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Review Article

Interdisciplinary View of Ageing and Cognition

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ABSTRACT

Cognitive decline as part of mental ageing is typically assessed with standardized tests; below-average performance in such tests is used as an indicator for pathological cognitive aging. In addition, morphological and functional changes in the brain are used as parameters for age-related pathological decline in cognitive abilities. However, there is no simple link between the trajectories of changes in cognition and morphological or functional changes in the brain. Furthermore, below-average test performance does not necessarily mean a significant impairment in everyday activities. It therefore appears crucial to record individual everyday cognitive requirements in functional terms. This would also allow reliable assessment of the ecological validity of existing and insufficient cognitive skills. Understanding and dealing with the phenomena and consequences of mental aging does of course not only depend on cognition. Motivation and emotions as well as personal notions about the quality and meaning of life and life satisfaction play an equally important role. This means, however, that cognition represents only one, albeit important, aspect of mental aging. Routines and habits for coping with life's challenges should be taught and acquired in childhood and early adulthood. A desirable goal is a greater cooperation between basic and applied sciences in aging research, a quick translation of the research results into practice, and a close cooperation between all disciplines and professions who advise and support the elderly.

Keywords: Cognitive aging; Mental aging; Functional cognition; Coping; Resilience; Life quality; Ageing research

INTRODUCTION

Aging and cognitive decline are very often portrayed as inseparable twins in human aging research. Thus, the dominating impression is that cognitive decline is a mandatory characteristic of individuals aged over 60 or 65. The main basis for this rather pessimistic view possibly results from laboratory-based studies that do not consider and examine every day cognitive competences and cognitive behaviors in the one and the same individual. Given this, one must ask: If aging is accompanied by cognitive decline, at what level of cognition does the decline begin and, when did the individual show the peak of cognitive performance and when did the decline start? There is no doubt that cognitive performance does not persist regardless of age, but rather shows an age-related decrease; often, older persons themselves experience and report such declines. Although age-related decreases in functionality are also found in other domains such as emotion, motivation, language and motor functions, these domains are rarely considered in an integrated way even though cognition critically depends on motivation and on emotional evaluation over the whole lifespan, and is also influenced by physical activity [1].

However, examination of the scientific literature of the past two decades reveals that research on aging has almost solely focused on cognition and its modulation by neurobiological factors. While cognition might be rightly viewed as the "queen of the brain" because it refers to the ability to analytically reflect on one's own thinking, feeling and behavior and it's social and moral evaluation, placing cognition at the highest level of mental functions. On the other hand, cognition can also be understood as a universal set of tools for developing, executing and supervising routines and habits that enable people to appropriately deal with the challenges of life faced by a particular individual through the use of adaptive strategies to changing physical and social environments and flexible coping

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mechanisms in the face of unsolvable situations. The meaning of one's own life and its realization may play a special role in older age, as meaningful factors in earlier life, e.g. occupation, care for one's children and their development or special social roles, become less engaging. The individual definition of meaningfulness depends on the individual's ideas, goals and evaluation of experiences as positive and negative. Of course, good or adequate health, wellbeing, positive social contacts with family and friends, mobility, and sufficient financial resources play an important part in how one assesses and perceives experiences that contribute to one's meaningfulness during older age. Not least, values attributed to positive aging may also depend significantly on cultural norms.

As already alluded to, cognition undoubtedly plays a decisive role in testing adaptive strategies in terms of their development or planning, implementation and supervision. This applies to how individuals deal with professional, economic, social and health challenges. A necessary mastery of the listed challenges includes not only the current handling of problems, but also preventive activities and measures. Notably, prevention should not (and usually, cannot) only be initiated when mental, physical, economic or social difficulties become recognizable. The ability to predict and plan feasible (and alternative) solutions for dealing with problems are prerequisites for successful coping, especially as one ages [2].

