

The Challenges of Aging – Sensory, Cognitive, Socio-Emotional and Health Changes in Old Age

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Age and Aging

The chronological age of a person is considered an objective measure. It is often used as an indicator of life experience, generational affiliation, or as a basis for defining which personal or professional phase of life a person is in. Unfortunately, this implied information is neither conclusive nor reliable. Chronological age does not tell anything about distinctive life events, the personal body of experience, or the reasons for a certain life course. Because of enormous inter-individual differences in life trajectories the chronological age does not even give us a hint about present functional or cognitive status. Besides, the meaning of chronological age has changed over the decades. In the late nineteenth century people over thirty were considered old, but this is young by today's standards, with life expectancy exceeding eighty or ninety years in developed countries. A large number of alternative concepts are used to describe the process of aging or its resulting status. With reference to biological age, factors like indicators of fitness, beginning of menopause, amount of grey hair, number of wrinkles, or nightly trips to the restroom are referred to. Regarding functional age, the labels of "Gogos", "Slow-gos", and "No-gos" were invented to describe the quality and range of motion and activity in old age. Correspondingly, intellectual abilities are referred to as cognitive fitness, cognitive age, or wisdom of age. In some cases life events are used to define what stage of life a person is in, mainly referring to social and occu-

pational life events, for example describing somebody as being a parent, divorced, widowed, retired, grandparent, or starting a second or third career. Accordingly, an age of attitude, moral, or lifestyle can be defined, often employing interests and activities such as openness for new things or lack of interest. It usually reflects the perspective of one generation to another. Last but not least, each person has a subjective age identification when asked how old she or he feels. Interestingly, research reveals that individuals in their teens have older subjective age identities, whereas across middle and late adulthood, individuals report younger age identities. Besides, women experience younger age identities than men across these adult years. Results also reveal that discrepancies between subjective and actual age are associated with personal fears of aging and life satisfaction (Montepare & Lachman, 1989). Thus, whenever we start speaking about "the good old days", we should take notice if this is actually about turning old ourselves. In summary, each approach to describing age and the process of aging serves its purpose, but limitations are obvious. Thus, we must carefully choose our words when speaking about the elderly in order to avoid labeling that reflects prejudice and stigmatization.

Changing Societies

Understanding the processes and implications of aging is one of the major challenges facing societies in the 21st century. From a traditional pyramid shape with broad base and tapering top, the world's population structure is literally about to be turned upside-down (Figure 1). While more and more people are getting even older due to increased life expectancy the decreasing birth rates further accelerate the process of population aging in developed and developing countries.

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	Population aged 60 years or over							
	Number (thousands)		Percentage of total population		Percentage 80 years or over		Percentage living alone	Percentage in labor force
	2006	2050	2006	2050	2006	2050	Men/Women	Men/Women
World	687 923	1 968 153	11	22	13	20	8/19	40/16
More developed regions	247 753	400 029	20	32	19	29	13/32	22/11
Less developed regions	440 170	1 568 124	8	20	10	18	5/9	50/19
Least developed countries	39 593	171 191	5	10	7	10	4/8	71/37
Australia	3 602	8 356	18	30	20	29	n.a.	21/9
Canada	5 939	13 646	18	32	20	31	14/33	23/11
United States of America	50 908	104 433	17	26	21	28	15/35	30/19
Europe	151 841	225 373	21	34	18	28	13/35	15/7

Table 1. Number of persons aged 60 years or over (United Nations, Population Division DESA, 2006).

In 2006, 17% of the population in the US and 21% in Europe was older than 60 years (UN 2002, 2006). Estimates indicate that these numbers will increase to 26% and 34% respectively by 2050 (Figure 2, Table 1). As such, this large segment of elderly defines society and gains influence not only in economics and politics but in all areas of public life. Today's population ageing is unprecedented, without parallel in human history – and the new century will witness even more rapid aging than did the century that just passed.

Among the world population, the fastest growing group is the “oldest-old”, or persons aged 80 years or

over. By 2050, this segment of the population is projected to reach 395 million or 4.3% of the world population (UN 2009). Within the segment of elderly different subgroups can be identified. According to chronological age at least three subgroups of elderly are commonly distinguished after middle adulthood (age 30 to 64 years): “Old age” (age 65 to 79 years), “Oldest-old” (age 80 and older), and “Centenarians” (age 100 and older). The latter represent an entirely new group of elderly, which has never existed before and about which not much is known due to limited existing research. In addition, today's elderly are not the same as the elderly thirty years ago. New generations are getting older. As an example Baby Boomers (people born after World War II between 1946 and 1964) have transformed societies with a broader sense of individualism. Their lifestyle is no longer predictable based on their age alone. On average they feel about fifteen years younger than previous generations of the same age. While most of their parents kept one job until retirement and married once, baby boomers have often changed careers with more opportunities for women, divorced and remarried, had methods for birth control available, have a higher educational level than their parents, have traveled more than any earlier generation and continue to be active after retirement (Traynor, 2009). In addition, with life expectancies of thirty, forty, and more years after retirement, there are different generations among the elderly at the same time. These facts lead to the conclusion that a differenti-

