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Individual differences in prospective memory aftereffects: The role of working memory capacity and inhibition.

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INDIVIDUAL DIFFERENCES IN PROSPECTIVE MEMORY AFTEREFFECTS: THE ROLE OF WORKING MEMORY CAPACITY AND INHIBITION

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ABSTRACT

This study examined attentional control and executive function (EF) in relation to canceled intentions in two experiments. After an intention is canceled, a commission error occurs when one continues to actively fulfill the intention in response to a prospective memory (PM) cue. Aftereffects are slower response times to inactive PM cues when encountered in ongoing processing. Attentional control was indexed by working memory capacity (WMC) and EF was indexed by three measures of inhibition. In prior canceled intention PM research, attentional control and inhibition have not been extensively studied. However, two major methodological factors in PM research could implicate attentional control and inhibition – focality for the former (the degree of similarity between the ongoing and PM tasks) and response type (requiring one or two responses when presented with a PM cue) for the latter construct. Experiment 1 found those with better inhibitory control to make fewer commission errors. Response type moderated the relationship between WMC and 2nd block *focal* aftereffects because of a negative relationship with a dual-task response type, but a positive relationship with a task switch response type. In Experiment 2, inhibition did not predict commission errors but negatively predicted aftereffects – those with better inhibitory control had smaller aftereffects. Separate hierarchical regression analyses were conducted for those that made commission errors and those that made no commission errors. WMC was found to negatively predict aftereffects in the *commission* error group and inhibition was found to negatively predict aftereffects in the *no commission* error group. Overall, inhibitory and attentional control were found to relate to both commission errors and aftereffects, thus future research should further explore how these individual differences may predict how PM intentions are deactivated.

CHAPTER 1. INTRODUCTION

1.1. Prospective Memory

Prospective memory (PM) involves remembering to fulfill an intention in the future when the appropriate context is present, such as stopping at the store to buy milk on the way home from work (Brandimonte, Einstein, & McDaniel, 1996; Ellis, 1996). The success of fulfilling an intention depends largely on the content of the intention to be performed (e.g., buying milk at the grocery store), how well the intention is formed (e.g., thinking of going to the store in the morning before you leave for work), the target context (e.g., the store) and the OGT (e.g., going about your day at work) (Cockburn, 1995). Serious consequences may occur if intentions are not fulfilled. For example, many patients have suffered adverse consequences because of improper medication adherence, such as forgetting to take a daily medication or failing to forget to stop taking a medication (Heathcote, Loft, & Remington, 2015). Two types of PM have been studied in the literature: Event-based and time-based PM.

1.2. Time-Based vs. Event-Based PM

Event-based PM entails fulfilling an intention in the future in response to a specific cue in the appropriate context, such as remembering to take your medication when you see the medicine bottle (Marsh, Hicks, & Cook, 2005). Alternatively, time-based PM involves fulfilling an intention after a particular amount of time or at a specific time, for example calling a co-worker in 20 minutes to remind them of a meeting. The present study will focus on event-based PM, which up until Einstein and McDaniel's (1990) seminal work was poorly understood.

In the laboratory, a popular methodology to measure PM is to have participants self-initiate a delayed, intended action while being engaged in an ongoing task (OGT; Einstein & McDaniel, 1990; Einstein, McDaniel, Richardson, Guynn, & Cunfer, 2005; Bisiacchi, Schiff,

Ciccola, & Kliegel, 2009). The OGT is typically attentionally demanding, such as a lexical decision task (LDT; judging strings of letters as words or nonwords), an image rating task, a reading task, or rating the pleasantness of words (Einstein, Smith, McDaniel, & Shaw, 1997; Hicks, Marsh, & Russell, 2000). In the beginning of a typical PM paradigm, participants are instructed to respond to 'special' cues differently (e.g., a face, word, concept, or category of items; Hicks, Marsh, & Cook, 2005). For example, in Einstein et al. (2005), participants were engaged in a word categorization task for the OGT and told to respond differently (e.g., with a different key) when shown the word *tortoise*. After a filler task to ensure the intention was retained in long-term memory (LTM), participants performed the OGT and had to self-initiate responding to the PM cue with the different key as opposed to the regular OGT response. Responding to the cue(s) differently in the OGT was the PM task – if the response was correct, participants are showing accurate retrieval of the intention to respond differently and eventual execution of that response. More recently, PM research has begun to focus on canceled intentions.

1.3. Commission Errors

A commission error in PM occurs when the intention has been canceled, but upon seeing the PM cue again, one continues to make the PM response. Previous research has evaluated whether the now inactive intention is fully deactivated in memory. Some have found that the intention is fully deactivated (Marsh, Hicks, & Bink, 1998; Scullin, Einstein, & McDaniel, 2009) as indicated by response time (RT) often being faster for OGT trials with intention cues after the intention has been canceled, as well as faster RT to prospective lure trials (West, McNerney, & Travers, 2007). Others have not found that the intention was fully deactivated with there still

being a cost to the OGT trials after the intention was canceled (Cohen, Dixon, & Lindsay, 2005; Penningroth, 2011).

A popular method used to measure commission errors in PM was created by Scullin et al. (2009) (See Figure 1.1). In the initial paradigm, participants performed an image-rating task in response to words and were also instructed to make a different response (press the *Q* key) to specific words (e.g., *corn* and *dancer* or *fish* and *writer*). These specific words were the PM targets. After an image-rating test block with the PM targets present, cancelation instructions were given, (e.g., you no longer need to press the Q key anymore – that task is finished). Participants then engaged in a LDT where the PM targets were still present. If participants continued to respond to the PM target words in the LDT with the special key (*Q*), a commission error occurred. Scullin et al. (2009) did not report any commission errors, but did find an intention interference effect where participants had longer RTs to PM target words than to control words (both trials types presented with different salient colored backgrounds) after the PM intention was canceled, which shows that the intention was not fully deactivated. The 0% rate of actual commission errors was replicated in Scullin, Bugg, McDaniel, and Einstein, (2011).

1.4. Aftereffects

It has been found that when compared to neutral items that do not have an associated intention, items related to completed but no longer active intentions result in longer latencies in OGTs (Marsh et al., 1998; Marsh, Hicks, & Bryan, 1999; Scullin et al., 2009). A term coined from these findings is aftereffects - when there is a longer RT to an inactive PM cue, which indicates that the PM intention still produces activation in memory (Walser et al., 2012). However, the explanation for aftereffects has been disputed in the literature because many

studies failed to find these results using similar paradigms. Cohen et al. (2005) and Penningroth (2011) hypothesized that completed intentions could remain activated immediately after the intention is completed, but then gradually decay over time.

