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On the Relation of Working Memory and Multitasking: Memory Span and Synthetic Work Performance☆

Thomas S. Redick*

Purdue University, United States

Recent research has identified working memory as a critical component of multitasking ability. These studies showed that working memory accounted for multitasking variance over-and-above that predicted by other cognitive, personality, and experience-based variables. However, a limitation of these previous studies was that the tasks selected to measure working memory were dual-tasks themselves. The purpose of the current research was to determine if working memory measures must be dual-tasks to predict multitasking performance, or if other types of working memory measures that do not rely upon the dual-task methodology predict multitasking just as well, if not better. Three different serial order memory span tasks (one dual-task and two single-task) and one multitask were administered to a sample of healthy young adults. The results showed that single- and dual-task working memory measures predicted multitasking to a similar degree. The results indicate there is something fundamental about working memory's relationship with multitasking ability.

Keywords: Working memory, Multitasking, Applied

Working memory functioning is important for many activities both in and out of the lab. While experimental work has shown effects of working memory load upon decision-making, attention, and memory search, individual differences research has demonstrated relations between an individual's working memory level and reading comprehension, fluid intelligence, and mathematics ability. As another example of individual differences research on working memory, one outside-of-the-lab activity that applied cognitive psychologists have frequently investigated is multitasking. Recent research has identified working memory as a critical component of multitasking ability (Ackerman & Beier, 2007; Bühner, König, Pick, & Krumm, 2006; Colom, Martínez-Molina, Shih, & Santacreu, 2010; Hambrick, Oswald, Darowski, Rench, & Brou, 2010; König, Bühner, & Murling, 2005; Morgan et al., 2013), and these studies showed that working memory predicted multitasking performance over-and-above other cognitive, personality, and experience-based variables. However, a limitation of many of these previous studies was that the tasks selected to measure working memory were multitasks themselves. The purpose of the current research was to determine if working memory measures must be dual-tasks to predict multitasking performance, or if other types of working memory measures that do not rely upon the dual-task methodology predict multitasking just as well, if not better. If single-task working memory measures predict multitasking performance, this implies that there is something fundamental about working memory's relationship with multitasking ability, irrespective of any overlap of the method used to measure both working memory and multitasking.

Memory Span Measures of Working Memory

All of the aforementioned studies included complex memory span tasks as working memory measures, in which participants

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* Correspondence concerning this article should be addressed to Thomas S. Redick, Purdue University, Psychological Sciences, 703 Third Street, West Lafayette, IN 47907, United States. Tel.: +1 765 494 5132. Contact: tredick@purdue.edu

must remember a sequence of items while also performing an interleaved distracting task. For example, in the reading span, examinees read sentences and make a decision about the veracity or sensibility of the statement, and are presented with an item to remember (e.g., letter). A number of these processing-and-storage stimuli are presented, before participants are asked to recall the to-be-remembered items in order. Tasks like reading span are often called processing-and-storage or complex span tasks in contrast to storage-only, simple span tasks such as letter span, in which participants are instructed to serially recall a sequence of letters in order without the additional interleaved distractor task. One current view is that individual differences in working memory, as measured by complex span tasks, reflect a person's ability to maintain a select number of items in active memory, retrieve information from inactive memory, and control attention to counteract interference and distraction (McVay & Kane, 2012; Shipstead, Lindsey, Marshall, & Engle, 2014; Unsworth, Fukuda, Awh, & Vogel, 2014).

Although earlier studies suggested a distinction between the working memory processes measured by complex versus simple span tasks (Daneman & Carpenter, 1980; Engle, Tuholski, Laughlin, & Conway, 1999), more recent research has indicated that simple and complex span tasks measure largely overlapping processes and account for similar variance in cognitive abilities, particularly when partial credit-scoring and longer simple-span list lengths are used (Colom, Rebollo, Abad, & Shih, 2006; Unsworth & Engle, 2007). In addition, studies using variants of a running span task, in which participants must report a specified number of items at the end of a sequence of stimuli (e.g., letters), produce strong correlations with complex span tasks and also account for shared variance in cognitive abilities (Broadway & Engle, 2010; Cowan et al., 2005).

