely affected (even comatose) patients to experience physiological movements adapted to their current state.

The therapist's hands are both sensor and assistant. They sense the motoric capabilities and needs of the patient, to provide stability and a supporting surface, and to facilitate selective movements. Priorities for therapy in the intensive care/acute phase are listed in ► Overview 1.4.

Eating and drinking is often not indicated in the early stage. In the acute phase, the primary concern of the therapist is to avoid sensory deprivation and adverse reactions in the facial-oral tract (Nusser-Müller-Busch 2013).

Overview 1.4 Therapy in the Intensive/Acute Phase

Adapted to the patient's level of vigilance, regular changes of position are offered, assisting the patient to sense and move differently.

Tactile/proprioceptive stimuli are applied:

- Placing him in a variety of positions, within a stable environment
- Moving his hands toward each other, in order to apply cream
- Bringing the hands to the face, in order to rest the head on the hands
- Guiding breathing manually
- Assisting and facilitating swallowing of saliva, whenever the first attempts occur
- Performing F.O.T.T. tactile oral stimulation to help patients feel the structures in their mouth and saliva and to elicit motor responses
- Performing oral hygiene procedures to keep the mouth clean and healthy, but also to stimulate facial, oral, or swallowing reactions and prevent oral deprivation or hypersensitivity

1.6.2 Rehabilitation Phase

The length of stay in an ICU is kept as short as possible. Many patients with TT and feeding tubes are transferred to peripheral wards or special departments for rehabilitation/departments for early rehabilitation (in some parts of Europe).

Before TTM can begin, the general condition and vital parameters of the patient, for example, the oxygen saturation must be assessed as sufficient. The cuff of a TT then can be deflated, and a speaking valve can be provided, in the beginning for short periods. Using a speaking valve, in which exhalation passes the physiological way through the larynx, allows residues in the larynx and pharynx to be sensed again. In neurologic patients this may lead to improved swallowing reactions and improved swallowing frequency (Seidl et al. 2002, ► Chaps. 9 and 10).

Initially (and occasionally later), severely affected patients may require two team members in co-therapy, for transfer, positioning, and support, or the implementation of efficient therapy (Fig. 6.21a–c).

In various positions, including sitting or supported standing, movements for chewing, transporting, swallowing, phonation, speech can be developed, improved, and shaped again (▶ Chaps. 4, 5, 6, 7, 8, 9, and 10). In a protected situation (Fig. 5.7a–c), a structured transition to assisted oral feeding can start, later assistance in the dining room with others can follow. Temporary diet adaptions or long-term diet modifications are considered (iddsi.org (2020).

1.6.3 Chronic Phase and Palliative Phase

The impairments resulting from brain diseases may last for life. Patients carry a further risk of secondary and long-term complications, which need to be addressed on a long-term base.

In the case of progressive, neurogenic diseases such as amyotrophic lateral sclerosis, multiple sclerosis, or Parkinson's disease, therapeutic support and resources need to be adapted to the respective phase of the disease. Therapy should activate the available potential, relieve symptoms, and maintain skills and movements in the interests of maintaining quality of life (review of safety-related factors, ▶ Sect. 5.4.2). The aim is to enable the patient to communicate, verbally and nonverbally, and/or eat and drink safely. Special aids like cups (▶ Sect. 5.7.3) and a modified diet can be used, also in combination with tube feeding.

Note

If a completely oral diet is not possible, a combination of oral and enteral nutrition (via PEG) is sought.

A daily oral intake of food – even a small dietary modified amount – maintains the movement capability of the structures relevant for swallowing and can help to maintain the health of the mucosa in the digestive tract (therapeutic eating, ▶ Sect. 5.5.2).

The necessity of artificial forms of nutrition and communication must be considered early on.

Agreement with the patient can then be reached, for example, PEG systems can be inserted while the patient's general condition still is adequate, and augmentative and alternative communication aids can be tested and used. While therapy is initially seen from a rehabilitative perspective, in many cases the focus later moves to a more preventive or palliative approach (▶ Sect. 4.3.2, ALS patient example).

Adapted dietary modifications can be integrated into nutrition during the palliative phase, if possible. Handling, positioning, and therapeutic measures (moistening of the oral cavity, breathing support, and oral hygiene) are applied to bring relief, particularly in the final phase (Penner et al. 2010, German guideline palliative care for adult patients with incurable cancer).