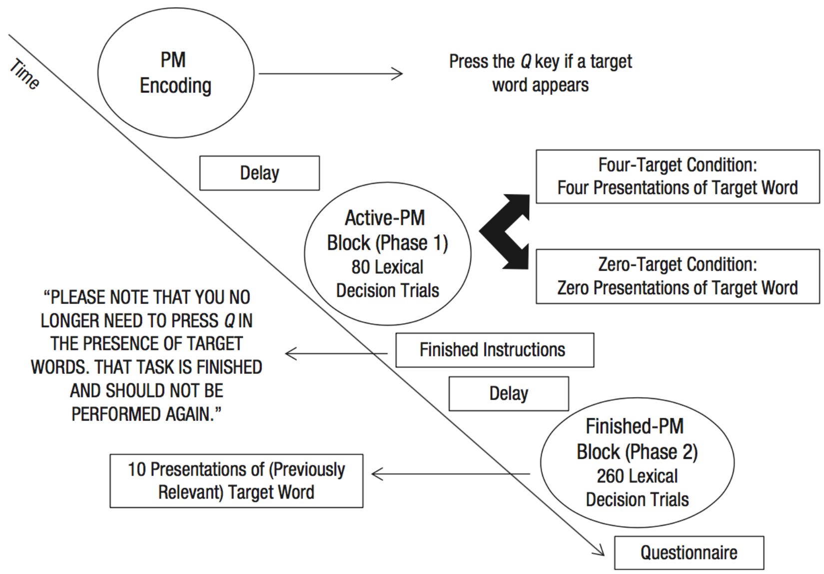

Figure 1.1 Bugg and Scullin (2013) paradigm

Walser et al. (2012) measured aftereffects across four experiments using a new paradigm they created – the *repeated PM cue paradigm.* See Figure 1.2 for a visual depiction of the paradigm. The OGT was a parity judgment for digits being odd or even and the PM task was to make a task switch response when shown a digit with a specific characteristic (e.g., press the spacebar instead of making your OGT response when you see a number in *bold*). Aftereffects were measured by canceling the once active PM intention (*bold number*) for a given block and creating a new intention (e.g., a *border* around a different number), while still being exposed to the now canceled intention-related cue context called a PM repeated trial (*bold number*). Participants were also shown 'oddball' trials that had a distinctive feature (e.g., *yellow background*) but were to be treated as an OGT trial because they did not satisfy the conditions of making a PM response. There were a few participants that made at least one commission error to

PM repeated trials (*M* = 9.9% of participants) and OGT performance was significantly slower, but this slowing *did* stop after further progression on the OGT, which supports what Cohen et al. (2005) and Penningroth (2011) hypothesized (i.e., slow deactivation).

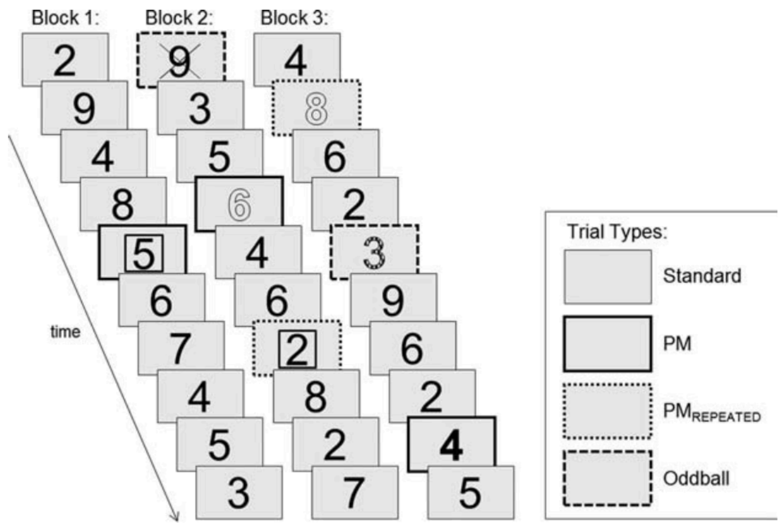

Figure 1.2 Walser et al. (2012) repeated PM cue paradigm

Limited research has been done examining individual differences in aftereffects or commission errors (McDaniel & Einstein, 2000). Shelton and Scullin (2017) theorized that because PM relies heavily on bottom-up (spontaneous retrieval of the PM intention) and top-down processes (monitoring for PM cues), that there should be individual differences within these processes, and these differences should extend to canceled intentions (Barrett, Tugade, & Engle, 2004). Brewer, Knight, Marsh, and Unsworth, (2010) found that when a retrieval cue for PM task is weak (e.g., not specific) that those with low WMC performed worse compared to high WMC participants. But, even though it has been claimed that WMC has been ‘widely’ studied in PM, the only research that was reviewed in Shelton and Scullin (2017) was the relationship between WMC and PM cue specificity and not canceled intentions. Moreover, another individual difference that has been explored in a few studies was not mentioned –

inhibition. Thus, in the next section I review the limited research that has been done in exploring individual differences in PM in relation to attentional control (measured via WMC) and executive function (EF) (measured via inhibition).

1.5. Attentional Control

Attentional control is one's ability to choose what is paid attention to and what is not (Barrett et al., 2004). Working memory (WM) is the part of memory involved with both storing/maintaining information, as well as actively processing and manipulating information and has been used to measure attentional control in previous research (Oberauer, 2002; Conway, Kane, Bunting, Hambrick, Wilhelm, & Engle, 2005; Banich, 2009). Baddeley and Hitch (1974) stated that the WM system consists of temporary memory stores with associated mechanisms for rehearsing information and a central executive that regulates the contents of the active components of memory. These associated mechanisms include the phonological loop (responsible for speech-based information) and visuospatial sketchpad (responsible for visual and spatial information; Baddeley & Hitch, 1974). Cowan (1995) proposed the "embedded processes" model of working memory, which states traces of information can be actively maintained in the 'limited' focus of attention (e.g., conscious awareness) or these traces of information can be kept active and accessible through rehearsal and coding processes (e.g., inner speech, chunking) in activated long-term memory (Kane, Conway, Hambrick, & Engle, 2007). Thus, while Baddeley and Hitch's model of WM emphasized how information is stored via specific associated mechanisms, the embedded process model developed by Cowan focused on the relationship between attention and awareness. Specifically, information within the focus of attention is activated more completely than information that is not within the focus of attention (but, is in activated long-term memory). But, if attention is re-directed to information that is in

activated long-term memory, then some features of this memory can be re-activated (Cowan, 1995).

The three-embedded-components model of WM by Oberauer (2002) is an extension of Cowan's embedded processes model and concludes there are three components of WM: Activated long-term memory, the direct access region, and the focus of attention. Activated long-term memory keeps information available that is relevant to the OGT, while some of the representations in activated long-term memory are held in the direct access region, which Oberauer stated is the *broad focus* and corresponds to Cowan's focus of attention in the embedded processes model (Oberauer & Hein, 2012; p. 164). The focus of attention can contain one single item, which is selected because it is relevant to the current cognitive task (Oberauer, 2002; Oberauer & Hein, 2012). The ability to complete these tasks that are not in the focus of attention can be influenced by working memory capacity (WMC).

