

# Selective attention in early Dementia of Alzheimer Type

Diego Fernandez-Duque<sup>a,\*</sup>, Sandra E. Black<sup>b</sup>

<sup>a</sup> Department of Psychology, Villanova University, 800 Lancaster Ave., Villanova, PA 19085, USA

<sup>b</sup> Department of Medicine, Sunnybrook Health Science Centre, University of Toronto, Canada

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## Abstract

This study explored possible deficits in selective attention brought about by Dementia of Alzheimer Type (DAT). In three experiments, we tested patients with early DAT, healthy elderly, and young adults under low memory demands to assess perceptual filtering, conflict resolution, and set switching abilities. We found no evidence of impaired perceptual filtering nor evidence of impaired conflict resolution in early DAT. In contrast, early DAT patients did exhibit a global cost in set switching consistent with an inability to maintain the goals of the task (mental set). We discuss these findings in relation to the DAT literature on executive attention, dual-tasking, and working memory.

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## 1. Introduction

In recent years, several studies have explored whether selective attention is impaired at early stages of Dementia of Alzheimer Type (DAT) (Baddeley, Baddeley, Bucks, & Wilcock, 2001b; Belleville, Rouleau, & Van der Linden, 2006; Fernandez-Duque & Black, 2006; Levinoff, Li, Murtha, & Chertkow, 2004; Levinoff, Saumier, & Chertkow, 2005; Logie, Cocchini, Della Sala, & Baddeley, 2004; Perry & Hodges, 1999; Rizzo, Anderson, Dawson, Myers, & Ball, 2000). This is important from a theoretical standpoint, since clinical changes in attention may provide a window into the neural mechanisms of attention. It is also important from a clinical perspective because understanding attention in DAT may aid its early diagnosis and treatment.

*Selective attention* refers to a variety of cognitive processes by which individuals flexibly choose which stimuli to process and which to ignore. It includes the ability to ignore perceptual distractors (i.e., *perceptual filtering*) as

well as the ability to withhold responses that conflict with one's goals (i.e., *conflict resolution*). As such, selective attention is central to goal-directed behavior. Selective attention in the visuospatial domain has been studied extensively with the visual search task (Wolfe, 2003). For this task, reaction time increases as a function of the number of distractors when the search is attentionally demanding. In those searches, DAT patients are abnormally slow (i.e., have a steep slope function). However, it is unclear whether this deficit is due to slowness in shifting attention from item to item or to ineffective processing of each item (Foster, Behrmann, & Stuss, 1999; Tales, Muir, Jones, Bayer, & Snowden, 2004). DAT patients are also impaired in rescaling the focus of attention, benefiting less than healthy subjects from cues that provide only approximate information about the target location in the search display (Parasuraman, Greenwood, & Alexander, 2000).

Unlike the visual search task, the spatial cueing task requires subjects to maintain central fixation while attending to the direction of a cue. This constraint allows the assessment of spatial selective attention independent from eye movements. Although the spatial cueing task is a rather simple task with easily understood instructions, its requirement to maintain central fixation may disproportionately

\* Corresponding author. Fax: +1 610 519 4269.

E-mail address: [diego.fernandezduque@villanova.edu](mailto:diego.fernandezduque@villanova.edu) (D. Fernandez-Duque).

tax DAT patients. For example, DAT patients may have difficulty keeping such instruction in mind and/or inhibiting saccades to peripheral stimuli. These confounds complicate the interpretation of DAT deficit in the spatial cueing task (Buck, Black, Behrmann, Caldwell, & Bronskill, 1997).

Selective attention can also be studied in non-spatial tasks. One popular method is to instruct participants to ignore some stimulus dimensions (e.g., identity, location) and respond based on a target dimension (e.g., color).<sup>1</sup> For example in the Stroop task, subjects ignore the word meaning and respond instead to the ink color. The stimulus ambiguity in tasks such as this forces participants to mentally keep track of the instructions by which the target response is to be selected. Such an ability to flexibly bind perception and response dispositions is sometimes called *mental set* and allows subjects, upon seeing the word RED written in blue ink, to disregard the redness of the word meaning and focus instead on the blueness of the ink, a phenomenon labeled *conflict resolution*. The ability to maintain a mental set is related to working memory capacity. Since working memory capacity may be compromised in healthy aging and DAT, impaired performance in conflict resolution in Stroop-like tasks is difficult to interpret (De Jong, 2001; Kane & Engle, 2003; Mayr, 2001; Nieuwenhuis, Broerse, Nielen, & de Jong, 2004; Fernandez-Duque & Black, 2006; Spieler, Balota, & Faust, 1996); it may reveal a deficit in selective attention proper, or an inability to maintain the mental set instead.