1.7 F.O.T.T. – Interprofessional 24-Hour Approach

» Assessment is treatment – treatment is assessment (Kay Coombes)

The aim of therapy is to shift limitations, remove restrictions, and create change. Motor learning can only take place if the newly acquired movements during therapy can be practiced and applied in different contexts throughout the day. The interprofessional team is comprised of all those involved in caring for the welfare of a patient during a hospital or rehabilitation stay, during home care, or in a nursing home.

1.7.1 The 24-Hour Day

Daily therapy sessions will not succeed, if the patient sits slumped in a wheelchair during therapy or spends the rest of the day supine in bed. Apart from the risk of pressure sores and abnormal patterns associated with the supine position (e.g., risk of limb contracture), nobody would wish to spend several hours in the same position.

Following the 24-hour approach, therapeutic support is applied, as and when required, by the present team member or relative over the course of the day.

► Example

- Each transfer, positioning of the patient, or other care measures (such as pulling away the duvet, oral hygiene) provide the patient with opportunities to gain movement experience and to learn.
- Each team member, carer, or relative learns how to support the patient in a structured way (e.g., wiping the mouth, after drooling or coughing, and subsequent swallowing).
- Tongue movements can be facilitated repeatedly during the day, for example, nurses can use the pressure of the spoon during feeding to initiate the tongue moving backwards (► Chap. 5).
- The activities of tooth brushing and dressing also can be used to train swallowing saliva. ◄

1.7.2 Clinical Reasoning Processes

» The team must see, read and interpret the patient! (Daniela Jakobsen)

Team members working with F.O.T.T. continuously use a cycle of assessment, treatment, and reassessment. They are continually involved in a process of identifying problems, attributing causes, and generating hypotheses, which are then tested and discarded if necessary. It is important to identify both the patient's problems and potentials. Continuous evaluation and interpretation of the patient's (motor) responses are necessary. Each team member can contribute to this process from the point of view of their own professional competencies.

The F.O.T.T. algorithm (► Chap. 12) is a tool for clinical reasoning, which recognizes potentials and problems based on a solution-oriented approach. Decision-making processes provide information on the clinical effect and are used to formulate viable therapeutic hypotheses (Klemme and Siegmann 2014). Algorithms and treatment paths are designed to guide the therapist and the team through these processes.

1.7.3 Therapeutic Expertise of the Interprofessional Team

» Meet the patients on their own terms. And what are your terms in doing so? (Nusser-Müller-Busch)

The multi-professional skills of all team members are required to identify the specific problems of each patient and to influence them through defined interventions. But the topic, which *handling skills* all team members might require to work effectively, has barely been addressed in the individual professional trainings!

Members of the team may note their limited skills when handling patients with fundamental postural problems and find that certain tasks may prove difficult:

- Recognizing a retracted jaw and tongue position may not help a speech therapist further if she is unable to move the patient out of their unfavorable sitting position!
- Performing neuropsychological tests while supine in bed does not improve a patient's understanding of the situation or their competencies for mastering everyday life!
- If the patient sits in an unsupported, unphysiological (slumped) position during a Fiberoptic Endoscopic Evaluation of Swallowing (FEES, Langmore 2001), it can influence the outcome of the assessment. A slumped position influences the structures responsible for swallowing and therefore adds to the patient's motor deficiencies. ◘ Figure 1.2 shows a patient in supported position during the FEES (◘ Fig. 1.2).

Each team member must be able (or learn) to bring the patients into a suitable starting position or to correct their position, if necessary. The combination of theoretical knowledge about postural control and hands-on work-

Fig. 1.2 Supported sitting position for FEES. The patient is sitting at the table with dorsal and ventral support for his trunk. His arms are supported on a height adjustable table. The therapist provides jaw support and assists the patient's right hand to hold the glass while he can take a sip from the glass. (© Jakobsen 2019. All Rights Reserved)

shops enhance skills and therapeutic competence within the team.

Inhouse workshops for the team are essential. Team members can self-experience normal facial-oral functions they usually perform automated on a daily base. They can self-experience and reflect on what it feels like for the patient to sit in a fixed asymmetric position and to be fed, to speak, or to swallow with the neck hyperextended. They can feel the implementation of a structured oral hygiene with stability provided by a jaw support grip or a structured mouth wiping.

The team will then probably react more attentively to the patients' impairments and use the therapeutic handling to their benefit. Practicing together has also the advantage of getting feedback from the colleagues. Neurological patients are often unable to provide this feedback verbally.