WMC refers to individual differences in the limited capacity of a person's WM (Engle, 2002). WMC is important because cognitive tasks can only be completed if one has the ability to complete the task (processing), while also maintaining information (Cowan, 2010). Specifically, WMC has been found to positively correlate with performance on various cognitive tasks, such as reading comprehension, complex learning, and reasoning (Daneman & Carpenter, 1980; Engle, 2002). Cowan proposed that our memory store is limited to 3 to 5 meaningful units within the central executive of WM when we are young adults. WM span measures were created to measure an individual's capacity in this limited memory storage. The WM span tasks were developed based on Baddeley and Hitch's model of WM, which emphasized that WM involves an immediate memory system that can store limited amount of information briefly while at the same time engaged in an ongoing cognitive task (Conway et al., 2005). Popular measures of WM

span/WMC are the operation-span (OSPAN), rotation-span (RSPAN), counting-span (CSPAN), and symmetry-span (SSPAN) tasks (Daneman & Carpenter, 1980; Turner & Engle, 1989; Unsworth, Redick, Heitz, Broadway, & Engle, 2009). In each of these tasks, for example the OSPAN, participants perform a series of operations (e.g., math equations) and then after each operation see a letter that needs to be memorized. After a variable number of operations and letters, participants must reconstruct the order the letters were presented in (Turner & Engle, 1989). Engle (2002) and Kane et al. (2007) concluded that those with a higher WMC have a greater ability to control their attention, not necessarily that they have a larger memory store.

A large part of using WM successfully in these various span tasks is rehearsing information and resolving potential interference (Kane & Engle, 2000). Proactive interference occurs when an old behavior interferes with a new behavior when they have similar contexts (Engle, 2002). For example, finding your parked car in a parking lot may be easy the first time, but many trips later it is harder to locate your car because your previous trips of finding your car are interfering with the newer occasion. This proactive interference is a bigger problem for people with low WM spans compared to high span individuals (Engle, 2017).

The role that WM plays in PM has been tested in the neuropsychological literature (Basso, Ferrari, & Palladino, 2010). In 5 experiments, Marsh and Hicks (1998) varied the difficulty of the OGT in an event-based PM task to see how taxing executive resources with a more or less complex OGT influenced PM accuracy. Marsh and Hicks (1998) found that PM accuracy was 25% worse under a high load condition compared to a low load condition, which shows that taxing executive resources negatively effects PM accuracy. More recently, Basso et al. (2010) varied the difficulty of the OGT in a PM experiment and found RT on the ongoing and PM tasks was significantly slower and PM accuracy was significantly lower when the WM load

was higher. This finding that a high WM load in the OGT has a detrimental effect on PM accuracy has been well replicated (Botto, Basso, Ferrari, & Palladino, 2014; Halahalli, John, Lukose, Jain, & Kutty, 2015). However, there has been no research examining the relationship between attentional control (WMC) and PM *errors* or aftereffects.

1.6. Focality

Previous research in PM has manipulated attentional control via focality (Einstein & McDaniel, 2005; McDaniel & Einstein, 2007). Focal tasks are those in which processing required by the OGT and noticing the intention relevance of PM cues overlaps a great deal (Einstein & McDaniel, 2005), thus requiring little attentional control. For example, responding to a specific cue word (e.g., *fish*) overlaps well with a task in which people are making word/nonword decisions about stimuli. An everyday example would be encountering and stopping to talk to a friend whom you intended to give a message (Einstein et al., 2005). Nonfocal tasks are those in which there is little such overlap, such as when people are told to respond to any animal word in the context of a lexical decision – identifying items from a category does not overlap highly or require the same cognitive resources used in identifying strings of letters as words or nonwords, thus does require attentional control in order to be successful in the task. An everyday example of nonfocal processing would be stopping at a grocery store that is out of your way to buy milk when you are in rush hour traffic and you're focusing on driving. Focal tasks typically result in PM accuracy being very high, sometimes near ceiling (Uttl, 2005; Scullin et al., 2011).

As argued by McDaniel and Einstein (2000), focal processing promotes involuntary/reflexive retrieval of the intention, therefore resulting in high PM accuracy. This reflexive retrieval of an intention is commonly called spontaneous retrieval in the literature

(McDaniel & Einstein, 2007). Thus, with spontaneous retrieval one does not need additional attentional resources in order to be successful. In contrast, in a nonfocal task, spontaneous retrieval is unlikely (McDaniel & Einstein, 2007) and participants engage in ‘monitoring’ for PM cues in order to be successful (Smith, 2003). This cost typically results in lower PM accuracy (e.g., Hicks, Franks & Spitler, 2017) and a slowing (i.e., cost) on the OGT, relative to focal conditions. Cost is usually measured by examining the RT for OGT trials. For example, Einstein et al. (2005) found a higher cost to OGT trials in the nonfocal condition (*M* = 1425 ms) compared to the focal condition (*M* = 1120 ms). It has been argued that participants have a higher cost to the OGT with a nonfocal intention because the executive attentional system is monitoring the environment for the target event. Once the PM target has been encountered, this attentional system interrupts the OGT activity (Smith, 2003; Einstein et al., 2005) and requires strategic attentional resources (Einstein & McDaniel, 2005).

Little research has been done examining the relationship between focality and commission errors in PM. Scullin, Bugg, and McDaniel (2012) created a focal versus nonfocal paradigm with salient versus non-salient PM cues (e.g., showing the PM cue with a bright red or blue background) and canceled the intention halfway through the experiment. The highest rate of commission errors was found in the focal/salient condition (*M* = 18%) compared to 3% in the nonfocal/salient condition. But Bugg and Scullin (2013) used the same paradigm (focal condition only) and found 0% of participants made a commission error. Furthermore, in Scullin and Bugg (2013), using the same PM target focal paradigm, some participants were only shown the now-inactive PM cue once where one group saw the cue after a short delay (trial 40) and others saw it after a long delay (trial 258). Scullin and Bugg (2013) found 25% of participants made at least one commission error with the percentage of commission errors not being reliably different

across delay type. Thus, based on Scullin et al. research, the rate of commission errors was highest in a focal paradigm using a salient background for PM target trials, but the rate of commission errors was not consistent across their various studies.

It has been suggested then that commission errors are the result of spontaneous retrieval and insufficient attentional control of the PM response (Scullin & Bugg, 2013; Walser, Goschke, Moschl, & Fischer, 2016). Thus, the difference in the rate of commission errors may be due to the task demands – in Scullin et al. (2012; Scullin & Bugg, 2013) the focal/salient condition was used with a LDT serving as the OGT. But, in Scullin et al. (2009; 2011) the OGT was an image rating task with no salient background for the PM cues. The method was nonfocal in Scullin et al. (2009; 2011) because of the overlap between identifying specific words (PM task) being different than rating the imageability of words (OGT). Therefore, 0% of participants making a commission error in this nonfocal paradigm could be because participants did not experience spontaneous retrieval of the intention after the intention is canceled or it could be because salient cues were not used in Scullin et al. (2009; 2011).

Research has shown that being able to fulfill an intention results in a lower rate of subsequent commission errors compared to not being able to fulfill the intention (Bugg & Scullin, 2013). Because PM accuracy is lower for nonfocal intentions compared to focal intentions, participants are not accurately fulfilling the nonfocal intention as many times as the focal intention and this difference in PM accuracy could be why commission errors are less likely with a nonfocal intention. Bugg and Scullin (2013) hypothesized that repeatedly performing the PM task correctly results in a greater number of episodic memory traces, resulting in a more detailed representation of intention completion. Consequently, it could be easier for the group that accurately fulfilled the intention correctly multiple times (focal

intentions) to update these memory traces once the intention is no longer active, resulting in few to zero commission errors. Alternatively, those with nonfocal intentions may find it more difficult to associate this cancelation to their intention representation, resulting in *more* commission errors for a nonfocal intention. However, little to no research has been done examining how nonfocal PM intentions influence the rate of commission errors except in Scullin et al. (2009; 2011; 2012).