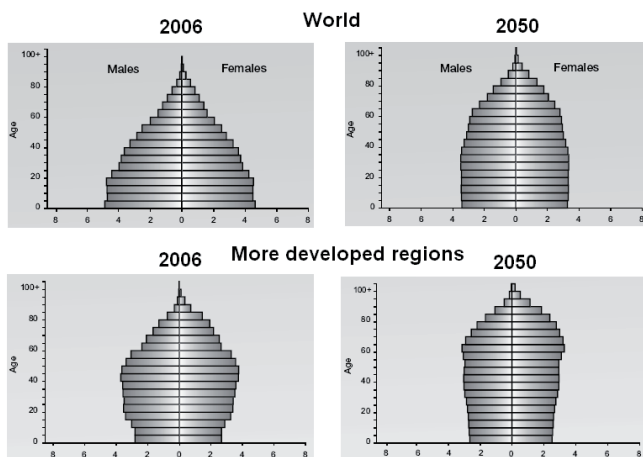


Figure 1. Population pyramids 2006 and 2050 (United Nations, Population Division DESA, 2006).

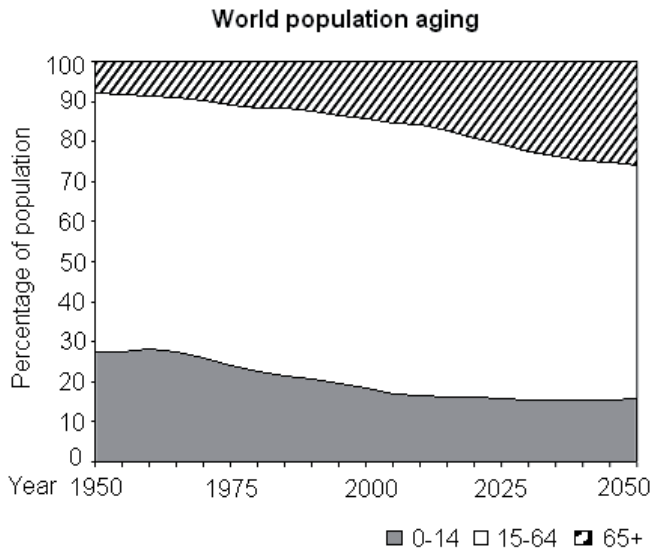


Figure 2. Distribution of population by broad age groups: 1950–2050 (United Nations, Population Division DESA, 2002).

ated view and knowledge about aging are needed when addressing elderly clients, for example, in audiological care.

Ability Changes in Old Age

Health in Old Age

In general, today’s elderly show much better health compared to earlier generations and the disability-free life expectancy is increasing. Still, aging affects all organ systems and usually in a negative way. Besides the obvious grey hair, stiff joints, or loss of subcutaneous fat tissue, aging may lead to bone resorption, less expandable lung tissue, less elastic connective tissue and all too often results in hypertension, arthritis, chronic joint symptoms, heart disease, cancer, or diabetes. This is just to name the most frequently occurring chronic healthcare conditions for adults over age 65. Typically age-related physiological changes do not lead to a loss of function, but to a restricted function of an organ or body structure. Also, in old age changes occur at the same time in different organ systems and body structures and interact with each other. These concomitant changes determine the duration and intensity of a clinical picture as well as its outcome, which may be a temporary functional restriction or a permanent disability. Consequently, old age is often associated with longer lasting convalescence, comorbidity, and chronic conditions. In the Berlin Aging

Study (BASE), of the more than one thousand participants aged 70 to 104 years old, 96% reported at least one diagnosis and 30% reported five and more diagnoses that would require medical treatment (Steinhagen-Thiessen & Borchelt, 1996). Most frequently, the cardio- and cerebro-vascular systems as well as the muscular-skeletal system are affected. Moreover, one third of the seniors over 70 years in this study suffered from life threatening diseases. Regarding mental health with increasing age, prevalence of dementia exponentially increases from 2% of people under the age of 65 years with doubling of numbers every five years up to 30% to 50% at the age of 90 years. Dementia is the leading cause of institutionalization among the elderly; prevalence among elderly nursing home residents is estimated to be 60% to 80%. Among dementia diagnoses, Alzheimer’s Disease is by far the most common type with about 54% of all cases, whereas vascular dementia accounts for about 16%, and combined diagnosis of Alzheimer’s and vascular dementia accounts for about 25% of the patients (Lobo et al., 2000). Today’s diagnostic manuals define dementia as the only mental disorder that is specifically related to age (DSM-IV, ICD-10) while other kinds of mental disorders for example mood disorders, anxiety disorders, substance related disorders, or sleep disorders are also common in old age. Highest prevalence rates among the elderly are usually seen for depression, insomnia, and dementia (Wernicke, Linden, Gilberg, & Helmchen, 2000).