F.O.T.T. courses are generally directed at multi-professional participants; 2 days introductory courses are offered as well as 5 days basic courses (with supervised treatment of patients), or advanced courses, for example, for the treatment of patients with tracheostomy (▶ back 14).

Dealing with the patient competently must be a priority for all professional groups involved in neurological rehabilitation. Learning with and from others provides an opportunity to enhance one's own knowledge and therapeutic skills.

References

Affolter F (1991) Perception, interaction and language. Springer, Berlin, Heidelberg, New York, pp 167–189

Affolter F, Bischofberger W (1993) Wenn die Organisation des zentralen Nervensystems zerfällt – und es an gespürter Information mangelt. Neckar, Villingen-Schwenningen

Banduras A (1986) Social foundations of thought and action: a social cognitive theory. Prentice Hall, Upper Saddle River

Bassoe Gjelsvik BE (2012) Die Bobath Therapie in der Erwachsenenneurologie. 2. Aufl. Thieme, Stuttgart

Biewald F (1999) Grußwort. In: Paeth Rohlfs B Erfahrungen mit dem Bobath-Konzept. Thieme, Stuttgart, S VI–VII

Bobath B (1977a) Treatment of adult hemiplegia. Physiotherapy 62:310–313

Bobath K (1977b) Die motorische Entwicklung bei Zerebralparesen. Thieme, Stuttgart

Bobath B (1990) Adult Hemiplegia. Heinemann Medical Books, London

Böggering J (2008) Einfluss einer cutanen elektrischen Stimulation des Halses auf den motorischen Kortex bei gesunden Probanden. Diplomarbeit Lehr- und Forschungslogopädie RWTH, Aachen

Bolser DC, Gestreau C, Morris KF, Davenport PW, Pitts TE (2013) Central neural circuits for coordination of swallowing, breathing, and coughing: predictions from computational modeling and simulation. Otolaryngol Clin North Am 46(6) https://doi.org/10.1016/j.otc.2013.09.013. Accessed 29 Mar 2019

Castillo Morales R (1998) Die Orofaziale Regulationstherapie, 2. Aufl. Pflaum, München

Coombes K (1996) Von der Ernährungssonde zum Essen am TisChap. In: Lipp B, Schlaegel W (Hrsg) Wege von Anfang an. Frührehabilitation schwerst hirngeschädigter Patienten Neckar, Villingen-Schwenningen, S 137–143

Coombes K (2002) Zitate im Rahmen des F.O.T.T.-Refresher Kurses im Therapiezentrum Burgau 12/2002. Therapiezentrum Burgau, Dr. Friedl Str. 1, 89331 Burgau

Davies PM (1994) Starting again. Early rehabilitation after traumatic brain injury or other severe brain lesion. Springer, Berlin Heidelberg

Davies PM (2000) Steps to follow. The comprehensive treatment of patients with hemiplegia. Springer, Berlin

Duysens J, Trippel M, Horstmann GA, Dietz V (1990) Gating and reversal of reflexes in ankle muscles during human walking. Exp Brain Res 82(2):351–358