Aftereffects have not been measured with canceled nonfocal intentions. After an intention is canceled, there is conceptually no longer an intention-related cue for which to monitor, which means monitoring should no longer be occurring before the first PM cue is shown in the PM inactive test block. Because focal intentions rely on spontaneous retrieval, it could be that aftereffects for focal intentions will be longer if spontaneous retrieval of the intention occurs and participants correctly make an OGT decision to the now inactive PM cue. For nonfocal intentions where spontaneous retrieval is less likely to occur, it could be that aftereffects are not found. But, again, since nonfocal intentions typically result in lower PM accuracy that updating the active intention to being canceled could be more difficult with a nonfocal intention, resulting in more nonfocal commission, thus longer nonfocal aftereffects. However, previous research has not examined how aftereffects may differ across canceled focal and nonfocal intentions.

Lastly, little research has been done examining the relationship between WMC, focality, and canceled intentions collectively. Brewer et al. (2010) examined the relationship between individual differences in WMC and focality in an event-based PM task and found that both low and high WMC span participants performed well on the focal PM task, but those with low WMC spans (M = .68) performed significantly worse than high span (M = .92) participants on the

nonfocal PM task. This supports the conclusion that controlled attention is necessary for successful PM for nonfocal tasks.

1.7. Executive Function

EF has been a large focus of study by neuropsychologists in trying to understand behavioral control (McCabe, Roediger, McDaniel, Balota, & Hambrick, 2010) and encompasses processing related to goal-directed behavior and controlling complex cognition, especially in new situations (Banich, 2009). Miyake et al. (2000) stated that EF has three components: Inhibition, task shifting, and updating (Miyake et al., 2000). Support has been found for inhibition, shifting, and updating being united or similar due to correlating with one another (inhibition and updating, $r = .77$, inhibition and shifting, $r = .79$, updating and shifting, $r = .38$) (Miyake & Friedman, 2012). However, research has also found evidence of diversity of these three executive functions based on observations that these three EFs differentially relate to different well-known measures of frontal lobe functioning (Miyake & Friedman, 2012).

Ball, Pitaes, and Brewer (2018) argued that attentional control and EF are responsible for the prospective component of PM (Brewer et al., 2010; Schnitzspahn, Stahl, Zeintl, Kaller, & Kliegel, 2013; Zuber, Kliegel, & Ihle, 2016). In the few studies that have measured all three functions in relation to PM accuracy, a trend has been found that inhibition is more related to PM accuracy than task shifting or updating (Fish et al., 2007; Leynes, Marsh, Hicks, Allen, & Mayhorn, 2003; Schnitzsphan et al., 2013). Inhibition refers to the processes that are necessary to focus on certain parts of information available while at the same time suppressing other parts that are irrelevant or distracting (Zuber et al., 2016). However, more recently Rey-Mermet, Gade, and Oberauer (2017) concluded that there are two parts to inhibition, 1) The ability to stop a dominant response and 2) The ability to ignore distracting information. Thus, there has been

discussion in the literature in terms of what inhibition truly encompasses. In terms of the relationship between inhibition and PM, little research has been done. However, Zuber et al. (2016) found in a latent variable model of PM that inhibition is related to PM accuracy (r = .39) and Schnitzsphan et al. (2013) found with a different PM task inhibition to be the strongest predictor of PM accuracy (β = .20).

In terms of inhibition and commission errors, when searching PsycINFO with the following key terms: *Prospective memory, commission errors, inhibition,* only 6 studies appear. Of those 6 papers, only Scullin et al. (2012) measured inhibition in relation to commission errors. Scullin et al. (2012) measured inhibition with the Stroop task (Stroop, 1935) and the Trail Making B task (Butler, Retzlaff, & Vanderploeg, 1991) and found older adults that made at least one commission error had poorer inhibition than older adults that did not make any commission errors – however this analysis was not conducted comparing younger adults that made a commission error to those that did not. Thus, more research needs to be done to explore the role that inhibition has in commission errors especially since only two measures of inhibition were used in Scullin et al. (2012) as well. Moreover, there has been no research conducted exploring the relationship between inhibition and the potentially more sensitive measures of RT aftereffects related to canceled intentions.

1.8. Response Type

One way in which the need for inhibitory control has been manipulated in PM research is via the response type use to PM cues. There are mainly two response conditions: Task switch and dual-task approaches (Burgess, Scott, & Frith, 2003; Hicks et al., 2005; Bisiacchi et al., 2009). In a task switch approach, participants make a PM response *instead* of an OGT response, while in a dual-task approach, participants make an OGT response followed by the PM response

or vice versa (Bisiacchi et al., 2009). The nature of making a task switch versus a dual-task response could have ramifications for accuracy in a PM task (Bisiacchi et al., 2009), but surprisingly, most previous research (as of 2009 at least) does not clearly specify the 'route they take in the methods descriptions' (Bisiacchi et al., 2009, p. 1363). This is especially surprising because a task switch response presumably would require a higher level of inhibitory control compared to a dual-task response (Meier, Woodward, Rey-Mermet, & Graf, 2009), because a task switch response requires a stop to the OGT response and then initiating the PM response (Bisiacchi et al., 2009). Moreover, Bisiacchi et al., (2009) found PM accuracy was significantly higher with a dual-task response, (*M* = 82%) compared to a task switch response (*M* = 74%), which could be the result of the former response requiring less inhibitory control than the latter.

In general, there has been limited research done to directly compare a task switch and dual-task response type in PM. The following three studies compared these response types in relatively different PM paradigms. Gilbert, Hadjipavlou, and Raoelison, (2013) found a PM hit rate of 31% for task switch and 71% for the dual-task response type. RT between the two response types revealed participants were faster in responding using the task switch response (*M* = 601 ms) compared to the dual-task response (*M* = 690 ms). Hicks, Spitler, and Cohen (2020) used a paradigm based on Scullin et al. (2009; 2011) and found PM accuracy was not significantly different in Experiment 1 across response type, but in a second experiment found PM accuracy to be significantly higher with a task switch response (*M* = 95%) compared to a dual-task response (*M* = 85%). Moreover, participants were faster with a task switch response (*M* = 725 ms) than a dual-task response (*M* = 780 ms). Lastly, Pereira, Albuquerque, and Santo (2018) did not find a significant difference in correct PM responses or RT across the different

response types. Thus, the response type used influences both PM accuracy and RT in *certain* paradigms.

PM accuracy may be higher with a dual-task approach because it does not require one to inhibit the OGT response in order to make a PM response. It has been documented in the literature that there is a switch cost with the task switch response and this cost could result in poorer PM accuracy or a speed-accuracy tradeoff (Rogers & Monsell, 1995; Bisiacchi et al., 2009). Alternatively, a dual-task approach may lead to lower PM accuracy because of a cognitive load of remembering to make two responses or sequence two responses in a particular order (e.g., OGT first, then PM second). Thus, there could be fewer resources available in a dual-task response compared to a single task (Bisiacchi et al., 2009). The response type used needs to be considered when comparing what previous research has found because of the limited number of available studies, and the possibility that the nature of the response type directly impacts PM accuracy.

