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Acta Psychologica 122 (2006) 27–44
acta psychologica
www.elsevier.com/locate/actpsy

The impact of secondary tasks on multitasking in a virtual environment

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Received 7 February 2005; received in revised form 28 September 2005; accepted 29 September 2005
Avialable online 22 November 2005

Abstract

One experiment is described that examined the possible involvement of working memory in the Virtual Errands Test (McGeorge et al. (2001). Using virtual environments in the assessment of executive dysfunction. Presence, 10, 375–383), which requires participants to complete errands within a virtual environment, presented on a computer screen. Time was limited, therefore participants had to swap between tasks (multitask) efficiently to complete the errands. Forty-two undergraduates participated, all attempting the test twice. On one of these occasions they were asked to perform a concurrent task throughout (order of single and dual-task conditions was counterbalanced). The type of secondary task was manipulated between groups. Twenty-one participants were asked to randomly generate months of the year aloud in the dual-task condition, while another 21 were asked to suppress articulation by repeating the word "December". An overall dual-task effect on the Virtual Errands Test was observed, although this was qualified by an interaction with the order of single and dual-task conditions. Analysis of the secondary task data showed a drop in performance (relative to baseline) under dual-task conditions, and that drop was greater for the random generation group than the articulatory suppression group. These data are interpreted as suggesting that the central executive and phonological loop components of working memory are implicated in this test of multitasking.

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doi:10.1016/j.actpsy.2005.09.002

PsycINFO classification: 2340

Keywords: Multitasking; Working memory; Phonological loop; Central executive

1. Introduction

The term "multitasking" can be used to refer to a situation where a person has to complete multiple tasks, but cannot execute them sequentially (due to time limitations) or simultaneously (due to physical or cognitive limitations). The tasks must therefore be interleaved with one another, each being suspended and then resumed after appropriate intervals (Burgess, 2000a, 2000b). Everyday domestic examples are cooking and shopping, but multitasking is also necessary for many jobs, for example, emergency medicine (Chisholm, Collison, Nelson, & Cordell, 2000) or management (Seshadri & Shapira, 2001). A number of studies have shown that patients with brain damage, particularly in the frontal lobes, can have great difficulty in applying efficient strategies in multitasking situations (Alderman, Burgess, Knight, & Henman, 2003; Burgess, Veitch, de Lacy Costello, & Shallice, 2000; Crépeau, Belleville, & Duchesne, 1996; Fortin, Godbout, & Braun, 2003; Goldstein, Bernard, Fenwick, Burgess, & McNeil, 1993; Knight, Alderman, & Burgess, 2002; Levine, Dawson, Boutet, Schwartz, & Stuss, 2000; Levine et al., 1998; Shallice & Burgess, 1991). However, little research has yet been conducted into the factors that constrain multitasking performance among healthy adults, and how the cognitive system deals with these complex situations (Law et al., 2004). Therefore, our aim was to investigate the cognitive demand of multitasking using a well-established theoretical framework—the multiple-component model of working memory (e.g., Baddeley & Logie, 1999). Specifically, we used dual-task methodology to investigate the involvement of the phonological loop and central executive components of working memory in a test of multitasking. The test used was a "Virtual Errands Test" created by McGeorge and colleagues (McGeorge et al., 2001) and based on the "Multiple Errands Test" of Shallice and Burgess (1991).

The Multiple Errands Test (MET) was created by Shallice and Burgess (1991) in response to the observation that some patients with frontal lobe lesions who had disruptions to everyday life skills nevertheless performed normally on traditional "executive" tests, which were supposed to be sensitive to frontal lobe damage. The idea was to tap cognitive processes analogous to those involved in real life open-ended planning situations, but to have a quantifiable measure of performance. The original version of the Multiple Errands Test involved taking participants to a local shopping centre and giving them a list of tasks. Most of these were easy, for example, "buy a brown loaf", but others were more difficult, for example, "find out the name of the coldest place in Britain yesterday". An important part of a time-limited shopping trip is finding an efficient route through the shopping precinct. Excessive backtracking will result in the time elapsing before all errands are completed. Therefore the errands have to be interleaved in an efficient manner, rather than simply tackled in the sequential fashion in which they are presented. Shallice and Burgess found that their three patients were impaired in their ability to attempt this task effectively compared to a group of control participants—the patients tended to break more rules and to be more inefficient.