LITERATURE REVIEW

Different trajectories of cognitive aging and aging of the brain

Research on the development of cognitive skills with age has consistently shown that cognitive performance decreases with age. Performance in the domains of perception, attention, memory and executive functions, in particular planning, problem solving and multi-tasking, decrease with increasing age, largely independently of the influence of negative lifetime events. Age-related decline in cognitive performance is supported by morphological and functional changes in the brain, as revealed by neuroimaging. Such analysis has shown that aging is accompanied not only by a reduced number of cortical neurons and thus, thickness of the gray matter, but also by decreased intra and intercortical connections and subsequent thinning out of brain networks. Thus, exchange of information between and cooperation of local, regional and supra-regional brain structures is impaired or lost. Although such observations suggest that brain imaging alone is sufficient to detect cognitive decline and diagnose mild cognitive impairment and early dementia, use of such a general diagnostic strategy presupposes existence of parallelism between the trajectories of changes in cognition and morphological and functional changes in the brain.

The assumption that morphological changes in the brain in old age are fundamentally associated with a decline in cognition was challenged by a pioneering study who showed that even striking neuro-morphological changes do not necessarily associate with loss of cognitive ability. These findings were confirmed by a number of authors, including who suggested that compensatory mechanisms might explain the discrepancy between the lack of correlation between morphological changes and cognitive performance. Today, there is consensus that impaired functions can be at least partly rectified through the recruitment of other structures or by co-activation of additional structures within a functional network. In this context, the concepts of brain reserve and cognitive reserve are key to understanding and explaining the discrepancy between morphological and cognitive measures. While brain reserve refers more to the "passive" capacity of the aging brain to cope with morphological alterations and consequent functional losses, cognitive reserve assumes that the brain actively compensates for functional losses by exploiting established cognitive processes and individual strategies [3].

So what factors contribute to the acquisition, growth and conservation of cognitive reserve (or to its reduction or impairment)? Research indicates a significant role of individual genetic predisposition, health, mood, lifestyle, and social factors. Research also indicates that lifestyle, regular physical activity and social activities help individuals to maintain or regain mental health; importantly, they may also contribute to the prevention or deceleration of pathological outcomes.

The assessment of cognitive decline and associated methodological difficulties

Cognitive performance and thus, its loss, are assessed with the help of standardized test procedures. The comparison of the individual test result with normative data allows classification of an individual's performance as 'above average', 'average' or 'below average'. Normative values usually take age, gender and education into account. So-called cut-off scores are used to classify a test result as "below average". This procedure is particularly important for the distinction between 'normal' age-related changes in performance and mild cognitive impairment or dementia. Notably, regardless of the test procedure or cut-off scores, the final result always relates to cognitive performance under standardized conditions. On the other hand, the conditions for cognitive assessment may have little or no commonality with the everyday conditions and requirements of the individual. Thus, while the test reveals cognitive underperformance under specific conditions, the result does not necessarily imply handicap under more 'real', everyday conditions. Thus, cognitive test procedures have limited and often insufficient ecological validity in diagnostic conclusions that a subject has a cognitive 'impairment' or 'disability'. According to the World Health Organization (WHO),"Dementia is a syndrome, usually of a chronic or progressive nature, caused by a variety of brain illnesses that affect memory, thinking, behavior and ability to perform everyday activities, there is deterioration in cognitive function beyond what might be expected from the usual consequences of biological ageing". This characterization suggests that the loss of cognition must be (significantly) greater than "normal" age-related cognitive changes and that this loss must also (significantly) affect individual everyday activities, i.e. represent a disability. Screening procedures alone do not meet these criteria

and do not allow statements regarding (still) average and (already) below average performance in the various cognitive domains. Clearly, appropriate age-related norms are essential for the classification into "average" and "sub-average" performance in standardized cognitive tests. Moreover, cognitive tests alone in mild and moderate cases of cognitive changes, e.g. in mild cognitive impairment or mild to moderate forms of dementia, only partially conform to the WHO definition of disability. In severe forms of dementia, cognitive difficulties become manifest in nearly all everyday life activities, and standardized tests can no longer be carried out. Therefore, systematic observations and surveys (in which family members and caretakers are included) of behavior are helpful additional instruments amendments for the evaluation of cognitive difficulties in everyday activities and requirements [4].