German guideline palliative care for adult patients with incurable cancer. http://leitlinienprogrammonkologie.de/Palliativmedizin.80.0.html. Accessed 17 May 2018
Horst R (2011) N.A.P. – Therapieren in der Neuroorthopädie. Thieme, Stuttgart, S 13
Hüther G, Weser I (2012) Das Geheimnis der ersten neun Monate, 2. Aufl. Beltz, Weinheim
Ibita.org. http://www.ibita.org/. Accessed 04 Apr 2019
Iddsi.org. https://iddsi.org/. Assessed 02 Aug 2020
Jeannerod M (1997) The cognitive neuroscience of action. Blackwell Publishers, Cambridge
Kandel EC (2007) Auf der Suche nach dem Gedächtnis. Pantheon, München 2007:87–88
Kandel EC, Schwartz JH, Jessel TM (eds) (2012) Neurowissenschaften: Eine Einführung. Akademischer Verlag, Heidelberg
Kleim JA, Jones TA (2008) Principles of experience dependent neural plasticity: implications for rehabilitation after brain damage. J Speech Lang Hear Res 51(1):S225–S239
Klemme B, Siegmann G (2014) Clinical Reasoning Therapeutische Denkprozesse lernen, 2. Aufl. Thieme, Stuttgart
Langmore SE (ed) (2001) Endoscopic evaluation and treatment of swallowing disorders. Thieme NY, Stuttgart
Logemann JA (1998) Evaluation and Treatment of Swallowing Disorders. Pro-ed Austin
Mayston M (2001) Problem solving in neurological physiotherapy – setting the scene. In: Edwards S (ed) Neurological physiotherapy – a problem-solving approach, 2nd edn. Churchill Livingstone Elsevier, Edinburgh
Mulder T (2003) Citations, lecture adaptation and flexibility of human motor system – implications for neurological rehabilitation. Allgemeines Krankenhaus St. Georg, Hamburg
Mulder T, Hochstenbach J (2003) Motor control and learning: implications for neurological rehabilitation. In: Greenwood RJ (ed) Handbook of neurological rehabilitation, 2nd edn. Psychology Press, New York
Muratori LM, Lamberg EM, Quinn L, Duff SV (2013) Applying principles of motor learning and control to upper extremity rehabilitation. J Hand Ther 26(2):94–103. https://doi.org/10.1016/j.jht.2012.12.007
Mütz S (2009) Einfluss einer oralen Stimulation nach F.O.T.T. auf den motorischen Kortex gesunder Probanden. Diplomarbeit Lehr- und Forschungslogopädie RWTH, Aachen
NDT, Neuro-Developmental Treatment. https://www.ndta.org/. Accessed 10 May 2018
Nusser-Müller-Busch R (2013) Schluckstörungen auf der Intensivstation: Atmen und Schlucken – eine vitale Beziehung. DIVI 4:7–14. https://doi.org/10.3238/DIVI.2013.007-0014
Paeth Rohlfs B (2010) Erfahrungen mit dem Bobath-Konzept. 3. Aufl. Thieme, Stuttgart
Pascolo PB, Budai R, Rossi R (2010) Critical review of the research leading to the mirror neuron paradigm - biomed 2010. Biomed Sci Instrum 46:422–427
Penner H, Bur T, Nusser-Müller-Busch R, Oster P (2010) Logopädisches Vorgehen bei Dysphagien im Rahmen der Palliativmedizin. Z Palliativmed 11:1–13
Rizzolatti G, Sinigaglia C (2008) Empathie und Spiegelneurone. Die biologische Basis des Mitgefühls. Suhrkamp, Berlin
Robbins J, Butler SG, Daniels SK, Diez Gross R, Langmore S, Lazarus CL, Martin-Harris B, McCabe D, Musson N, Rosenbek J (2008) Swallowing and dysphagia rehabilitation: translating principles of neural plasticity into clinically oriented evidence. J Speech Lang Hear Res 51:276–300
Schultheiss S, Wolter T, Schauer H, Nahrstaedt H, RO Seidl (2015) Einfluss der Körperposition auf die Atem-Schluck-Koordination. HNO 63(6):439–446 – Effect of body position on coordination of breathing and swallowing. https://www.ncbi.nlm.nih.gov/pubmed/26059790. Accessed July 2018
Seidl RO, Nusser-Müller-Busch R, Ernst A (2002) Der Einfluß von Trachealkanülen auf die Schluckfrequenz. Neurol Rehabil 8:302–305
Seidl R, Nusser-Müller-Busch R, Hollweg W, Westhofen M, Ernst A (2007) Pilot study of a neurophysiological dysphagia therapy for neurological patients. Clin Rehabil 21(8):686–697
Sticher H, Lehmann K (2017) Schluckrehabilitation therapeutisch unterstützen – Das Schlucken fördern. physiopraxis 15(03):38–41
Vaughan-Graham J, Eustace C, Brock K et al. (2009) The Bobath Concept in Contemporary Clinical Practice. Top Stroke Rehabil 16:57–68
Vaughan-Graham J, Eustace C, Brock K, Swain E, Irwin-Carruthers S (2015) The Bobath Concept in Contemporary Clinical Practice. Topics in Stroke Rehabilitation 16(1):57–68
WHO – World Health Organization (2012) International Classification of Functioning, Disability and Health (ICF) http://www.who.int/classifications/icf/en. Deutsche Fassung: http://www.dimdi.de/static/de/klassi/icf/index.htm. Accessed 16 Mar 2015
Wulf G (2007) Motorisches Lernen. Physiopraxis Refresher 1(7):3–10
Wulf G (2009) Aufmerksamkeit und motorisches Lernen. Urban & Fischer/Elsevier, München
Wulf G, Lewthwaite R (2016) Optimizing performance through intrinsic motivation and attention for learning: the OPTIMAL theory of motor learning. Psychon Bull Rev 23(5):1382–1414