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# Interference control, working memory capacity, and cognitive abilities: A latent variable analysis

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ABSTRACT

The present study examined whether various indices of interference control were related to one another and to other cognitive abilities. It was found that the interference control measures were weakly correlated and could form a single factor that was related to overall memory performance on the tasks as well as to measures of working memory capacity and fluid and crystallized intelligence. Furthermore, it was found that both working memory capacity and memory performance mediated the relation between interference control and intelligence and both accounted for variance in intelligence over and above that accounted for by interference control. These results suggest that interference control is an important cognitive construct that is related to other cognitive abilities. These results have implications for a number of areas that rely on the notion of interference control as an explanatory construct.



## 1. Introduction

The notion that the ability to control one's memory is an important aspect of remembering has long been a topic of interest for memory researchers. For instance, Atkinson and Shiffrin (1971) in a paper pointedly titled "The Control of Short-Term Memory" emphasized that control processes such as rehearsal, coding, decisions, and retrieval strategies were important components of remembering. Furthermore, Atkinson and Shiffrin emphasized that these processes were under the direct control of the individual and thus performance by a given individual was determined in large part based on which control processes were utilized in a given task and the individual's ability to adequately use those control processes. Thus, it can be expected that individuals who are better able to control aspects of their memories will demonstrate better performance on a number of memory tasks and will likely show better performance in a number of situations that rely on an efficient memory system than individuals who are less able to control the aspects of their memories.

### 1.1. Interference control and cognitive abilities

One function that has received a great deal of attention of late is the ability to control interference of information in working memory (WM). Specifically, recent work has suggested that the ability to deal with interference or conflict from recently presented information that was once relevant, but is now irrelevant, is one key component of WM and one reason why WM tasks tend to predict performance on many higher-order cognitive tasks. In these interference control views it is assumed that relevant and irrelevant representations compete for limited access in WM requiring individuals to either prevent these irrelevant representations from gaining access in the first place or to get rid of them once they have gained access (Braver, Gray, Burgess, 2007; Hasher, Lustig, & Zacks, 2007; Kane, Conway, Hambrick, & Engle, 2007; Unsworth & Engle, 2007). Note in the current paper interference control refers only to interference from competing memory traces and does not index other potential inhibitory constructs such as resistance to prepotent responses. Currently these views differ in the mechanism(s)

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that is responsible for preventing or resolving this interference with some arguing for inhibition or suppression as the key mechanism (Hasher et al., 2007), while others argue for the role of active goal maintenance (Braver et al., 2007; Kane et al., 2007), or for the use of accurate retrieval cues and source monitoring processes to focus the search process (Hedden & Park, 2003; Unsworth & Engle, 2007). Regardless of the specific mechanism(s) that is postulated to deal with interference each of these interference control views suggests that the ability to effectively deal with interference is an important control process that is utilized in a number of memory tasks and may be one important determinant of individual differences in cognitive abilities more broadly.

Additional recent work has specifically focused on interference control as a potentially important control function not only in healthy young adults, but also in healthy older adults (Hasher et al., 2007), healthy children (Dempster 1992, Kail, 2002), individuals with reading disabilities (Chiappe, Hasher, & Siegel, 2000), as well individuals with frontal damage (Janowsky, Shimamura, Kritchevsky, & Squire, 1989) to name a few. In each of these situations it is suggested that the low ability participants demonstrate poorer overall performance in part due to deficits in interference control in which they cannot effectively prevent or resolve conflict between competing traces. Furthermore, recent neuropsychological and neuroimaging work has suggested that several areas seem to be related to interference control including inferior frontal gyrus, lateral prefrontal cortex, and possibly the anterior cingulate (see Jonides & Nee, 2006 for a review). Finally, recent work has suggested that interference control is likely needed in a number of real world situations where task irrelevant information competes for access in WM including stress and anxiety, depression, stereotype threat, as well as potentially socially inappropriate responses (see Unsworth, Heitz, & Engle, 2005 for a review). For instance, Joormann and Gotlib (2008) have recently shown that depressed individuals are poorer at interference control when the irrelevant material is negative in nature. Thus, interference control is an important explanatory construct in a number of research domains.

This work points to a fairly standard view of interference control (e.g., Dempster & Corkill, 1999; Friedman & Miyake, 2004) in which the ability to deal with interfering representations in WM is required on many memory tasks and in many real world situations. Individuals who perform poorly on these memory tasks do so, in part, because they are unable to deal with interference due to deficits in inhibition, active maintenance, or source monitoring. Furthermore, aspects of the frontal lobes are critical for this ability to effectively deal with interference. This standard view suggests that measures of interference control obtained from various memory tasks are all in fact measuring the same thing, and that this common variance is related to other importance cognitive abilities such as intelligence (Dempster & Corkill, 1999).

Recent work has focused on this last point and has attempted to examine the extent to which indices of interference control are related to one another and to other measures of cognitive abilities. For instance, Friedman and Miyake (2004) examined the extent to which multiple measures of interference control were related to one another and were related to other inhibitory constructs (such as resistance to prepotent responses) and to other putative measures of inhibition and executive functions. Friedman and Miyake (2004) found that indices of interference control were moderately related to one another and loaded on the same factor. Furthermore, this interference control factor was related to performance on a measure of working memory capacity (WMC) as well as the White Bear Suppression Inventory (Wegner & Zanakos, 1994), but was generally not related to the other inhibition related tasks and factors. Thus, this work suggests that interference control represents a distinct cognitive construct that is related to other cognitive abilities.

Using another large sample of participants and tasks, Salthouse, Siedlecki, and Krueger (2006) found little evidence that several indices of interference control were related to one another, or any evidence that they were related to other cognitive abilities such as fluid and crystallized intelligence (gF and gC). Given the lack of evidence of a distinct interference control factor in their study, Salthouse et al. suggested that it was still an open question as to whether interference control measures are related to one another at the individual level and whether they are related to other cognitive abilities. Furthermore, some additional studies have suggested a relationship between indices of interference control and WMC and performance on cognitive abilities measures (e.g., Bunting, 2006; Cantor & Engle, 1993; Dempster & Corkill, 1999). Thus, the evidence that different indices of interference control are related to one another and to other cognitive abilities is somewhat mixed and as noted by Salthouse et al. (2006) more work is needed to examine the notion of a distinct interference control factor that is related to other cognitive abilities.

### *1.2. The present investigation*

The purpose of the current paper was to better explore the notion that individuals differ in their interference control abilities and that these abilities are related to other important cognitive abilities. Specifically, similar to Friedman and Miyake (2004) and Salthouse et al. (2006), multiple indicators of interference control and of the various cognitive abilities constructs were used to form latent variables and the relation among the latent variables was examined. The three interference control tasks chosen for investigation were:

1. A version of the Brown-Peterson task with category switches to assess the buildup and release of proactive interference. A great deal of work has been done on this task elucidating the build and release of proactive interference as well as determining various individual, group, and neuropsychological differences.
2. A cued-recall directed forgetting task (Tolan & Tehan, 1999) with category cues to assess directed forgetting and susceptibility to interference. Like the Brown-Peterson task discussed above, this task has been used to examine interference and cuing effects in immediate memory tasks as well as individual and group (aging) differences in these processes (Tehan & Hauff, 2000).
3. A recent probes recognition task (Nelson, Reuter-Lorenz, Sylvester, Jonides, & Smith, 2003) to assess susceptibility to interference and conflict from recent trials. This task has