Individual and more general characteristics in cognitive aging

Like younger persons, older inividuals display very variable cognitive characteristics. For this reason, trends and average changes of cognition in elderly subjects based on group studies are not directly applicable to individual subjects. Cognitive performance in the elderly is often compared with that of younger people despite wide scales across adulthood and overlapping performance by older and younger subjects in a complex cognitive task. Consideration should be given to the facts that elderly persons generally have good learning skills and memory, especially in the presence of social interactions, and that increased processing and response times appear to be a typical "symptom" of cognitive aging. Thus, time-dependent cognitive test performance ('power tests') and cognitive activities under time restraints are often less informative and subject to greater measurement errors. However, adaptation to the subject's time schedule allows personalized prospective time-pressure management and can also enhance wellbeing. Interestingly and happily, many centenarians still have good cognitive skills that also ensure appropriate time and task management, allowing them to sufficiently and independently cope with the demands of everyday living.

Mental health, cognition and influencing factors

Health can be defined as "a dynamic state of internal equilibrium which enables individuals to use their abilities in harmony with universal values of society. Basic cognitive and social skills; ability to recognize, express and modulate one's own emotions, as well as empathize with others; flexibility and ability to cope with adverse life events and function in social roles; and harmonious relationship between body and mind represent important components of mental health which contribute, to varying degrees, to the state of internal equilibrium". Thus, cognition, emotion, resilience, life satisfaction and social skills represent the most important and essential factors contributing to mental health.

Mental health and cognitive function interact in many ways throughout life. Poorer mental health is associated with lower cognitive function, especially with respect to cognitive skills in social processes and interactions; the latter contribute significantly to mental health. A broad range of physical, biological, lifestyle, and psychological factors are known to be either protective or to represent risk factors. For example, regular physical, cognitive and social activities and engagement are known to have protective effects, as is postponement of retirement (if possible) for those in cognitively and socially "enriched" occupations. While education tends to determine cognitive and social activities among the elderly, cognitively-stimulating/engaging activities remain of crucial relevance [5].

An important aspect of mental health, not just in older age, is dealing with stressful conditions in such a way that stress–daily or chronic (e.g. social stress; does not cause chronic brain pathology, including cognitive impairment. Importantly, the acquisition of helpful strategies for dealing with stress and especially for preventing chronic consequences is therefore an important component of mental health maintenance, especially with respect to mood, as well the ability to maintain control of situations, which is not always reduced in old age. Interestingly, individuals are often not conscious of these factors until they reach a certain age/stage of life. Sufficient cognitive, motivational and emotional resources act as protective reserves and have a very beneficial effect on the quality of life in older age. Studies on centenarians have shown, that despite biological risk factors, cognitive abilities and beneficial stress-coping strategies are preserved and can reduce the severity of mental disability. Admittedly, functional loss of vision, audition or motor skills can affect cognition and mental health and limit social participation and mobility, but these are not essential obstacles to cognitive performance in older age [6].

Resilience, meaning of life and life quality

The constructs of brain reserve, cognitive reserve, and functional compensation are used to explain the preservation of cognition in the presence of (pathological) brain alterations; this capacity is also called "resilience". From a psychological perspective, resilience refers to the "ability to overcome the difficulties experienced in the different areas of one's life with perseverance, as well as good awareness of oneself and one's own internal coherence by activating a personal growth project" . Resilience plays an essential role over the entire course of life, but especially in the early and late stages, when personality factors also play a role. Undoubtedly, providing and supporting the acquisition of resilience strategies that will serve an individual throughout life is of critical importance during early human development. Finding an individual meaning in life and the resulting actions and evaluations seem to be decisive for how satisfied people are or can be with their quality of life. Finally, reflection on the meaning of one's own life often only becomes manifest at later ages when major events become less likely or changes in daily life are predictable and attention tends to be focused on the approach of the end of life, and one's health and financial status and legacy. Decisive for the evaluation of one's own quality of life and life satisfaction are the personal values and criteria used to assess these parameters–typically, health, functional capacity and autonomy, emotional comfort, leisure, environmental quality, social networks, and positive social interactions, spirituality, home and neighborhood, and financial security. Gender is also an important consideration along with

