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# Scenario: Change in Cognitive Function

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It is commonly accepted that aging is accompanied by a decline in cognitive performance. Moreover, many elderly people complain about their memory (Bolla et al. 1991). Studies have demonstrated that these complaints are based on cognitive dysfunctioning (Jonker et al. 1996). Decline in cognitive functioning and subjective complaints about memory are, therefore, phenomena that should not be under-estimated. They influence the quality of life of older people (Fioravanti et al. 1996), and are commonly associated with functional disability and a need for institutional care (Graham et al. 1997). As yet, it is unclear why cognitive functions deteriorate and which factors determine the rate of decline.

### Evolution of cognitive change

Two theories have been proposed, related to the evolution of cognitive changes in life (Rabbitt 1990). The *continuous decline hypothesis* states that the decline starts early in life and gradually continues or accelerates with age. The *terminal drop hypothesis* implies that the decline manifests itself abruptly. Terminal drop may occur after a major event, such as a physical disease, loss of partner, etc. Of course, terminal drop is more likely to occur in the second half of the life-span, which is characterized by an increasing number of physical illnesses, and psycho-social changes. Up to now, research has been almost exclusively based on cross-sectional studies and on comparisons of performance between young individuals and elderly people. The results of this research have suggested that cognitive decline starts at a relatively young age, and is characterized by gradual decline. However, this may be a biased view. Continuous decline in cognitive function might partly be an artefact of the older age groups, in which more individuals show poorer cognitive performance. Moreover, Salthouse (1987a) has rightly pointed out yet another important observation, which the standard research models – based on comparisons of performance between

young and elderly people – have failed to address, i.e. the large variation in the results of test performances among groups of older people.

This could indicate that older people differ with regard to the age at which the decline starts, but that there are also differences in the rate of cognitive decline. Therefore, we do not know which evolution of cognitive change might apply: continuous decline or terminal drop, or a combination of both.

### **Age-related difference in cognitive decline**

One important observation is that, in aging, not all aspects of cognitive performance decline to the same extent (Salthouse 1988). Jolles et al. (1995) argue that older people have problems with the following: (a) they are less efficient in learning new information, which results in problems and complaints about memory, (b) their capacity to plan new activities and to solve complex problems declines remarkably quickly, and also (c) the attentional processes decline considerably. A comparable view on the various effects of aging on cognitive performance is held by Cattell (1963), who distinguishes fluid and crystallized intelligence. The second category concerns those cognitive processes that are age-independent, such as implicit and semantic memory. The first category, fluid intelligence, mainly corresponds with the age-related cognitive processes and activities described by Jolles et al. (1995).

### **Explanatory models for cognitive deterioration**

Central to any understanding of cognitive decline associated with old age is the question of whether all such cognitive decline is disease-associated and related to psychosocial factors, or whether it can occur as part of so-called 'normal' aging.

Research on cognitive aging has produced various theoretical explanations for the observed age-differences in cognitive performance. The two most important theories concern the *limited processing resources* and *age-related slowing*. The theory of *limited processing resources* ( Craik and Bird 1982) suggests that the decreased ability of older people, compared to younger people, to perform cognitive tasks is caused by a decline in the mental energy needed to perform the purposive cognitive processes of working memory. Age-differences in cognitive performance decrease if cues are offered to support older people in storing or remembering topical information. This would imply that more mental energy would be available for the cognitive processes. However, experimental evidence is scarce. One important problem in the verification of this hypothesis is the lack of a valid qualitative method for the assess of cognitive resources.

Salthouse (1985b) states that age-related decline in cognitive function is the result of a decline in the speed at which information is processed in the cognitive system. His theory, *age-related slowing* of cognitive function, is by far the best documented and the least challenged theory in the field of aging and cognition, although various mechanisms have been suggested as causes for slowing down the speed of information-processing (Salthouse 1985a). However, even if the elderly are allowed an unlimited length of time in which to perform tests, age-related differences in cognitive performance persist. A useful explanatory model for the decline in cognitive functions mentioned above – both theories combined – is in line with both the theory of Salthouse and the hypothesis of Craik and Bird. In brief, this combined theory implies that each cognitive activity needs resources, which could be time, space or energy. If resources decline, less capacity is available to process information.