Somatic as well as mental conditions may lead to functional limitations and disability. In order to shift the focus from cause to impact, the International Classification of Functioning, Disability, and Health (ICF, WHO 2001) describes human functioning on three different levels: functioning at level of body or body part, the

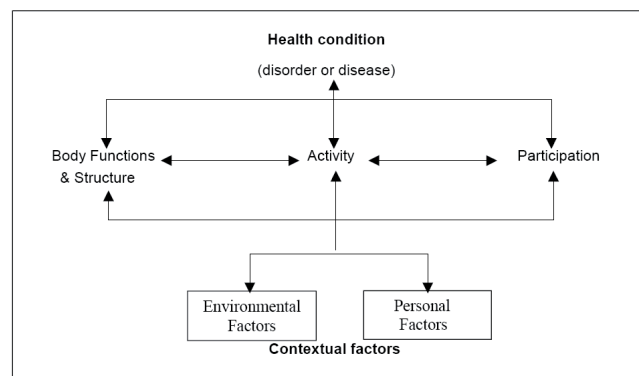


Figure 3. International Classification of Functioning, Disability and Health (ICF, WHO, 2001).

whole person, and the person in a social context (Figure 3). Correspondingly, three levels of disability can be described: impairments of body function (e.g., hearing loss), activity limitations (e.g., difficulties using the telephone), and participation restrictions (e.g., less frequent contacts with friends). With this ICF acknowledges disability no longer only as a “medical” or “biological” dysfunction, but takes into account the social aspects and the impact of the environment on a person’s functioning, which is especially important when confronted with multiple impairments in old age.

Sensory Decline in Old Age

Depending on the study and its design, hearing loss is estimated to be prevalent in about 30% to 40% of the population between the ages of 65 and 74 years and in about 50% to 80% of people 75 years and older (cf., Cruickshanks et al., 1998, U.S. Congress, Office of Technology Assessment, 1986). Although aging affects hearing at all frequencies, the high frequencies are affected more impacting the perception of high-pitched and low-energy speech sounds in particular (e.g., consonants *s*, *th*, *f*, *t*, *k*). Presbycusis, as the age-related hearing impairment is referred to, is often associated with additional difficulties besides elevated thresholds for high frequencies. These difficulties become particularly evident in complex or noisy listening situations and reveal, for instance, problems with frequency resolution, temporal resolution, localization, separation of speech in background noise, or understanding in reverberant surroundings (Pichora-Fuller & Souza, 2003; Wingfield, 2000). Referring to the ICF system, the impact of such hearing impairments for an individual becomes most apparent when looking into activity and participation restrictions resulting in everyday life. Common complaints include: difficulties communicating in noise, lacking the ability to hear whispered conversation or side remarks, no longer being able to participate in group discussions, great difficulties understanding on the phone, disorientation and insecurity in road traffic, no longer enjoying music or singing, missing sounds of nature. Moreover, there are strong emotional reactions resulting from these difficulties. A person may report feeling isolated, trapped within one’s own world, making oneself unpopular, a sense of insecurity in everyday life, or experiencing “an awful silent world”. These examples give only a rough insight into the enormous relevance of hearing in our lives. Research shows that hearing impairment certainly has an impact on health-related qual-

ity of life, social, psychological, and socio-emotional functioning and is particularly related to depression, loneliness, anxiety, distress, and somatization (e.g., Nachtegaal et al., 2009). To make matters worse, sensory decline is not limited to the auditory system; the visual system is frequently affected as well. Age-related visual impairments are common for people who have problems with visual acuity, color discrimination, adaptation to seeing in the dark, contrast sensitivity, and peripheral vision acuity. This causes problems with reading small print, interpreting correctly facial expressions, seeing in the dark or when light is diffuse, driving, or judging distances. In addition, negative age-effects on motor abilities such as balance, manual dexterity, or psycho-motor reaction times are very common. With this information in mind it becomes clear that the combined effects of multi-sensory decline may have an even worse impact and may affect the most common, simple tasks in everyday life. Visual impairment combined with dexterity problems makes it difficult to handle small devices like a hearing instrument. For the hearing impaired, difficulties seeing cause additional problems with noticing facial expressions and gestures during a conversation; or when using a hearing instrument to recognize small parts of the instrument and to read its user guide. Therefore, audiological care must pay attention to individual abilities, concerns, and needs of the elderly client. This means that constraints and resources in other capability domains, besides hearing, have to be taken into account.

Cognitive Resources in Old Age

When talking about “hearing” we refer to the essentially passive function that provides access to the auditory world via the perception of sound. The term is primarily useful to describe impairment, typically using audiometry (Pichora-Fuller & Singh, 2006). In the consensus definition of the Eriksholm Workshop in 2003, which uses WHO’s ICF classification and definitions as benchmark, “hearing” is clearly differentiated from more active processes of “listening”, “comprehending”, and “communicating”, where cognitive and social factors come into play (Kiessling et al., 2003). “Listening”, understood as the process of hearing with intention and attention for purposeful activities, demands the expenditure of mental effort and relies on higher cognitive abilities. “Comprehending” follows successful listening and is defined as the unidirectional reception of information, meaning, and intent, whereas “communicating” is the bidirectional transfer of information, meaning, or intent

between two or more people. In summary, good hearing is a precondition for successful listening, comprehending, and communicating, but it is not sufficient. In order to segregate relevant information from the speech stream it is especially important to concentrate, to hold information in a short-term memory or working memory, to recognize words, meanings or to read between the lines by integrating new information into long-term memory and by comparing it with accumulated knowledge. All this happens with speech arriving at a rate of two to three words per second, with no clear separation of usually under-articulated words, with rapid parsing of incoming words and phrases for their function within and across sentences in order to assemble semantic content of sentences in terms of an overall meaning or abstract idea (Wingfield, 2000). By describing the processes involved in speech perception, two directions of information flow become apparent: a bottom-up analysis of acoustic input towards words and meaning (from cochlea to cortex) and a top-down analysis using the listener's knowledge for context-driven expectations and listening strategies for allocating cognitive resources such as attention or memory. With age, the continuous interaction of bottom-up and top-down speech processing may be compromised through a decline in sensory abilities, in cognitive abilities, or both.