the fact that values depend on, and play a key role in, culture, society, and religion. At the same time, it deserves noting that there are basic expectations of life quality/life satisfaction, such as Activities of Daily Living (ADL), general health, sensory abilities, mobility and autonomy and energy that apply across many or all cultures, regardless of ethnicity, cultural or religious affiliations [7].

As already mentioned, the adoption of criteria and values regarding satisfaction with life and quality of life and their implementation in one's own life, as well as the testing of coping strategies, are initiated during childhood when they are also easily engendered and practiced. In a broader sense, early education should extend beyond the mere acquisition of cultural skills such as reading, writing, arithmetic, worldly knowledge, and professional activities. Rather, education should also impart knowledge about different forms of life quality and life satisfaction, and their influences on one's own long-term mental health, from very early on. This knowledge should include both the semantic and the procedural components that are important for implementation of appropriate coping strategies in different life situations. The combination of both forms of knowledge will subsequently foster the development of personalized strategies that are ultimately transformed into routines and habits that promote skills that help coping with the various demands of life. These represent mental and behavior programs that can be used flexibly according to the circumstances. Importantly, routine learning and habit formation play an important role in behavior change, including healthy behaviors, health-related quality of life, resilience, and stress tolerance. Although habit formation depends on protracted systematic repetition of the desired behavior, habits are known to guide and help children and adolescents to develop, learn, optimize and maintain routines and habits that are relevant for healthy mental aging and thus, satisfaction with, and quality of, personal life. Training in such skills should therefore be a compulsory part of education programs. There is consensus that each individual should be “happy”, also with advancing age according to their own understanding of happiness, so long as this does not impinge on the rights of others. Apart from the values that a person develops and relies on, mood and motivation play a crucial role in defining an individual’s sense of happiness. Accordingly, those dealing with age-related changes in cognition need to be aware of, and equipped for early detection and treatment of mood disorders (especially depression and apathy) [8].

Cognitive performance and functional cognition

As mentioned earlier, cognitive performance as assessed with standardized tests, may not have meaningful ecological significance at the individual level, and therefore cannot be used to reliably infer the availability or impairment of cognitive functions in ADL. In milder forms of cognitive decline, determination of the "critical minimum" of cognition required in the individual’s daily life appears to be more informative regarding the degree of cognitive disability. For this, a systematic survey of the individual’s everyday requirements in the relevant areas of life is necessary; this is especially important in the case of elderly persons. Interestingly, even centenarians may still possess cognitive functional capacity for coping with everyday life challenge. The systematic investigation of individual living conditions in older age and their cognitive requirements that take into account the previous acquired executive strategies and habits; can help build a catalog that focuses on functional cognition. If functional (or also instrumental) cognition embraces the notion of cognitive abilities in the various life situations, the focus would then be the individual’s available cognitive abilities and skills dealing with daily routine tasks. Systematic observation and the diagnostic assessment should, therefore, be based on the specific use of existing cognitive capacities in everyday situations with or without assistance. Thus, assessment of functional cognition would complement more general assessments of functional ability in the elderly. In case of reduced cognitive functions and resulting difficulties in ADL, i.e. in mild cognitive impairment and mild-to-moderate dementia, training of cognitive functions may be supportive, with the potential to improve cognition [9].