Only Hicks et al. (2020) has compared response type for canceled intentions. In two experiments, Hicks et al. (2020) found a small percentage of participants made at least one commission error in the task switch condition, but 0% of participants made a commission error in the dual-task condition. Because a standard lexical decision takes place first in a dual-task context, inhibiting subsequent PM responses that would ordinarily follow may be easier compared to a task switch context. This idea was tested in a follow-up experiment where the dual-task response was flipped – participants made their PM response first, followed by their OGT response. For the first time, a small percentage of participants made at least one commission error in the dual-task condition. These results provide support that in a dual-task response with the OGT response required first, participants are able to allocate their attentional

resources before making their response to the PM cue when it is inactive. However, measures of inhibition were not included to assess whether inhibition is a key mechanism that differentiates the task-switch from the dual-task response context.

Thus, it appears that the response type influences PM accuracy and the rate of commission errors based on the previous work reviewed here. However, the PM paradigm used was inconsistent across the three studies that examined the response type in terms of PM accuracy. Hicks et al. (2020) used a focal task, while Gilbert et al. (2013) and Periera et al. (2018) used a nonfocal task. A systematic study exploring WMC (focality) and inhibition (response type) in a PM paradigm where the intention has been canceled has not been done. Based on the literature showing variations in PM accuracy and commission errors based on both of these constructs, I believe it is critical to explore these relationships. Moreover, WMC and inhibition have been studied in relation to aftereffects, which is necessary because this should be a more sensitive measure of whether canceled intentions have been deactivated. Therefore, measuring aftereffects in Walser's paradigm with attentional and inhibitory control manipulated would provide valuable insight.

1.9. Attentional Control and Executive Function

Previous research has sometimes found a relationship between WMC and inhibition. For example, St. Clair-Thompson and Gathercole (2006) found a moderate relationship (r = .31) between the Stop Signal task (a measure of inhibition) and a spatial span measure (a measure of WMC). However, in this same study the authors did not find a significant relationship between the Stroop task (a measure of inhibition) and the spatial span measure (r = .20). Most importantly, there are a multitude of inhibition measures that have been developed and used in psychology research, but only a few have been measured in relation to WMC measures. Thus,

while sometimes a relationship is found between these automated measured of WMC and some measures of inhibition, the strength of this relationship is not strong and there is variance that is unaccounted for. Kane et al. (2007) stated that the WMC automated complex span tasks (e.g, OSPAN, RSPAN, SSPAN) can predict performance on tasks that require some level of attentional control (e.g., no go, Antisaccade, MSIT tasks). However, these automated span measures do not perfectly predict attentional control in the aforementioned tasks; some variance is unaccounted for.

1.10. Focality and Response Type

No research has been done examining the relationship between focality and response type in relation to commission errors and aftereffects. WMC or attentional control measures the difference in focal and nonfocal PM intentions, with the former requiring less attentional control because it has been found that accurate focal PM response relies on spontaneous retrieval. Nonfocal PM intentions require more attentional control because evidence of monitoring has been found because of a cost to OGT trials with an active nonfocal intention. Moreover, inhibition measures the difference between the task switch and dual-task response type, with the former requiring more inhibitory control compared to the latter. Thus, the present study proposed an exploratory study of the interaction between inhibition and WMC with the manipulation of response type and focality.

1.11. The Dynamic Multiprocess Framework

In terms of theories of prospective memory, there has been limited incorporation of inhibition and response type, but some incorporation of WMC and focality. One theory proposed by McDaniel and Einstein (2000) is the Multiprocess Framework, which incorporates attentional processes, primarily looking at the methodological factor of focality. The Multiprocess

Framework states that PM retrieval can depend on attention-demanding processes (monitoring) or relatively automatic processes (spontaneous retrieval). There are multiple processes that contribute to spontaneous retrieval, 1) the PM cue leads to bottom-up retrieval of the intention after an association has been created between the PM cue and the intention; 2) a discrepancy plus search process in which encountering a PM cue (a discrepancy), leads one to search their memory to find out the origin of the discrepancy; 3) an alert process where salient and discriminative stimuli capture attention, thus leading to a deeper level of processing of the PM cue (McDaniel & Einstein, 2000, 2007; Cona, Scarpazza, Sartori, Moscovitch, & Bisiacchi, 2015). Whether one engages in spontaneous retrieval or strategic monitoring is dependent upon a multitude of factors, such as focality (Einstein et al., 2005; Cona et al., 2015; McDaniel & Einstein, 2000; Scullin & Bugg, 2013).

Producing successful PM as the result of monitoring or spontaneous retrieval has been thoroughly supported in the literature (McDaniel & Einstein, 2000; Einstein & McDaniel, 2005; Einstein et al., 2005) with monitoring occurring with nonfocal PM (Marsh, Hicks, Cook, Hansen, & Pallos, 2003) and spontaneous retrieval occurring with focal PM targets (e.g., Einstein et al., 2005; Einstein & McDaniel, 2005; Hicks et al., 2005; Marsh et al., 2003). The Dynamic Multiprocess Framework proposed by Scullin, McDaniel, and Shelton (2014) explored the relationship between monitoring and spontaneous retrieval more closely and concluded that people dynamically deploy either monitoring or spontaneous retrieval when necessary (see Figure 1.3).

Focality has been manipulated and studied within the Dynamic Multiprocess Framework, however the role of inhibition, measured by response type, has not been explored systematically. Moreover, commission errors and the process of deactivating an intention, measured by

aftereffects, have not been incorporated into the Dynamic Multiprocess Framework. It is largely believed that commission errors are the result of spontaneous retrieval and lack of cognitive control (Scullin & Bugg, 2013). But these conclusions were based on work only using a focal paradigm where spontaneous retrieval was responsible for successful PM accuracy. Therefore, while it has been concluded that commission errors are the result of spontaneous retrieval, which coincides with the Dynamic Multiprocess Framework, paradigms where monitoring occurs (nonfocal paradigms) have rarely incorporated canceled intentions. Because the Dynamic Multiprocess Framework concluded that participants can dynamically deploy different attentional strategies, an individual difference approach measuring inhibition and WMC could provide further support showing that based on the task demands throughout the experiment, participants are utilizing inhibition and WM to different degrees.

1.12. The Preparatory Attentional and Memory (PAM) Theory

Smith and Bayen (2004) proposed the preparatory attentional and memory processes (PAM) theory of PM to account for the general attention-demanding nature of PM. Smith (2003) focused on how holding an intention affects the OGT in that there needs to be task interference in order to have successful PM. Thus, PM can never be automatic or occur because of spontaneous retrieval as McDaniel and Einstein (2000) claimed in their Multiprocess Framework. Smith (2003) found that those with a focal PM intention were slower on ongoing LDT trials compared to a control group that performed the OGT only (see also Marsh et al., 2003). However, the number of PM targets used by Smith (six different PM targets) was higher than what has been predominantly used in the literature (e.g., compared to the two PM targets used by Scullin et al. 2009; 2011), which can account for finding a cost. Moreover, Loft and Yeo (2007) found that participants with lower cost to OGT trials, had poorer PM, which means that

because there was no cost to the OGT trials, thus no preparatory attention, their PM accuracy suffered.