Development of cognitive resources in old age can be best described through three basic principles: multi-dimensionality, multi-directionality, and inter-individual differences. Different dimensions of cognition develop differently – with some showing stability, some decline, and others increase of functional level. Even within an ability domain, such as memory, several different types of memory and subfunctions have to be distinguished. While negative age effects are well known for encoding, recalling, or recognizing of relatively new information from the episodic memory (e.g., remembering what I did yesterday), semantic memory (e.g., vocabulary, world knowledge), implicit memory (e.g., using previous experiences without conscious awareness), and procedural memory (e.g., remembering how to button a shirt) prove to be relatively unaffected by age. Also, semantic memory even improves with age – reflected in comprehensive vocabulary and elaborated world knowledge sometimes leading to what is called wisdom of age. For most cognitive abilities, inter-individual variability increases with age and most often differences are bigger between persons of the same age than between persons of different age groups. Still, general developmental trends have been identified. On the one hand, increas-

ing age is associated with a slowing in speed of information processing, with diminished capacity of working memory and with difficulties in processing parallel, interfering information through divided attention and inhibitory cognitive control, all basically limiting how fast and how much information can be processed by the cognitive system (e.g., Park, 1999, Lemke & Zimprich, 2005). On the other hand, increasing age is associated with broader semantic knowledge, extended social and communication experience as well as better use of context information and listening strategies, all of which are used by elderly listeners to compensate for diminished sensory input (Wingfield, 2000).

Socio-Emotional Changes in Old Age

Confronted with numerous ability changes, often resulting in activity limitations and participation restrictions, one may come to the conclusion that elderly people cope with this in a negative way. However, surprisingly, research results indicate that elderly show high ratings of general well-being equal to those of younger people (Costa et al., 1987). This may be due to the same kinds of pragmatism and adapted expectations as recently stated by Jane Fonda (age 71): “Either you let the pain define you or you get on with your life.” The actress was wearing a corset after surgery when receiving an award in Berlin. The so called “paradox of well-being” gives an indication that regulation of emotions is quite effective in old age although research is very limited in this field. It seems that very intense emotions, both positive and negative, are less frequently experienced in old age, especially anger seems to be actively avoided by the elderly. Besides changed reactivity towards emotional stimuli and very effective self-regulatory processes, Lawton (1989) proposes that the emotional balance is realized by proactively avoiding negative emotions and searching for social environments that increase the probability of positive emotions.

Age-Specific Goals, Needs, and Values

A value change is mainly observed from one generation to another. An example is the sense of duty of the old generation expanded by the individualism of the new baby-boomer generation. Within an individual however, values are very stable across later adulthood and old age. Besides, in later life the realization of ability changes and of a limited life perspective typically lead, among other factors, to a re-evaluation of one's life situ-

ation and needs along with an adjustment or selection of goals. While in middle adulthood capabilities, self-fulfillment, enjoyment, social involvement are prominent, goals and provisions are made for later on. On the other hand, in old age, health and well-being, safety and security, autonomy, and social participation become central objectives.

Contextual Changes in Old Age

By definition, aging describes the multidimensional process of developmental change across the life span. However, aging processes do not take place independently of contextual factors, which according to WHO's ICF system (2001) represent the complete background of an individual's life and living and comprise two components: environmental factors and personal factors (Figure 3).

A Changing World

Looking back, just a few decades gives us an impression how much has changed with regard to environmental factors like housing, technology, traffic, nutrition, medical treatment, and social services, to name just a few. Such simple things as heating, telephone, public transportation, micro ovens, meals on wheels, pain killers, flue shots, medical insurance, or pension plans are often taken for granted by a majority of seniors today. We should be aware however that these are still quite new, modern comforts.

Living Arrangements in Old Age

For the individual, getting older is associated with a number of contextual changes. The transition to retirement is above all connected with a change of daily routine and greatly increases the importance of one's home. This is even more the case in advanced age when restrained physical mobility increasingly leads to a concentration of daily activities in and around the home. Everyday life in old age is, above all, life at home (Kohli, Kuenemund, & Zaehle, 2005). Because living arrangements also shape patterns of care-giving, it becomes often necessary to move into a smaller apartment, retirement center, or nursing home. Reasons may be that children move out and often far away; health issues make it difficult to clean a big house, to take care of a garden, to drive to the shopping center; partners get ill or die; or medical help or caretaking is needed for oneself. In the

latter situation, the impact is even more dramatic if one lives alone, like 13% of men and 32% of women over the age of 60 do in the more developed countries (Table 1). According to the Federal Inter-agency Forum on Aging-Related Statistics in 2004 the rate of nursing home residence in the US was 9 in 1,000 at age 65 to 74 years, compared with 36 in 1,000 at age 75 to 84 years, and 139 in 1,000 at age 85 years and older. Recent declines in rates of nursing home residence observed in the US and other more developed countries may reflect broader changes in the health care systems. Other forms of residential care and services, such as assisted living and home health care, have become more important and more prevalent in many countries.