Bridging the interdisciplinary gaps in future research strategies

Identifying research topics that can contribute to the promotion of optimal mental aging, and social and health services and institutions, is an important challenge in the development of health policy. As alluded to above, non-pharmacological measures can play a significant role in preventing mental disabilities in older age. These may include cognitive strategies, routines and habits that enable the individual to master the challenges of life and to acquire and maintain a good quality of life and sense of satisfaction with life in terms of both, physical and mental health. However, it is important that these measures are not first implemented once the feeling of “getting old” is experienced. Rather appropriate interventions should be undertaken during childhood and adolescence. Nevertheless, even in the presence of cognitive impairments in older age, improvements can be achieved through suitable treatment paradigms.

There are numerous scientific reports on mental aging in the basic neurobiological, medical, psychological and social science literature, some of which suggest practical solutions. A desirable goal of research in this arena would be greater cooperation between the different disciplines and professions in order to achieve timely and effective translation of the various scientific findings into the ‘real’ life conditions of elderly people. At the same time, there should be greater liaison between science and politics in the health and social sectors, with attempts to bridge interdisciplinary gaps in order to translate research into benefits for the realties faced by aging individuals. At the same time, it is important that prevention and exercise programs aimed at maintaining cognition are carefully appraised for their ecological validity and functional significance. Another area of research could involve investigations into the exploitation and ecological validation of smart technologies to assist elderly people while also facilitating and maintaining their ability to live independent lives. In addition, a valid measurement, assessment and understanding of reserve/resilience in aging would help implement early measures for prevention or slowing down of

cognitive decline. The complex interaction between genetics, the environment and lifestyle should, of course, be taken into account in all research areas on aging [10].

DISCUSSION

As discussed earlier, cultural factors play an important role in understanding and dealing with mental aging and values about quality of life and satisfaction. Cultural differences should therefore be taken into account when evaluating differing research results because they cannot be compared directly. However, differing study outcomes can be used to gain valuable insight into any given cultural area. Interestingly, however, there are shared cross-cultural understandings of quality of life, both in personal and in more general terms. Personal indicators include emotional and physical well-being, interpersonal relations and social inclusion, material well-being, and self-determination. The more general indicators include spiritual qualities on meaning in life, awe and wonder, wholeness and integration, and kindness to others. In contrast, cultural factors play a major role in shaping lifetime mental health. Taking these criteria into account in aging research would help therapists' understanding of the problems faced by the elderly, especially those with pathological conditions such as dementia.

Advanced age is associated with cognitive, mental and physical changes. Nevertheless, elderly individuals retain their individuality and personality which are the sum of their life history and individual experiences. Therefore, personalized programs are important for maintaining functionality in everyday life. However, this also implies that elderly people accept such offers and (are able to) translate them into their personal lives. Curiosity, interest in problem-solving, and willingness to flexibly adjust routines and habits according to the demands brought on by aging are also crucial ingredients to the ability to successfully cope with everyday challenges. These attitudes and skills are acquired during childhood and early adulthood, but can nevertheless be further developed, depending on the individual's conditions and needs. The development and adaptation of routines and habits, and their continuous optimization in the context of current living conditions and challenges requires the flexible use of cognitive reserves under the guidance of executive functions, including development, selection and use of current problem-solving and adaptive strategies, error control and, if necessary, error correction. Motivation for cognition and the emotional (positive and negative) evaluation of one's own routines and habits play a powerful role in this fundamental process. Notably, positive or negative outcomes of action act to amplify (reinforce) learning of routines that are based on a widespread neural system that predicts, assesses and motivates reward-based motivation and reward [11-12].

CONCLUSION

Functional adaptation is a highly complex, dynamic process that depends on multiple factors and requires appropriate mental resources. The magic word is learning. Learning means regular practice, which is seldom possible without exertion. The potential to learn in terms of adaptation of functional abilities persists even into old. To realize this, however, it is important that learning goals are set in such a way that they are meaningful, necessary, and feasible for individual aging persons. The quote, "Growing old may seem as normal as growing up, seems an appropriate thought with which to close this brief overview of cognitive changes and needs during aging. Briefly, despite age-related biological changes, mental aging is amenable to positive influences; mental aging is not necessarily a fateful process.

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