A study by Starr et al. (1997) demonstrated that cognitive decline can not be attributed to age alone, even in healthy elderly people. Holland and Rabbitt (1991) reported on the influence of health on various aspects of cognitive functions. Van den Heuvel et al. (1996) found a modest association between cognition and depressive symptoms. Many authors, e.g. Perlmutter and Nyquist (1990), found that education influenced cognitive performance. In addition, environmental factors, such as physical activity or social participation, may have beneficial effects on cognitive performance (Hulsch et al. 1993, Christensen and Mackinnon 1993, Smits et al. 1995).

### Rate of cognitive decline

So far, only a very limited amount of research has addressed the determinants of the rate at which age-related cognitive processes, in particular so-called fluid intelligence, deteriorate. Whether cognitive aging is an inherent aspect of cerebral biological aging, and thus the extent to which psychosocial factors influence the rate of cognitive decline, is still unclear. Drachman (1983) claims that both genetic and contributory factors can modify the rate of cerebral aging and, as such, this might be an explanation for the difference in the rate of cognitive decline in older individuals. Some evidence suggests that genetic factors play a dominant role in cognitive decline at an earlier age, but their influence could decrease with age due to contributory factors.

Recently (Jolles et al. 1995), the concept of 'biological life-events' (BLEs) was proposed to indicate those factors that are related to physical or mental health, experienced at any point in life and thought to be related to brain dysfunctioning, other than grossly impairing conditions such as dementia and brain trauma. BLEs are assumed to be factors with potential, but so far unproven, influence on the brain, such as mild head trauma, multiple operations under general anesthesia, and histo-

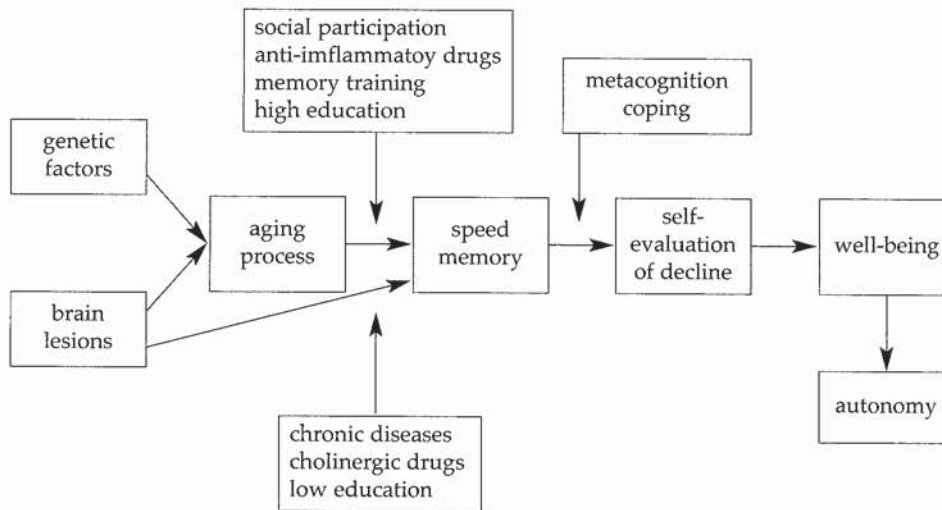
ry of alcohol consumption. Other possible health-related factors which may influence the rate of cognitive aging are mild hypertension, diabetes mellitus type II, medication and exposure to neurotoxic factors (Houx and Jolles 1993, Van Boxtel 1997). Such factors might have a long-term impact on cognition and brain function, without causing any noticeable inconvenience to the individual. Elderly people with a history of BLEs would therefore be susceptible to accelerated cognitive decline, and may be at greater risk of developing dementia.

### **Cognitive decline: normal or pathological aging?**

There is increasing evidence that a continuum exists between cognitive decline and dementia (Huppert and Brayne 1994). Moreover, the development of strategies to prevent or delay the onset of dementia has drawn new attention to the problem of mild cognitive impairment in the elderly (Graham et al. 1997). Much research effort to date has been devoted to delineating the borderline between normal cognitive aging and pathological conditions, such as Alzheimer's disease. Therefore, when studying the predictors of cognitive decline in elderly people, it would seem worthwhile to also consider the risk factors (accelerating and protective) which are associated with Alzheimer's disease (Writing Committee Lancet Conference 1996).

### **LASA**

The design of the Longitudinal Aging Study Amsterdam (LASA) includes tests for fluid intelligence, memory and information-processing speed, and various disease-related and psychosocial variables. LASA therefore provides a very suitable background to provide more insight into the question of which factors contribute to cognitive decline in older individuals. The model presented below, partly based on risk factors associated with Alzheimer's disease, might be considered as a guideline for the study of determinants of change in cognitive function with aging and factors which influence the rate of cognitive decline.