*Mental set* (aka *task set* or *goal set*) is the high-level control setting that serves as the basis for target selection. The ability to maintain a *mental set* has been studied extensively in set switching paradigms. These studies have revealed that performance deteriorates when the mental set alternates across trials instead of remaining constant throughout the experiment. In part, this decrease in performance is due to a local switch cost: after having focused on color ink in trial  $n - 1$ , the mental set needs to switch to word meaning. This process requires effort and usually leaves a residual cost that cannot be eliminated until the occurrence of the new item. This local switch effect, although important, cannot fully account for the performance cost brought about by the presence of set switching. More precisely, response to ambiguous stimuli suffers even in non-switch trials, provided that these occur in a block that also contains switch-trials. This cost is sometimes referred to as the 'global set-selection cost' and seems to

be related to the capacity to maintain the currently relevant mental set in the presence of distracting information.

Global set-selection cost has been reported to become larger during healthy aging (Kray & Lindenberger, 2000; Mayr, 2001). There is also neuropsychological evidence to suggest that patients with DAT might be impaired in their global set-selection. For example, the ability to switch mental sets is impaired even at early stages of the disease: patients with mild DAT perform poorly in the set shifting task of the CANTAB (Cambridge neuropsychological tests automated battery) which requires subjects to alternate between two stimulus dimensions (e.g., color and shape) (Dorion et al., 2002; Robbins et al., 1994; Sahakian et al., 1990). Furthermore, poor set switching performance in neuropsychological tasks is a good predictor of disease progression in patients at the pre-clinical stage (Albert, 1996; Albert, Moss, Tanzi, & Jones, 2001). One of these predictors is the Trail Making task—part B, in which letters and numbers are randomly distributed on a sheet of paper and the subject has to trace the items in ascending order alternating between letter and number (e.g., 1-B-2-C-3). In healthy adults, performance in this task relates to performance in experimental set switching tasks (Arbuthnott & Frank, 2000).

These findings are consistent with the hypothesis that the ability to maintain mental set may be affected even at very early stages of DAT, including the prodromal stage labeled Mild Cognitive Impairment (MCI). Patients with a diagnosis of MCI have subjective memory complaints and perform below normal in neuropsychological tests of long-term memory. However, they are able to carry out normal activities of daily living and have normal general cognitive function in intelligence tests. Although as a group MCI patients may be impaired in response inhibition and set switching, a substantial number of patients seem to show only deficits in episodic memory (Perry, Watson, & Hodges, 2000). This latter group of patients fits the criteria for amnesic Mild Cognitive Impairment (MCI-a) (Petersen et al., 1999). Nonetheless, even the MCI-a is a heterogeneous group, and subtle deficits of attention are revealed in experimental designs. In one such study, researchers divided MCI-a patients by those who had mostly hippocampal atrophy and those who had mostly small vessel cerebrovascular disease (as revealed by white matter hyperintensities in the MRIs) (Nordahl et al., 2005). Although both groups were equally impaired in episodic memory, those with small vessel disease were significantly impaired in tasks that required maintenance of a mental set, such as working memory and continuous performance tasks.<sup>2</sup> Even healthy adults with a genetic risk of developing DAT may experience difficulties in some of these functions (Parasuraman, Greenwood, & Sunderland, 2002).

<sup>1</sup> Another popular method to study non-spatial attention is the negative priming paradigm. This task measures the cost in performance when the target of a current trial was also the distractor in the preceding trial. Effective inhibition in trial  $n - 1$  leads to a cost (negative priming) when the item reoccurs as a target in trial  $n$ . DAT reduction in negative priming has been found in some studies but not others, and it is unclear whether the reduction is due to a deficit in selective attention or in memory (Amieva, Phillips, Della Sala, & Henry, 2004; Ko, Kilduff, Higgins, Milberg, & McGlinchey, 2005; Vaughan, Hughes, Jones, Woods, & Tipper, 2006).

<sup>2</sup> Obviously, this is not to say that all the deficits exhibited by these patients can be traced back to an inability to sustain a mental set.

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