Multitasking

Multitasking is important for many aspects of human behavior, particularly in certain employment sectors (e.g., medical field, military, aviation) where multitasking is necessary for vocational success and multitasking failures pose serious safety-related consequences. In the current work, I adopted the definition of multitasking provided by Oswald, Hambrick, and Jones (2007), whereby multitasking requires: (a) performing multiple tasks; (b) consciously shifting from one task to another; and (c) performing the component tasks over a relatively short time span. There are numerous operational definitions possible for multitasking, but in the current study I used the SynWin multitask, an established measure of synthetic work (Elsmore, 1994; Hambrick et al., 2010, 2011; Proctor, Wang, & Pick, 1998; Salthouse, Hambrick, Lukas, & Dell, 1996). SynWin involves simultaneous performance of four unrelated tasks varying in self- and externally-paced timing, visual and auditory information processing, and verbal and numerical stimuli (Figure 1). SynWin is thus similar to other tasks used in applied multitasking research, including the SIMKAP (Bratfisch & Hagman, 2003) and Multi-Attribute Task Battery (MATB; Comstock & Arnegard, 1992).

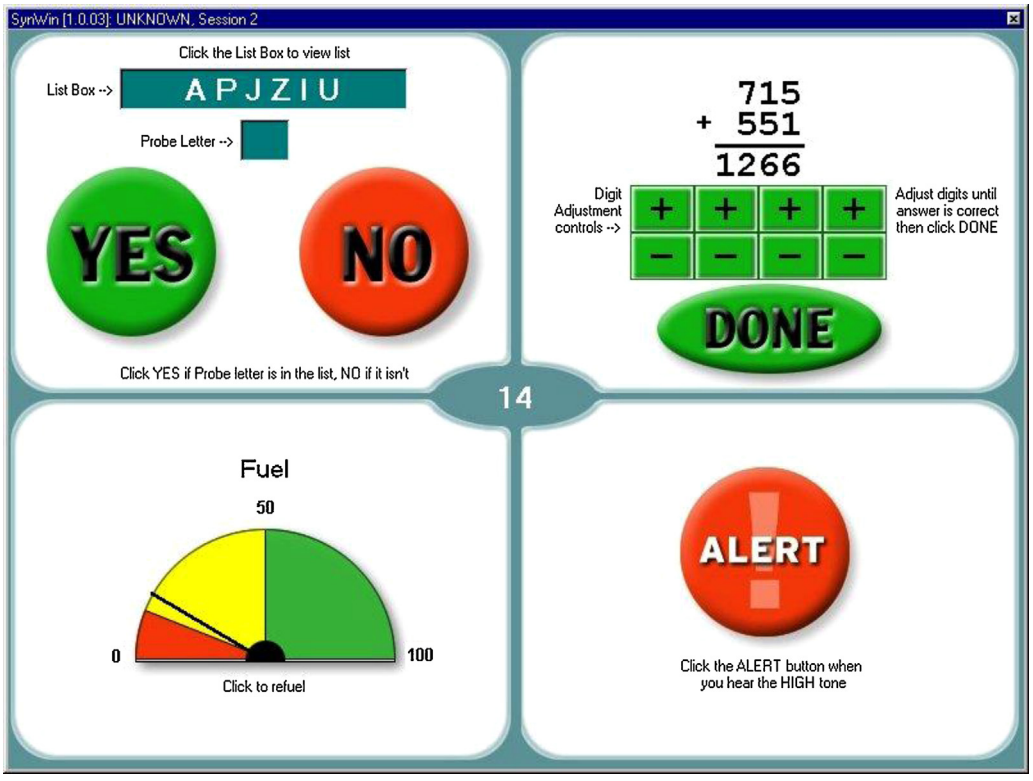

Figure 1. Example screenshot from SynWin.