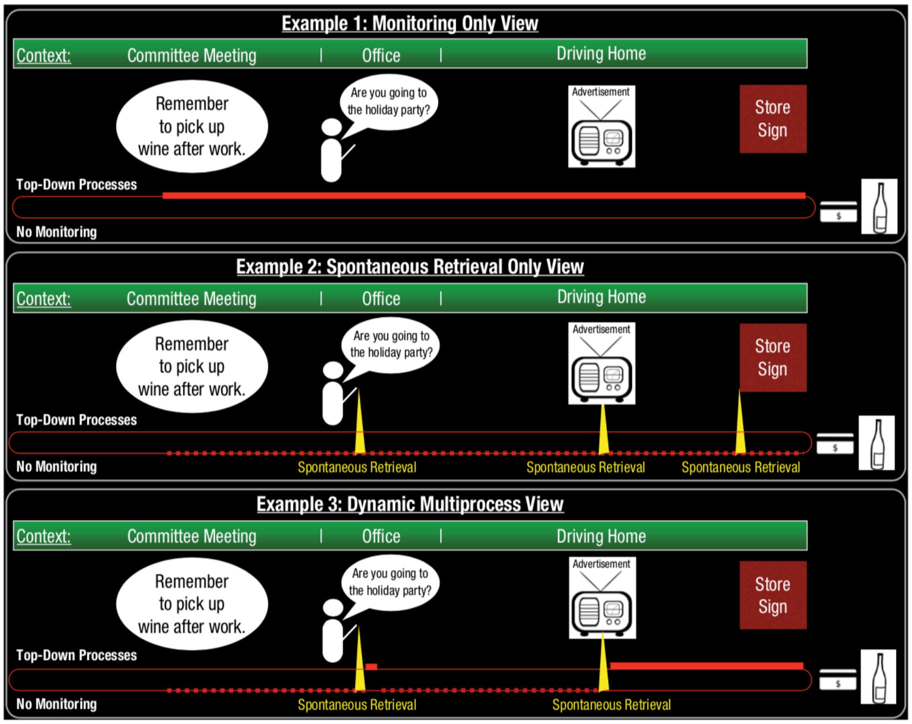

Figure 1.3 The Dynamic Multiprocess Framework (Scullin et al., 2014). For each example, the bottom bold solid line indicates monitoring and yellow spikes indicate spontaneous retrieval.

Because previous research largely supports that commission errors are the result of spontaneous retrieval, in part, it has not been theorized how the PAM theory could explain commission errors. It could be that there is insufficient preparatory attention when the intention is canceled, which results in commission errors. Therefore, participants are not monitoring for trials where the PM cue was shown because participants are unaware that PM targets will still be appearing, resulting in faster RT on OGT trials (Beck, Ruge, Walser, & Goschke, 2014; Scullin & Bugg, 2013; Walser et al., 2012). For the present study, if there is are differences in OGT trials across focal and nonfocal intentions, this would provide evidence for the PAM theory. WMC has not been measured in relation to the PAM theory. If preparatory attentional processes are necessary for accurate PM performance, it could be that those with higher WMC (higher

attentional control) would have better preparatory attentional processes, thus higher PM accuracy. Whether preparatory attentional processes then predict better attentional control to cancel the PM intention, thus reducing the number of commission errors or evidence of aftereffects, will be explored in the present study.

1.13. Delay Theory

The delay theory states that there is an accumulation of evidence to make PM responses and that there is a 'race' between the OGT and PM task to make either response, resulting in different decision thresholds (Heathcote et al., 2015). These decision thresholds are modified based on the attention allocation policy participants deploy at the beginning of the experiment (Hicks et al., 2005; Marsh et al., 2005; Loft, Kearney, & Remington, 2008), and are flexible depending on the task demands. The threshold to reach a PM response is generally set higher than that of an OGT response because of the former not occurring as often as the latter. And with a higher threshold, there is more time allowed for processing to retrieve the intention, resulting slower RT to PM trials compared to OGT trials (Strickland, Heathcote, Remington, & Loft, 2017). Thus, PM costs occur because of strategic slowing on the OGT trials (in nonfocal PM tasks) and this slowing allows more time for the PM response to reach the appropriate threshold to happen. The delay theory is in comparison to what Strickland et al. (2017) called 'capacity-sharing' theories – the Dynamic Multiprocess Framework (Scullin et al., 2014) and PAM theory (Smith, 2003) – which have theorized there is a limited capacity being shared between the OGT and PM tasks.

However, the delay theory does not address why commission errors occur except that PM errors are failures that result from the difference in processing efficiency between the OGT and PM task (Loft & Remington, 2013). Loft and Remington (2013) theorized that there should be

fewer PM errors if participants are given more processing time for PM trials, which would indicate that those who make a dual-task response should have higher PM accuracy compared to a task switch response because the former includes 'more processing time' by making their OGT response first. However, as stated previously, the difference in PM accuracy with different response types is variable and has not been studied extensively. Moreover, the same could be true for canceling the intention – since there are still fewer trials with the now inactive PM cue in the test block after the intention is canceled, participants need more processing time to make the correct response. This could be explained by aftereffects, which if there is evidence of this slowing to inactive PM cues, would indicate participants are taking the time to allocate their attention appropriately to not make a PM response after it is canceled. Lastly, like with the previous theories of PM reviewed, WMC and inhibition have not been incorporated into the delay theory. The delay theory of PM has theorized that participants attention allocation policy is flexible based on changing task demands. Thus, WMC and inhibition may be factors that determine how flexible a person's strategy is. Specifically, those with lower inhibitory control may require more time to make the correct PM response (whether it be active or canceled), resulting in slower RT to PM trials across the experiment. And because the delay theory states that participants allocate attention policies at the beginning of the experiment, using the measure of WMC for attentional control can indicate whether those with better attentional control (higher WMC) are better able to perform the PM task and cancel the intention.

1.14. Current Study

The present study examined the relationship between WMC and inhibition, and focality and response type, as predictors of two main dependent variables: Commission errors and aftereffects. Nearly all research that has examined commission errors thus far has used focal PM

paradigms. Thus, more research needs to be done with canceled nonfocal intentions, especially if aftereffects are found. Because nonfocal intentions require more attentional control compared to focal intentions, examining the relationship between canceled nonfocal intentions and aftereffects can provide valuable insight as to how well one can cancel a more attentionally demanding intention, especially when including WMC as an individual difference variable.

In terms of response type and canceled intentions, the limited research that has been done so far has found a dual-task response type eliminates, or nearly eliminates, commission errors (Hicks et al., 2020) compared to a task switch response. However, research examining how the response type influences potential aftereffects is lacking. Moreover, there is an inconsistency in the literature whether a task switch or dual-task response is more or less difficult in a PM paradigm (Gilbert et al., 2013; Hicks et al., 2020). If a dual-task response results in higher PM accuracy, this could lend support to the delay theory because having participants make the OGT response first causes a delay before the PM response can be made. Examining the relationship between those with lower WMC and poorer inhibition across these two response types can measure how attentionally demanding either response type is.