Social Network in Old Age

Social relationships constitute a very powerful resource for well-being and autonomy in old age. Social networks are primary sources of instrumental and emotional support for developing an attitude towards and coping with age-related changes. An inherent problem though, is that members of a social network are often of the same age, therefore struggling with the same kind of problems and may not be available long-term due to death, health problems, or mobility restrictions. Thus, not only the number but also the frequency of social contacts becomes reduced in old age. Recent data from Switzerland show that 38% of the people over 75 years meet with relatives, friends, etc. less than once a week (FORS, 2006). However, older adults also become more selective about their social networks as stated in the theory of socio-emotional selectivity (Carstensen & Mikels, 2005). Because they place a high value on emotional satisfaction, older adults often spend more time with familiar individuals with whom they have had rewarding relationships. As a result, the elderly have often less, but equally satisfying social relationships as younger persons. This selective narrowing of social interaction maximizes positive emotional experiences and minimizes emotional risks as individuals become older. In old age, social networks are mostly reduced to family members (spouse/ partner, children, siblings) and very few close friends. Also here, demographic development will lead to changes in the near future as, in industrialized countries, trends show that less people have even less children at an older age and attitude towards marriage and divorce is changing as well as the bond between family generations (Kohli, Kuenemund, & Luedicke, 2005). Although many older persons who live alone are socially

active and financially secure, those who live alone are more likely to need outside assistance in the case of illness or disability and are at greater risk of social isolation and poverty (UN, 2006). The higher longevity of women and the fact that men are on average about three to four years older than their wives translate into highly divergent trajectories for the two genders as they grow older. In Europe, the proportion of widowed men increases from 2% (age 50–59) to 30% (age 80 and older), whereas the proportion of widowed women increases from 8% to 69%. As a result, 63% of men but only 16% of women over 80 years still live with a married or registered spouse (Kohli, Kuenemund, & Luedicke, 2005).

Finances in Old Age

The saying “money makes the world go round” applies in old age as well. Furthermore, no other generation before has had as much money available as today’s older generation. Not only does it provide a sense of security and autonomy, but is a precondition for financing of personal and technical support, such as house calls, nursing service, home delivery, assisted transport, or hearing systems. In old age, income from work is no longer the main source to support consumption, although many people work well above retirement age (Table 1). Instead, assets, real estate, insurances, and pension plans – provisions made earlier in life – can be used to generate liquidity. Besides, social and family support may substitute for or contribute to financing important necessities in old age, such as nursing and long-term care. The US Social Security Administration reports that the major sources of income for older people are: Social Security (reported by 90% of older persons), income from assets (59%), public and private pensions (41%), and earnings (22%) (National Research Council, 2004).

Use of Technology in Old Age

Older people use many technology items. In fact, new technologies are often not optional but rather difficult to avoid, for instance answering machine, fax, clock radio, microwave oven, voice menu systems, ticket machines, or online accounts. However, almost 75% of the people report experiencing difficulties in usage of technology products in everyday life. In old age, problems are mainly due to perceptual limitations for seeing or comprehending text or symbols, due to movement control for holding or opening items, or due to remember-

ing instructions or warnings (Fisk, Rogers, Charness, Czaja, & Sharit, 2009). Design guidelines and their application for the development of technology for older people are urgently needed. It is estimated that over 50% of the reported usage problems in daily life can be addressed through human factor design efforts. In addition, inadequate training for use of assistive technology can often be identified as one of the significant barriers for using a device (Helal, Mokhtari, & Abdulrazak, 2008). If, from the start, emphasis is placed on the transfer of skills in everyday life and on cross-training for personal use and environments, transition to assistive technology use will be much more effective.

Development and Compensation in Old Age

Selection, Optimization, and Compensation

Three universal processes of adaptation have been identified as essential for development across the lifespan and optimal aging (Baltes & Baltes, 1990). The theory of selective optimization with compensation by Paul Baltes can best be illustrated by an example. When concert pianist Arthur Rubinstein was asked in an interview how he managed to maintain such a high level of expertise playing the piano at the age of eighty years, he hinted at the coordinated use of three strategies. First, Rubinstein said that he played fewer pieces (selection); second, he indicated that he now practiced these pieces more often (optimization); and third, he suggested that to counteract his loss in mechanical speed, he now used a kind of impression management, such as introducing slower play before fast segments, to make the latter appear faster (compensation). In general, given that physical and cognitive resources of human organism are limited, a selection including prioritization or adaptation of goals is necessary. This becomes even more important in old age when time and capabilities are perceived as more constrained. Optimization refers to the improvement or acquisition of capabilities, resources, or behavior, necessary to achieve the goals selected as relevant. Compensation, finally, is operative whenever a given set of means is no longer available, either because of direct loss (e.g., hearing loss), because of negative transfer (e.g., incompatibility between goals), or because of new limiting constraints in time and energy (e.g., the exclusive consumptive focus on the tasks of resilience and regulation of loss) (Baltes, 1997).

Regulation of Emotion and Motivation

Despite the accumulated confrontation with challenges and losses when getting older – of which only a few were addressed in this paper – most individuals state a positive, active, and developmentally oriented view of aging. The theory of socio-emotional selectivity provides a powerful explanation how this emotional balance is realized (Carstensen & Mikels, 2005). In old age, when time and capabilities are perceived as more constrained, emotionally meaningful goals are pursued and generate motivation because they can be realized in the present. Thus, proactive avoidance of negative emotions and search for rewarding social environments increase the focus on the positive. This effect is reinforced by the selective influence of emotions on attention and memory.

