Editorial

Theoretical and practical implications of dual-task performance in Alzheimer’s disease

The ability of human beings to perform more than one thing at a time has long been a focus of study in the literature on human attention and memory. Evidence from studies of healthy volunteers has suggested that there may be an identifiable cognitive function responsible for dual- or multi-task coordination in overall task performance. The failure of this coordination function is a characteristic impairment of mild Alzheimer’s disease patients both in a laboratory setting (Baddeley et al., 1986; Della Sala et al., 1995; Greene et al., 1995; Collette et al., 1999; see also the paper by Baddeley et al. in this issue), and in everyday tasks such as holding conversations (Alberoni et al., 1992), or walking while talking (Camicioli et al., 1997). There are published reports of dual-task deficits in the healthy elderly (see review in McDowd and Shaw, 1999). However, these studies do not take account of the lower initial levels of performance on each task performed on its own (Hartley and Little, 1999).

Moreover, there is no evidence that dual-task performance is affected by normal ageing, provided that tasks are chosen to rely on different parts of the cognitive system, and the level of difficulty of the two individual tasks is adjusted so as to equate single-task performance across groups (see Fig. 1). However, mild Alzheimer’s disease patients show substantial performance decrements under such dual-task conditions (see Fig. 1).

Baddeley and colleagues (this issue) have, in addition, reported that increasing the demands of a single task has no greater impact on Alzheimer’s disease patients than it does on healthy controls, and that the dual-task deficit in Alzheimer’s disease can be demonstrated using different combinations of tasks (Baddeley et al., 2001). This lends further support to the suggestion that Alzheimer’s disease patients have a specific difficulty with dual-task performance rather than general cognitive demand.

Some of our own recent research has shown that the effect is robust across practice, appears regardless of the relative cognitive demand of each task and can be demonstrated when combining two memory-loaded tasks providing that each task employs theoretically distinct cognitive resources (e.g. Logie et al., 2000). Other studies have shown that the size of the dual-task decrement increases as the disease progresses and this progressive decrement is much greater than that seen for individual tasks (Baddeley et al., 1991).

Several other cognitive tasks, such as episodic memory and response inhibition, have been shown to be sensitive to the effects of Alzheimer’s disease (e.g. Perry et al., 2000). However, these tasks are also sensitive to the effects of normal ageing. The specific nature of the dual-task deficit in Alzheimer’s disease, in the absence of an impact of normal ageing, offers considerable potential for developing non-invasive instruments to aid diagnosis, to track the progression of the disease and to evaluate the effectiveness of any treatments that might become available.

From a theoretical point of view, the findings contribute to the understanding of the organization of cognitive resources in the human brain. One view is that there is available a single, general purpose pool of attentional resources that can be allocated on demand until the demand exceeds the resource available. Therefore, in the case of Alzheimer’s disease these resources would be reduced resulting in poorer cognitive performance overall. Such a view would have some difficulty with the finding that dual-task performance appears to be impaired in Alzheimer’s disease, while the patients are not differentially affected by increasing the demands of a single task. A second view is that cognition is limited by the speed with which the cognitive system can operate, and that normal ageing results in a slowing of processing. Baddeley and colleagues extend this argument to investigate whether cognitive slowing might offer a possible interpretation of the cognitive impairments in Alzheimer’s disease (Baddeley et al., 2001). However, the speed of processing view faces a significant challenge from their findings that speed of responding in a focal attention task does not result in differential impairments for Alzheimer’s disease. The results are more consistent with the alternative interpretation (Baddeley et al., 1986, 1991) that cognition is supported by several, specialized functions, coupled with a coordination function. Baddeley and colleagues add to the gamut of studies showing that thorough analyses of Alzheimer’s disease patients’ performances contribute to our understanding of
Fig. 1 Mean percentage immediate serial ordered recall of digit sequences at span length performed as a single task and concurrently (dual task) with perceptuomotor tracking (data from Baddeley et al., 1986).

the architecture of normal cognition (see Della Sala and Venneri, 2000).

Neuroimaging techniques have also been used to investigate the impact of increasing cognitive load and of requiring dual-task performance. Some studies have shown that simultaneous performance of two tasks results in activation of brain areas that are not active when each task is performed on its own (D’Esposito et al., 1995). Other studies have shown the contrasting finding that dual-task performance increases activation only in those areas that were active during single-task performance (Adcock et al., 2000). One possible resolution arises from a difficulty in linking brain imaging techniques with models of cognition, specifically the possible use of alternative cognitive strategies by the volunteers in the studies. It has been known for some time that volunteers adopt different strategies in cognitive laboratory tasks (e.g. Logie et al., 1996). In most behavioural studies, this tendency is treated as random variation with relatively large numbers of volunteers contributing to the aggregate data. These aggregate data then serve as the basis for conclusions and theory development, and the variance due to the use of alternative strategies is treated as error variance in the statistics. However, in neuroimaging studies, much smaller numbers of healthy volunteers are used, and the brain areas that are activated will reflect those areas that are associated with whatever strategy the volunteer happens to adopt for the task. This requires clear evidence that every participant is using the same cognitive resources to perform a given task, coupled with thorough cognitive task analyses.

In summary, the dual-task coordination hypothesis supported by Baddeley and colleagues’ data provides a plausible account for the cognitive performance impairment in Alzheimer’s disease patients. However, there remains considerable uncertainty as to the possible links between brain organization and cognitive organization with respect to dual-task performance in healthy adults and healthy ageing, as well as in Alzheimer’s disease. Nevertheless, the dual-task paradigm appears to add to theory and to offer a viable and fruitful approach to the development of clinical tools.

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References