Ideally, there are two 'camps' of theories of PM – there are capacity theories, the Dynamic Multiprocess Framework and PAM theory, and the delay theory that is based on the accumulation of evidence in order to make either an OGT or PM response to each trial. All three of these theories have in common that attentional control can vary based on the PM paradigm. The Dynamic Multiprocess framework states the ability to deploy attentional resources is dynamic and can change based on task demands, while the PAM theory believes that PM accuracy always relies on active maintenance of the PM intention, resulting in slower RT to OGT trials. The delay theory of PM states that these costs to OGT trials that occur when a PM

intention is active is the result of strategic slowing on the OGT trials. Thus, the delay theory could both take into account attention and inhibitory control based on the attention allocation strategy the participant deploys based on task demands. However, interestingly there has been little research that has incorporated individual difference measures of attentional control – such as WMC and inhibition in any of these theories. Moreover, these three theories of PM do not account for commission errors or aftereffects. Thus, the proposed study addresses significant gaps in the literature, as well as a novel approach to measuring attentional control in relation to commission errors and aftereffects.

1.15. Hypotheses and Predictions

The first goal of the proposed study was to determine how focality and response type impact PM accuracy. First, it was predicted that PM accuracy would replicate previous research that has reliably found PM accuracy to be higher for focal intentions compared to nonfocal intentions (Einstein et al., 2005). Second, it was predicted that PM accuracy would be higher with a task switch response compared to a dual-task response based on our previous research (Hicks et al., 2020). Alternatively, Gilbert et al. (2013) found that PM accuracy was lower with a task switch response compared to a dual-task response. Thus, because the nature of the repeated PM cue paradigm is fast paced (judging if a digit is odd or even), inhibiting the pre-potent OGT response could be more difficult in the task switch response group because of a speed accuracy trade-off (faster RT, lower PM accuracy). If this is found to be true, higher PM accuracy for a dual-task response would lend support to the delay theory of PM.

The second goal of the proposed study was to determine how focality and response type impact commission errors. Based on previous research, it was predicted that there would be a higher rate of commission errors for focal compared to nonfocal intentions based on focal

intentions relying on spontaneous retrieval and nonfocal intentions relying on monitoring. Alternatively, Bugg and Scullin (2013) found that when participants are not able to fulfill an intention, more commission errors occurred. Previous research has sometimes found a trend with lower PM accuracy with a dual-task response compared to a task switch response (Hicks et al., 2020 [in prep]). Thus, it could be that those with canceled nonfocal intentions could make more commission errors because the memory trace of fulfilling the nonfocal intention is weaker (e.g., nonfocal intentions are fulfilled less often than focal intentions), thus more difficult to update with a canceled intention.. In terms of inhibition and the response type with commission errors, a higher rate of commission errors is predicted with a task switch response compared to a dual-task response (Hicks et al., 2020). Based on the literature, it has been concluded that commission errors are due in part to poor inhibitory and attentional control. Therefore, those with low inhibitory control in the task switch condition would have the highest rate of commission errors. Alternatively, because we found PM accuracy to be significantly lower with a dual-task response, deactivating a dual-task response could be more difficult, resulting in a higher rate of commission errors in the dual-task group. Moreover, response type has not been explored in the repeated PM paradigm, thus this will be the first study to explore the relationship between response type and commission errors in this paradigm.

The third goal of the present study was to examine aftereffects in Walser's repeated PM cue paradigm (2012). Walser's original repeated PM cue paradigm used a focal intention (e.g., make the PM response when presented with a specific digit and deviant feature) and task switch response. Therefore, in the present study nonfocal intentions and a dual-task response were included in order to compare aftereffects across these two factors of PM. By doing so, the role of inhibitory control across the two response types and attentional control across focal and nonfocal

intentions can be examined. For focality, longer aftereffects for canceled focal intentions are predicted compared to nonfocal intentions because if participants experience spontaneous retrieval of the focal intention, even if the response is correct (making an OGT response to a now canceled PM intention), this will result in longer RT compared to nonfocal intentions where spontaneous retrieval is unlikely. Alternatively, since participants are unaware they will continue to be presented with inactive PM cues after the intention is canceled, that upon seeing the first inactive *nonfocal* PM cue will cause participants to change their attention allocation strategy to again monitor for nonfocal PM cues in order to make the correct response (an OGT and not a PM response to the inactive cue). This could then result in longer RT to nonfocal inactive PM cues and longer nonfocal aftereffects. Moreover, assuming a significant relationship is found between commission errors and aftereffects, if more nonfocal errors are found then longer nonfocal aftereffects could result from this, which would represent it is more difficult to deactivate a nonfocal intention, resulting in longer RT to the nonfocal PM repeated cue. This could be the result of poorer nonfocal PM accuracy, thus making it more difficult to deactivate an intention that was not fulfilled at every opportunity when it was active.

In terms of inhibitory control, manipulated by the response type, there are two alternative predictions for aftereffects. First, it could be that a task switch response results in longer aftereffects because participants must inhibit their pre-potent prospective response immediately in order to make their OGT response. Support for this hypothesis will be found if those with poorer inhibition in the task switch group have the longest aftereffects compared to those with higher inhibition in the task switch group. Secondly, because Hicks et al. (2020) has previously found a dual-task response type to result in lower PM accuracy, that a dual-task response is potentially more difficult to make. Therefore, when making a dual-task response to the inactive

PM cue, participants must first make their OGT response, and then make a second correct OGT response, both of which may require more attentional control to sequence the correct response. Thus, because two responses are needed to be able successfully not make a commission error in the dual-task group, longer aftereffects in the dual-task group could be found. Lastly, those with poorer inhibitory control are susceptible to commission errors with a task switch response more, so aftereffects may be shorter for the those with poorer inhibitory control within this group because they are able unable to exert the effort to inhibit the pre-potent PM response.

The fourth goal was to address how well the individual difference measures of inhibition and WMC can predict commission errors and aftereffects. First, correlational analyses will be conducted to test the relationship between the span measures, which have been found to highly correlate, and the inhibition measures, which research has disputed the correlational relationship between different types of inhibition measures. Previous research has also not explored the relationship between commission errors and aftereffects in the repeated PM cue paradigm, thus these relationships will be explored across focality and response type. Lastly, multiple hierarchical moderator regression analyses will be conducted with response type as the moderator to the test the relationship between our predictors, WMC and inhibition, and the outcome variables, commission errors and aftereffects. By including the response type as a moderator, I can explore how this major factor influences the relationship between inhibitory and attentional control with the two outcome variables.

In terms of focal and nonfocal commission errors as the outcome variables, previous research has concluded that commission errors are the result of spontaneous retrieval and poor inhibitory control. However, there has been no theoretical development on commission errors in PM research. Therefore, the proposed analyses explore inhibitory and attentional control as

predictors of focal/nonfocal commission errors, with the major factor of response type as a moderator. Because previous research has found PM accuracy to be significantly different based on WMC for nonfocal intentions, but not for focal intentions, this could extend to canceled intentions. Thus, WMC could significantly predict nonfocal commission errors because those with lower WMC having a more difficult time allocating their attention to cancel nonfocal intentions. However, response type could moderate this relationship since a task switch response presumably requires more inhibitory control compared to a dual-task response type. Alternatively, because previous research (although limited) has found very few commission errors with a nonfocal intention, WMC will only be a significant predictor for focal commission errors because canceling a focal intentions requires more attentional control. Since our previous research has found a dual-task response type to nearly eliminate focal commission errors, it is predicted that response type will moderate this relationship WMC and focal commission errors.

