

## Working Memory Capacity and Errors Following Interruptions

Cyrus K. Foroughi\*, Parasteh Malihi, Deborah A. Boehm-Davis

George Mason University, Fairfax, VA USA

Errors following interruptions are problematic in many environments. Previous interruption research has focused on mitigation methods (e.g., alerts, cues) to reduce the deleterious effects of interruptions. However, little research has examined whether any individual difference measures can be used to predict how many errors individuals are likely to make following interruptions. The goal for the present research was to determine whether individual differences in working memory capacity, a measure of interference management (e.g., Kane & Engle, 2002), relate to errors following interruptions. Participants completed a procedural interruption task and multiple measures of working memory capacity. We found a moderate negative relationship ( $r = -.35$ ) between a composite variable of working memory capacity and the number of errors made following interruptions. In safety-critical environments, it may be best to assign individuals with higher working memory capacity to tasks where errors may have dire outcomes.

**Keywords:** Interruptions, Working memory capacity, Individual differences, Interference management, Errors

During a routine shift, an air traffic controller instructed a small, 10-passenger plane to hold on a runway before take-off. Before he was able to clear the plane for take-off, he was interrupted to assist another aircraft. Following the interruption, instead of telling the small passenger plane to take off, he cleared a Boeing 737 to land on the same runway. Sadly, disaster followed, and 34 people lost their lives as a result of this accidental, interruption-induced error (NTSB, 1991). As this example shows, errors following interruptions are problematic, and can be disastrous. In safety-critical environments, interruptions have been shown to increase procedural (e.g., failure to record medication administration) and clinical (e.g., wrong drug) errors in the hospital (Westbrook, Woods, Rob, Dunsmuir, & Day, 2010), and automobile accidents (NHTSA, 2012). They also have been implicated in pilot error and flying accidents (Fitts & Jones, 1947; NTSB, 1991; see Werner, Cades, & Boehm-Davis, 2015 for a recent review).

Not surprisingly, research has focused on mitigation methods to reduce the deleterious effects of interruptions. This research shows that alerts, cueing, training, and non-invasive brain stimulation all can reduce the disruptive effects of interruption, but they are limited (Blumberg et al., 2014; Cades, Boehm-Davis, Trafton, & Monk, 2011; Foroughi, Blumberg, & Parasuraman, 2015; Trafton, Altmann, & Brock, 2005; Trafton, Altmann, Brock, & Mintz, 2003). Alerts and cues rely on proper system design to be effective. That is, a system must be in place to provide an alert or cue in order to be effective. Training has been

shown to be effective only for specific primary task and interruption pairs (Cades et al., 2011). That is, when either changes (a new primary task or a new interruption), these training effects appear to vanish. Given that task components and the types of interruptions we face constantly change, training appears to be unreliable at remedying the negative effects of interruptions. Finally, transcranial direct current stimulation (tDCS) has been shown to reduce the number of spatial errors individuals make following interruptions by 25%, but a majority (i.e., 75%) of the errors still occurred (Foroughi, Blumberg, et al., 2015).

The majority of previous research has focused on the aforementioned mitigation methods, with few efforts to examine alternative methods that may be able to mitigate the disruptiveness of interruptions. One such alternative is selection. That is, selecting individuals who may have a predisposition (i.e., individual differences) to make fewer errors following interruptions may provide another method to reduce the deleterious effects of interruptions. Working memory capacity (WMC) is an individual difference measure that has been shown to predict performance as measured by time (Foroughi, Werner, McKendrick, Cades, & Boehm-Davis, 2016; Werner et al., 2011). However, to our knowledge, it has not been examined in the context of errors following interruptions.

WMC can be used to measure how well an individual manages interference (e.g., Kane & Engle, 2002). Kane and Engle (2003) argued that “information maintenance in the face of interference is the critical function of working memory capacity”

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\*Correspondence concerning this article should be addressed to Cyrus K. Foroughi, 4400 University Drive, MS3F5 Fairfax, VA, 22030-4444, USA. Contact: [cyrus.foroughi@gmail.com](mailto:cyrus.foroughi@gmail.com).

**Figure 1.** The financial management task. To successfully complete this task, individuals must enter information into one of twelve boxes located at different locations. Interruptions occur randomly, but always after successfully completing a box.

(p. 48). Because interruptions act as interference to any task being completed (Altmann & Trafton, 2002; Foroughi et al., 2016), those who can better manage interference are likely to make fewer errors following interruptions.

Therefore, the goal for this research is to determine whether WMC is related to errors following interruptions. To determine this, participants completed a battery of working memory tasks (viz., operation span, reading span, symmetry span), and the Financial Management task, a procedural task with built-in interruptions that can be used to measure the number of errors one makes following interruptions (Foroughi, Blumberg, et al., 2015; Trafton, Altmann, & Ratwani, 2011; see Figure 1). We hypothesized that individuals with higher WMC would make fewer errors following interruptions as they would be better able to manage interference (e.g., Kane & Engle, 2002) in the face of being interrupted compared to individuals with lower WMC.

## Method

### Participants

Fifty students ( $M = 22.4$  years old,  $SD = 2.9$ , 32 females) from George Mason University participated for course credit. Five

individuals failed to meet the minimum accuracy required for a valid score on the spans tasks that were used to measure working memory capacity so their data were excluded from all analyses.

### Tasks and Materials

**Financial management task.** The primary task was a computer-based, procedural task called the Financial Management Task (Foroughi, Blumberg, et al., 2015; Foroughi et al., 2016; Trafton et al., 2011; see Figure 1). The goal for this task is to successfully complete client stock order information. First, participants must decide which stock to buy or sell, and then fill in twelve pieces of information relevant to that order, one component at a time, in one of twelve different boxes located on different parts of the computer screen. Participants must place this information in a specific order starting with the upper left box (labeled 1 in Figure 1), then the upper right box (labeled 2 in Figure 1), continuing on until the last piece of information is placed on the bottom right box (labeled 12 in Figure 1). To progress through the task, participants must enter the correct information in the correct box. If the participant chooses an incorrect piece of information and attempts to move on, the box

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