Cognitive Top-Down Compensation for Bottom-up Sensory Decline

As discussed with the example of hearing loss, cognitive resources for the top-down compensation in old age involve better use of listening strategies, better use of context information, better use of prosody (e.g., intonation, timing, stress), broader experience in social interaction and social situations as well as broader vocabulary, semantic, and linguistic knowledge compared to younger age. Thus, by activating associated latent resources, allocation of time and effort, and by use of cognitive and behavioral strategies the older people try to maintain or reestablish a prior functional level. In addition to these successful psychological mechanisms, an actual improvement of sensory input by means of technology, for instance by using a hearing system or glasses, has great potential to reduce necessary top-down compensation and listening effort for successful comprehension.

Compensating by Organizing Help and Use of Assistive Technologies

Optimization and compensation may also include the use of external help by means of personal or technical support. Given that even among centenarians, only one third is severely handicapped and needs extended care, whereas one third is autonomous in every day life, and another third needs partial care, but can go outdoors, a growing need for ambulant care can be stated (Lehr, 2006). Not only do a majority of seniors want to age-in-place, but from a societal per-

spective it seems to be cost effective to support this preference over institutionalization. Efforts must include the involvement of family caregivers by means of practical support, guidance, and counseling, especially in stressful and high-pressure situations. Besides, community support, daycare concepts, out-patient and ambulant services have to be established and improved relative to availability, quality, reliability, and flexibility. In this area, research is missing with respect to evaluation and suggestion of effective and affordable services.

Maintaining mobility and functional independence requires successful performance of a wide variety of activities. Elderly people are open to the idea of using assistive technology, although they may struggle for instance with a number of usability issues (Fisk et al., 2009). They want to remain independent for as long as possible into old age and feel these products have the potential to help them. Although politics, research, and industry have just started to pay attention, efforts are supported by two movements. One is the introduction of accessibility legislation in a number of countries that ensures the building of environments and services that do not discriminate against people with disabilities. The other is the universal design philosophy that aims to create products and environments that are accessible and usable more easily by a wider public. Like accessibility in public space, fall prevention at home is an equally important requirement for seniors. General precautionary guidelines can be very helpful (e.g., NIHSeniorHealth: <http://nihseniorhealth.gov/falls/homesafety/01.html>) and structural modifications for things like potential tripping hazards or lighting issues can mostly be quite easily addressed. Concerning assistive technology development is picking up speed and is no longer limited to the examples of wheelchairs, walkers, or eyeglasses. In the age of technology and internet, new channels for communication, home-monitoring systems, support by robots, and memory support systems are no longer out of reach (e.g., <http://awarehome.imtc.gatech.edu/>). Also in the hearing aid industry we are no longer referring to a simple “hearing aid”, but to “hearing systems” that provide access to the auditory world by digital signal processing, by automatic adaptation to the environment in order to continuously improve hearing and speech comprehension, and by wireless connection to other media (e.g., FM systems, mobile phone, GPS device, TV, MP3 player).

Learning and Brain Plasticity in Old Age

Age-related physiological changes in the healthy brain are undeniable and include moderate loss of brain mass, especially in the hippocampus and prefrontal cortex (associated with encoding and recalling information from episodic memory and with executive functions respectively), reduced interconnectivity of neurons, reduced concentrations of certain neurotransmitters (e.g., dopamine, acetylcholine), and reduced blood flow in the brain (Reuter-Lorenz & Lustig, 2005). However, there is also evidence for cortical plasticity in old age as well as for the preventive positive effect of staying active (Hultsch, Small, Hertzog, & Dixon, 1999, Cabeza, Anderson, Locantore, & McIntosh, 2002). The human brain can be shaped by external influences like learning and practicing. Improvement of performance has been shown for several programs of activation including cognitive and memory training, although the improvement is usually higher for younger than older participants, and training effects are often not ability specific (Kliegl, Smith, & Baltes, 1990, Zehnder, Martin, Altgassen, & Clare, 2009). Also, for example, for those practicing music throughout their entire life, it has been shown that the decline of grey matter volume in the frontal cortex with increasing age is prevented (Sluming et al., 2002, Jäncke, 2009). With age, musicians showed no or a smaller decrease in grey matter density in the frontal cortex compared with non-musicians. While all kinds of activities have the potential to shape body and brain, a recipe for successful or optimal aging would definitely include physical activity, cognitively demanding activities, social involvement, and financial precautions. It is essential to start all of these activities early in life and to continue throughout the entire life span. It is all about: “Use it or lose it!”

Conclusions and Practical Implications for Audiological Care

- Knowing about the challenges of aging is an essential part of the audiological profession and a precondition for meeting the needs and providing appropriate technical solutions, rehabilitation, and services to the growing number of hearing impaired elderly.
- Research shows that differences in cognitive abilities are often bigger between persons of the same age than between persons of different age groups. Therefore, instead of judging by age, we should try our best

to relate, get to know, and earn the trust of a client! Age does not tell us anything about personal worries and individual needs related to hearing impairment.

