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European Journal of Pharmacology 490 (2004) 83–86
www.elsevier.com/locate/ejphar

Neuropsychology of cognitive ageing, minimal cognitive impairment, Alzheimer's disease, and vascular cognitive impairment

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Accepted 27 February 2004

Abstract

In this review, the neuropsychological symptoms of different diseases in the elderly are described. After a brief explanation of relevant principles in the neuropsychological assessment of older individuals, a summary of the complex relation between ageing and cognition is presented. It may be concluded that cognitive decline is not an inevitable outcome of ageing, and may well be the result of unrecognised pathology. The term mild cognitive impairment is reserved for patients whose impairment is objectively demonstrable but is not pronounced in more than one domain of cognition and does not seriously affect activities of daily living. The initial phase of Alzheimer's disease is marked by a progressive deterioration of episodic memory. When the process advances, the impairment spreads to other functions, such as semantic memory, language and visuo-spatial ability. Vascular dementia is the second most common type of dementia; however, it is increasingly being recognised that vascular dementia is actually a heterogeneous syndrome and that several vascular pathologies can lead to cognitive deterioration. In contrast to the striking deficits produced by cortical infarcts, lesions of the subcortical white matter are mainly associated with a non-specific slowing of behaviour. Cerebrovascular disease also plays an important role in forms of cognitive decline other than dementia, and as such, it appears to be no less prevalent in old age than Alzheimer's disease. Neuropsychology is an important asset to the study and treatment of cognitive decline, but must be embedded in a multi-disciplinary context.

Keywords: Cognitive ageing; Alzheimer's disease; Cognitive impairment, vascular; Cognitive impairment, mild

1. Introduction

In this review, we describe the neuropsychological symptoms of different diseases in the elderly. In order to understand these different symptoms, we start with a brief explanation of relevant principles in the neuropsychological assessment of older individuals and present a summary of the complex relation between ageing and cognition.

2. Neuropsychological assessment

Neuropsychological assessment aims to identify cognitive impairments in a maximally objective manner. To this end, patients are confronted with standardised tasks, preferably well documented with regard to reliability, validity and norms. Neuropsychological assessment is a powerful aid in the detection of early dementia, but has certain limitations. Firstly, the test results will be useful only if the subject is fully cooperative. Secondly, individual variation in cognitive performance is—especially in the elderly—considerable, even among people with the same demographic characteristics (age, sex, education); therefore, a wide margin of uncertainty must be allowed before impairment can be inferred. Even so, the impairment may be due to many causes besides brain dysfunction. Finally, a good deal of interpretation may be required to decide what functional disturbance(s) underlie a deviant test result.

3. Domains of cognition

The interpretive problem mentioned above is connected with the attribution of impairment to separate domains of cognition. For instance, a diagnosis of dementia requires the

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doi:10.1016/j.ejphar.2004.02.046

presence of impairment in memory and at least one other domain. Although it is hardly possible to divide cognition into mutually exclusive areas, the following domains can be regarded as relatively independent:

3.1. Memory

Memory complaints in the elderly may actually be due to problems in other areas, such as concentration, word finding, and executive function (see below). Impairment of memory proper is primarily connected with episodic memory, the recollection of past events in their context of time and space. Severe loss of memory for recent events is called anterograde amnesia. Forgetfulness for events predating the onset of impairment is called retrograde amnesia. Semantic memory, consisting of knowledge of concepts and facts, functions more or less independently from episodic memory and is intimately connected with language functions.

3.2. Language

Language deficits can be grouped in three categories, relating to speech expression, naming, and comprehension.

3.3. Visuo-spatial functions

Problems of spatial thinking may among others be manifested by impaired construction (e.g., inability to copy designs) and problems of spatial orientation (finding one's way in familiar or less familiar surroundings).

3.4. Executive functions

These are capacities involved in the planning and regulation of goal-directed behaviour. Impairment may be reflected by diverse symptoms, including apathy and loss of initiative (or conversely disinhibition and impulsivity) and perseveration (inappropriate repetition of responses). A basic aspect of executive functioning is working memory, the ability to attend to several aspects of a task at the same time, as for instance in mental arithmetic.

4. Cognitive ageing

The prevalence of brain disorders affecting cognition—such as stroke and dementia—increases steadily with age. The question may be posed whether cognition also declines in ageing people who are spared from such afflictions. In other words, is cognitive decline a normal feature of ageing? At first glance, the answer appears to be ''yes''. Even when recognised brain disease is excluded, elderly people invariably obtain lower averages on cognitive tests than younger age groups. The age effect is relatively small for tests appealing to ''crystallised'' abilities, i.e., skills and knowledge gained through schooling and experience, such as vocabulary and common sense. In contrast, the elderly are at a considerable disadvantage on tests for ''fluid'' ability, which require the subject to respond to novel situations. The most affected areas are episodic memory, spatial ability and executive functions. To a large extent, the changes are determined by a slowing of information processing, rather than a loss of capacity (Verhaeghen and Salthouse, 1997).