## References

- Bolla KI, Lindgren KN, Bonaccorsy C, Bleecker ML (1991). Memory complaints in older adults: fact or fiction? *Archives of Neurology* 48: 61-64.
- Boxtel MPJ van (1997). *Physical Health, Vascular Risk Factors, and Age-related Cognitive Decline*. Thesis, Universiteit Maastricht.
- Cattell RB (1963). Theory of fluid and crystallized intelligence: a critical experiment. *Journal of Educational Psychology* 54: 1-22.
- Christensen H, Mackinnon A (1993). The Association between Mental, Social and Physical Activity and Cognitive Performance in Young and Old Subjects. *Age and Ageing* 22: 175-182.
- Craik FIM, Byrd M (1982). Aging and cognitive deficits: the role of attentional resources. In: Craik FIM & Treub S (eds). *Aging and Cognitive Processes*. New York: Plenum Press, pp. 191-221.
- Drachman DA (1983). How normal aging relates to dementia: a critique and classification. In: Samuel D et al. (eds), *Aging of the Brain*. New York: Raven Press, pp. 19-31.
- Fioravanti M, Zavatinni G, Buckeley AE (1996). Quality of life in chronic diseases of the aged: the importance of cognitive deterioration. *Archives of Gerontology and Geriatrics* 22: 195-205
- Graham JE, Rockwood K, Beattie BL, Eastwood R, Gauthier S, Tuokko H, McDowell I (1997). Prevalence and severity of cognitive impairment with and without dementia in an elderly population. *Lancet* 349: 1793-1796.
- Heuvel N van den, Smits CHM, Deeg DJH and Beekman ATF (1996). Personality: A moderator of the relation between cognitive functioning and depression in adults aged 55-85. *Journal of Affective Disorders* 41: 229-240.
- Holland CA, Rabbitt P (1991). The course and causes of cognitive change with advancing age. *Reviews in Clinical Gerontology* 1: 81-96.
- Houx PJ, Jolles J (1993). Age-related decline of psychomotor speed: effects of age, brain health, sex and education. *Perceptual and Motor Skills* 76: 195-211

- Hultsch DF, Hammer M, Small BJ (1993). Age differences in cognitive performance in later life: Relationships to self-reported health and activity life style. *Journal of Gerontology* 48: 1-11.
- Huppert FA, Brayne C (1994). What is the relation between dementia and normal aging? In: Huppert FA et al. (eds), *Dementia and Normal Aging*. Cambridge: Cambridge University Press, pp. 3-11.
- Jolles J, Verhey FRJ, Riedel WJ, Houx PJ (1995). Cognitive impairment in elderly people. *Drugs & Aging* 7: 459-479.
- Jonker C, Launer LJ, Hooijer Ch, Lindeboom L (1996). Memory complaints and memory impairment in older individuals. *Journal of the American Geriatrics Society* 44: 44-49
- Perlmutter M, Nyquist L (1990). Relationships between self-reported physical health and mental health and intelligence performance across adulthood. *Journal of Gerontology* 45: 145-155.
- Rabbitt PMA (1990). Applied cognitive gerontology: some problems, methodologies and data. *Applied Cognitive Psychology* 4: 225-246
- Salthouse TA (1985a). Speed of behavior and its implications for cognition. In Birren JE, Schaie KW (eds), *Handbook of the Psychology of Aging*. New York: Van Nostrand Reinhold, pp. 400-426.
- Salthouse TA (1985b). *A Theory of Cognitive Aging*. North Holland, Elsevier.
- Salthouse TA (1987a). The role of experience in cognitive aging. In: Schaie KW (ed.) *Annual Review of Gerontology and Geriatrics* 7. New York: Springer, pp. 135-157.
- Salthouse TA (1988). The role of processing resources in cognitive aging. In Howe ML, Brainerd CJ (eds), *Cognitive Development in Adulthood*. New York: Springer-Verlag, pp. 185-239.
- Smits CHM, Rijsselt RJT van, Jonker C, Deeg DJH (1995). Social participation and cognitive functioning in older adults. *International Journal of Geriatric Psychiatry* 10: 325-331.
- Starr JM, Deary IJ, Inch S, Cross S, MacLennan WJ (1997). Age-associated cognitive decline in healthy old people. *Age and Ageing* 26: 295-300.
- Writing Committee Lancet Conference (1996). The challenge of the dementias. *Lancet* 347: 1303-1307.