- For elderly clients, hearing impairment is often one of several health issues. This fact has consequences not only for the motivation towards a hearing solution, but also for device choice, counseling and training in use and handling. It seems essential to pay attention to multi-sensory impairments in elderly clients and to consider, for instance, visual or manual dexterity restrictions when deciding on a form-factor, a specific product, demonstrating function, or instructing handling and usage. For instance, it is a good idea to provide information not only via oral instruction but also by written and illustrated instructions in sufficient font size for review and self-learning at home.
- When talking with elderly clients some slowing of conversation helps understanding, but slowing too much risks making comprehension worse. Offering additional time to process by pausing at periodic “natural” intervals improves comprehension and recall. Where one pauses is as important as how long and has been proven to be most effective when a pause follows natural processing units (e.g., sentences, clauses).
- It can also be helpful to not provide all information at once, but instead choose a step-by-step approach with hands-on tasks for the client to verify not only whether something was understood, but also whether it can be realized and handled. By doing so, disappointment and frustration can be avoided. Instead, this approach will hopefully lead to self-confidence and empowerment for the clients, which provide the basis for further proactive trial and usage in their own environment.
- When instructing elderly clients regarding the use of assistive technology such as a hearing system, it can be beneficial to address and involve not only the client but also any accompanying significant others, who often provide support in handling the device at home.
- Follow-ups, repetitive instruction, and training in the context of actual use can increase the probability of successful usage.
- Good hearing is a precondition for staying active, being involved, participating in social life, and preserving one’s cognitive and functional level. The evidence-based argument of “use it or lose it” – can generate a strong motivation towards state-of-the-art hearing solutions and audiological rehabilitation. Tell your clients about it!

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References

- Baltes, P. B. (1997). On the incomplete architecture of human ontogeny: Selection, optimization, and compensation as foundation of developmental theory. *American Psychologist*, 52, 366–380.
- Baltes, P. B. & Baltes, M. M. (1990). Psychological perspectives on successful aging: The model of selective optimization with compensation (1-34). In P. B. Baltes & M. M. Baltes (Eds.), *Successful aging: Perspectives from the behavioral sciences*. New York: Cambridge University Press.
- Cabeza, R., Anderson, N. D., Locantore, J. K., & McIntosh, A. R. (2002). Aging gracefully: Compensatory brain activity in high-performing older adults. *Neuroimage*, 17 (3), 1394–402.
- Carstensen, L. L. & Mikels, J. A. (2005). At the intersection of emotion and cognition: Aging and the positivity effect. *Current directions in psychological science*, 14 (3).
- Costa Jr., P. T., Zonderman, A. B., McCrae, R. R., Cornoni Huntley, J., Locke, B. Z., & Barbano, H. E. (1987). Longitudinal analyses of psychological well-being in a national sample: Stability of mean levels. *Journal of Gerontology*, 42 (1), 50–55.
- Cruickshanks, K. J., Wiley, T. L., Tweed, T. S., Klein, B. E., Klein, R., Mares-Perlman, J. A., & Nondahl, D. M. (1998). Prevalence of hearing loss in older adults in Beaver Dam, Wisconsin. The Epidemiology of Hearing Loss Study. *American Journal of Epidemiology*, 148, 879–86.
- Federal Interagency Forum on Aging-Related Statistics (2008). *Older Americans 2008: Key Indicators of Well-Being*. Federal Interagency Forum on Aging-Related Statistics, Washington, DC: U.S. Government Printing Office.
- FORS – The Swiss Centre of Expertise in the Social Sciences (2006). Swiss Household Panel. <http://www.swisspanel.ch/>
- Helal, A. S., Mokhtari, M., & Abdulrazak, B. (2008). The engineering handbook of smart technology for aging, disability, and independence. Hoboken, New Jersey: John Wiley & Sons.
- Hultsch, D. F., Small, B. J., Hertzog, C., & Dixon, R. A. (1999). Use it or lose it: Engaged lifestyle as a buffer of cognitive decline in aging? *Psychology and Aging* 14: 245–263.
- Jäncke, L. (2009). Music drives brain plasticity. *F1000 Biology Reports*, 1 (78), 1–6.
- Kiessling, J., Pichora-Fuller, M. K., Gatehouse, S., Stephens, D., Arlinger, S., Chisolm, T., Davis, A. C., Erber, N. P., Hickson, L., Holmes, A., Rosenhall, U., & von Wedel, H. (2003). Candidature for and delivery of audiological services: Special needs of older people. *International Journal of Audiology*, 42 (Suppl. 2), 92–101.
- Kliegl, R., Smith, J., & Baltes, P. B. (1990). Testing-the-limits and the study of adult age differences in cognitive plasticity of a mnemonic skill. *Developmental Psychology*, 25 (2), 247–256.
- Kohli, M., Kuenemund, H., & Luedicke, J. (2005). Family structure, proximity and contact (164-170). In A. Börsch-Supan, A. Brugiavini, H. Jürges, J. Mackenbach, J. Siegrist, & G. Weber (Eds.), *Health, ageing and retirement in Europe – First results from the Survey of Health, Ageing and Retirement in Europe (SHARE)*. Mannheim: Mannheim Research Institute for the Economics of Aging (MEA).
- Kohli, M., Kuenemund, H., & Zaehle, T. (2005). Housing and Living Arrangements (41-47). In A. Börsch-Supan, A. Brugiavini, H. Jürges, J. Mackenbach, J. Siegrist, & G. Weber (Eds.), *Health, ageing and retirement in Europe – First results from the Survey of Health, Ageing and Retirement in Europe (SHARE)*. Mannheim: Mannheim Research Institute for the Economics of Aging (MEA).
- Lawton, M. P. (1989). Environmental proactivity and affect in older people (135–163). In S. Spacapan & S. Oskamp (Eds.), *The social psychology of aging*. Newbury Park, Calif.: Sarge.
- Lemke, U. & Zimprich, D. (2005). Longitudinal changes in memory performance and processing speed in old age. *Aging, Neuropsychology, and Cognition*, 12, 57–77.
- Lobo, A., Launer, L. J., Fratiglioni, L., Andersen, K., Di Carlo, A., Breteler, M. M., Copeland, J. R., Dartigues, J. F., Jagger, C., Martinez-Lage, J., Soininen, H. & Hofman, A. (2000). Prevalence of dementia and major subtypes in Europe: A collaborative study of population-based cohorts. Neurologic diseases in the elderly research group. *Neurology*, 54 (11 Suppl 5), 4–9.
- Montepare, J. M. & Lachman, M. E. (1989). “You’re only