Upon closer examination, these age-related differences are less straightforward than they seem. Firstly, even if major neurological diseases are excluded, the older group can certainly not be said to be free from pathology. In the aged, normality means little more than that the person in question has no complaints calling for clinical attention. Secondly, a comparison of age groups, being cross-sectional, tends to be contaminated by cohort effects. That is, the conditions in which the subjects grew up were probably less conducive to intellectual development in the older than in the younger group. Therefore, their average performance may have been lower than that of the comparison group when they were of the same age. Longitudinal studies (i.e., testing the same subjects at different ages) would avoid such cohort effects, but have other drawbacks. Results will be enhanced by the effect of repeated testing, and poorly functioning subjects will be lost to follow-up more often than well-functioning subjects. Consequently, longitudinal research will tend to underestimate age effects (Small, 2001). Thirdly, the performance of older subjects, more than in younger subjects, may be attenuated by factors irrelevant to the capacities tested, such as poor vision, hearing loss, fatigue, and a less competitive attitude. Finally, the degree of decline is by no means uniform across individuals. The deterioration of average performance is typically accompanied by an increase in variability, indicating that while the loss of capacity may be considerable in some, it may be slight or even absent in others (Verhaeghen and Salthouse, 1997). An obvious explanation is that individuals differ in the extent to which their brain has, in the course of a lifetime, been exposed to noxious influences such as traumatic impact, toxic substances and oxygen shortage. Additionally, there may be individual differences in the strength and endurance of reparative mechanisms (Ball and Birge, 2002). Indeed, cognitive decline is known to be associated with previous health and lifestyle factors (Scarmeas and Stern, 2003), especially those relating to vascular risk (Anstey and Christensen, 2000). The concept of ''cognitive reserve'' is often invoked to explain the finding that high education appears to protect against cognitive decline (Stern, 2003). It is debatable to what extent such reserve must be attributed to environmental (i.e., schooling) or genetic influences (aptitude). One genetic factor associated with a higher risk of cognitive decline (as well as dementia) is apolipoprotein E4 (Anstey and Christensen, 2000).

In summary, we may conclude that although the impact of ageing on cognition is hard to estimate, decline may be called normal in a statistical sense, meaning that it is fairly

common. However, cognitive decline is not an inevitable outcome of ageing, and may well be the result of unrecognised pathology.

5. Mild cognitive impairment

Since cognitive decline sets in well before dementia can be diagnosed, attempts have been made to define impairments that may reflect the preclinical stage. The term mild cognitive impairment is reserved for patients whose impairment is objectively demonstrable but is not pronounced in more than one domain of cognition and does not seriously affect activities of daily living (DeCarli, 2003). Several definitions of mild cognitive impairment have been proposed. The most widely used criteria are those for 'amnestic' mild cognitive impairment formulated by Petersen et al. (1999). These are aimed at the detection of isolated memory impairment that may be indicative of developing Alzheimer's disease. While criteria for mild cognitive impairment provide a convenient clinical procedure for identifying people at risk of developing dementia, there are numerous limitations. Firstly, even strict criteria still allow considerable latitude in assessment methods, for instance in the quality and number of tests used. In connection with this, studies of the prevalence of mild cognitive impairment and its rate of conversion to dementia are poorly comparable and yield highly variable results. Furthermore, different types of dementia may not be equally recognisable by their early symptoms (Luis et al., 2003).

6. Alzheimer's disease

Alzheimer's disease is by far the most frequent cause of dementia, increasing in prevalence from less than 1% below the age of 60 to more than 40% above the age of 85. The initial phase is marked by a progressive deterioration of episodic memory. Other impairments may be entirely absent in the beginning or consist of mild disturbances of naming and executive function. When the process advances, the impairment spreads to other divisions of memory and other domains of cognition (see paragraph 3). Although the patients will at first be aware of their decline (which sometimes leads to depression), insight will gradually fade and be replaced by denial and rationalisation. In due time, formal testing becomes impossible, but an examination with simple tasks and questions will disclose deficits in all domains of cognition.

7. Vascular cognitive impairment

Vascular dementia is the second most common type of dementia, but actually consists of a heterogeneous collection of clinical pictures (O'Brien et al., 2003). The combined occurrence of Alzheimer's disease and vascular dementia is probably more common than has been assumed. In the past, attention was mainly directed at multi-infarct dementia, a syndrome caused by large cortical infarcts, leading to multiple functional disturbances. Nowadays, it is recognised that vascular dementia can also be caused by abnormalities in smaller blood vessels, leading to lacunar infarcts and white matter lesions in subcortical areas. Except for so-called strategic infarcts, the cognitive effects of such 'small-vessel disease' are usually quite different from those of Alzheimer's disease. Patients with white matter lesions demonstrate a clinical syndrome of subcortical dementia. The cognitive performance remains largely adequate, though conspicuously slowed. This slowing is accompanied by relatively mild impairments of memory (mostly affecting reproduction) and executive function (mainly reflected by loss of mental flexibility and difficulty in dealing with complex situations). The patient is usually well aware of his limitations.

Unlike Alzheimer's disease, cerebrovascular disease is not necessarily progressive. As such, it can also cause more limited and static cognitive impairment. An obvious example is the effect of single cortical infarcts, which consist of circumscribed functional disturbances corresponding with the location of the infarct. It is also suspected that subcortical ischaemia contributes substantially to 'normal' age-related decline (Gunning-Dixon and Raz, 2000; Ferro and Madureira, 2002). Thus, vascular cognitive impairment seems ubiquitous, and is probably no less prevalent in old age than Alzheimer's disease.

8. Conclusion

Not long ago, cognitive aging was viewed as a general deterioration of cognition (reflected by a decreasing IQ) and dementia as an acceleration of this process. Presently, we know that cognitive decline occurs in various forms, marked by considerable differences in the nature and order of development of behavioural symptoms. This knowledge is an important asset to the early detection, management and treatment of dementia. However, the neuropsychological approach to dementia certainly has limitations and is at its proper place only in a multidisciplinary context. The concerted effort of all branches of neuroscience is required for patient care, as well as research on cognitive decline in aging individuals.

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