- as old as you feel”: self-perceptions of age, fears of aging, and life-satisfaction from adolescence to old age. *Psychology & Aging*, 4 (1), 73–78.
- Nachtegaal, J., Smit, J. H., Smits, C., Bezemer, P. D., van Beek, J. H., Festen, J. M., & Kramer, S. E. (2009). The association between hearing status and psychosocial health before the age of 70 years: results from an internet-based national survey on hearing. *Ear and Hearing*, 30 (3), 302–312.
- National Research Council (2004). *Technology for adaptive aging*. Steering committee for the workshop on technology for adaptive aging. R. W. Pew & S. B. Van Hemel (Eds.), Board on Behavioral, Cognitive, and Sensory sciences, Division of Behavioral and Social Sciences and Education. Washington, DC: The National Academies Press.
- Park, D. C. (1999). The basic mechanisms accounting for age-related decline in cognitive function. In D. Park & N. Schwarz (Eds.), *Cognitive aging: A primer*. Philadelphia, PA: Psychology Press Taylor & Francis Group.
- Pichora-Fuller, M. K. & Singh, G. (2006). Effects of age on auditory and cognitive processing: Implications for hearing aid fitting and audiologic rehabilitation. *Trends in Amplification*, 10 (1), 29–59.
- Pichora-Fuller, M. K. & Souza, P. E. (2003). Effects of aging on auditory processing of speech. *International Journal of Audiology*, 42 (6), Suppl. 2, 11–16.
- Reuter-Lorenz, P. A. & Lustig, C. (2005). Brain aging: reorganizing discoveries about the aging mind. *Current Opinion in Neurobiology*, 15 (2), 245–51.
- Sluming, V., Barrick, T., Howard, M., Cezayirli, E., Mayes, A., & Roberts, N. (2002). Voxel-based morphometry reveals increased gray matter density in Broca’s area in male symphony orchestra musicians. *Neuroimage* 2002, 17, 1613–22.
- Steinhagen-Thiessen, E. & Borchelt, M. (1996). Morbidity, medication, and functional limitations in very old age (131–166). In P. B. Baltes & K. U. Mayer (Eds.), *The Berlin Aging Study (BASE): Aging from 70 to 100*. New York: Cambridge University Press.
- Traynor, R. M. (2009). A Rocky Mountain High approach to the Baby Boomer generation. *The Hearing Journal*, 62 (1), 10–17.
- United Nations, Population Division of the Department of Economic and Social Affairs (2002). *World Population Ageing 1950–2050*. (<http://www.un.org/esa/population/publications/worldageing19502050/>)
- United Nations, Population Division of the Department of Economic and Social Affairs (2006). *World population prospects: The 2006 revision*. <http://www.un.org/esa/population/publications/wpp2006/wpp2006.htm>
- United Nations, Population Division of the Department of Economic and Social Affairs (2009). *World population prospects: The 2008 revision – Highlights*. <http://www.un.org/esa/population/>
- U.S. Congress, Office of Technology Assessment (1986). Hearing impairment and elderly people – A background paper. (Publication No. OTA-BP-BA-30). Washington, DC: U.S. Government Printing Office.
- Wernicke, T. F., Linden, M., Gilberg, R., & Helmchen, H. (2000). Ranges of psychiatric morbidity in the old and the very old – results from the Berlin Aging Study (BASE). *European Archives of Psychiatry and Clinical neuroscience*, 250, 111–119.
- Wingfield, A. (2000). Speech perception and the comprehension of spoken language in adult aging (175–196). In D. Park & N. Schwarz (Eds.), *Cognitive aging: A primer*. Philadelphia, PA: Psychology Press Taylor & Francis Group.
- World Health Organization. (2001). International Classification of Functioning, Disability and Health (ICF). Geneva: WHO. <http://www.who.int/classifications/icf/en/>
- Zehnder, F., Martin, M., Altgassen, M., & Clare, L. (2009). Memory training effects in old age as markers of plasticity: A meta-analysis. *Restorative Neurology and Neuroscience*, 27, 5.