In previous research, it has largely been concluded that commission errors are the result of poor inhibitory control. Thus, it is hypothesized that inhibitory control will predict focal commission errors, while not for nonfocal commission errors because focal intentions rely on spontaneous retrieval, which requires more inhibitory control. Alternatively, since a focal intention is canceled and a nonfocal intention is then introduced and there is not block of trials with no new intention, that inhibitory control will not differentially predict focal or nonfocal commission errors. Lastly, because a task switch response requires a higher level of inhibitory control compared to a dual-task response type and commission errors are the result of poor inhibitory control, that the response type will moderate the relationship between inhibitory control and both focal and nonfocal commission errors.

Lastly, for the outcome of aftereffects, both focal and nonfocal, there has been no research examining differences in aftereffects across focality or response type. More importantly, the role of inhibitory control and attentional control has not been explored. Thus, the present study explored the role of inhibitory control (manipulated by the response type) and attentional control (manipulated by focality) as predictors in a multiple linear regression analysis, with focal and nonfocal aftereffects as the outcome variables, and response type as a moderator variable.

However, the following are some tentative alternative predictions for the relationship WMC and inhibition and focal and nonfocal aftereffects with response type as a moderator. Since focal intentions rely on spontaneous retrieval, which does not require attention control, but does require inhibitory control to not make an erroneous PM response to an inactive PM cue, that inhibition will predict focal aftereffects. Since a task switch response theoretically requires more inhibitory control, response type was predicted to moderate this relationship between inhibition and focal aftereffects. In terms of WMC predicting focal aftereffects, since focal intentions do not require attentional control, WMC should not predict focal aftereffects. But, attentional control may be necessary to successfully not make a commission error to an inactive focal intention, thus WMC could have some predictive power.

For nonfocal aftereffects, since attentional control has been found to influence nonfocal PM accuracy, that WMC should predict when these nonfocal intentions are canceled with those with lower attentional control having longer nonfocal aftereffects compared to those with higher attentional control. It is difficult to predict whether response type would moderate this relationship between WMC and nonfocal aftereffects, but because it could be that a dual-task response type is more difficult, thus requiring a higher level of attentional control to be successful compared to a task switch response, that response type would moderate this

relationship. Lastly, inhibition should not predict nonfocal aftereffects since nonfocal intentions rely on monitoring and not spontaneous retrieval. But, since participants are not expecting to see an inactive nonfocal intention, that inhibitory control will be needed equally compared to a focal intention to not make a PM response to the inactive PM cue, thus resulting a significant relationship between inhibition and nonfocal aftereffects. Since Gilbert et al. (2013) found a significant difference in response type with a nonfocal PM cue, there is a potential for response type to moderate the relationship between inhibition and nonfocal aftereffects as well.

CHAPTER 2. EXPERIMENT 1 METHOD

2.1. Participants

Participants were Louisiana State University undergraduate students and received class or extra credit in exchange for participation. A power analysis was conducted using G*Power 3 (Faul et al., 2007) to determine the sample size needed to detect if focality, response type, WMC, or inhibition will have an effect on aftereffects in Walser's paradigm. Based on these four predictors (focality, response type, WMC, and inhibition), a statistical power of .90, an alpha level of .05, and a small to moderate effect size (**d** = .05), an estimated 213 participants were required to determine this small effect. One-hundred and twenty-two participants (M_{age} = 18.72, 111 females) were randomly assigned to either the task switch or dual-task response type group (data collection was stopped to make methodological changes for a second experiment). Two participants were removed from analyses because of PM accuracy lower than 60%, 3 participants were removed for aftereffects that were more than 2.5 standard deviations from the mean, 3 participants were removed because of a Go Task or No Go Task score 2.5 standard deviations below the mean, and 2 participants were removed for an OSPAN score 2.5 standard deviations below the mean. These exclusions resulted in 114 participants (M_{age} = 18.74, 105 females).

2.2. Design

PM accuracy was analyzed across the two independent variables, response type (between-subjects) and focality (within-subjects) in a 2 x 2 mixed factors ANOVA. To analyze PM accuracy, only blocks 2-5 were included in analyses. In block 1, PM repeated trials were presented based on PM cues shown in the two practice blocks (focal and nonfocal). Including these PM repeated trials in the first block could confound overall accuracy and RT within the test block. Because focality is a within-subjects variable, block 6 was also removed from accuracy

analyses to make an equal comparison of 2 focal and 2 nonfocal blocks. This decision was also made based on firsthand experience witnessing data collection and participants' general fatigue within the 6th block of trials at the end of a 2 hour experiment. Accuracy across trial type (PM, OGT, PM repeated, oddball), response type, and focality was analyzed in a 2 x 2 x 4 mixed factors ANOVA. The impact of trial type, response type, and focality on RT was analyzed in a 2 x 2 x 4 mixed factors ANOVA.

To examine commission errors, a 2 x 2 mixed factors ANOVA was conducted to examine the impact of response type and focality. Like with PM accuracy and RT analyses, only blocks 2-5 were included in the following analyses. The proportion of commission errors were analyzed across block, response type, and focality in a 2 x 2 x 4 mixed factors ANOVA. A second way to analyze commission errors in PM research is to delineate between commission error 'people' or those that make 0 commission errors compared to those that make 1 or more errors. Groups were created to analyze these commission error 'people' across response type only. Lastly, RT to the different trial types and across response type were analyzed based on these groups of commission error people to evaluate attention allocation to different trial types based on how many commission errors were made in separate 2 x 4 mixed factors ANOVA.

To examine overall aftereffects, oddball RT was subtracted from PM repeated RT for correct decisions only (e.g, no commission errors). If the intention to the previous PM cue still has residual activation, then there should be longer RTs to PM repeated trials compared to oddball trials, resulting in a positive overall aftereffects value. First, a 2 x 2 mixed factors ANOVA was conducted to examine aftereffects across response type and focality. Second, based on Walser et al. (2012) that found aftereffects to decline over time, aftereffects across response

type and focality were analyzed across test block in a 2 x 2 x 4 mixed factors ANOVA, again, with the removal of blocks 1 and 6.

For correlational and regression analyses, Pearson correlational analyses were used to analyze the relationship between the latent variables of OSPAN, RSPAN, and SSPAN as a measure of WMC, and the latent variables of the Antisaccade, MSIT, and no go tasks as a measure of inhibition.

Composite measures of WMC and inhibition were created with average scores on each construct based on correlational analyses. Hierarchical regression analyses were conducted to determine if response type moderates the relationship between, 1) WMC and commission errors (focal and nonfocal), 2) Inhibition and commission errors (focal and nonfocal), 3) WMC and second block aftereffects (focal and nonfocal), and 4) inhibition and second block aftereffects (focal and nonfocal). If moderation was found to be significant, follow up analyses were done and scatter plots were created to examine the interaction. If WMC or inhibition were found to be significant predictors, follow up scatter plots were created to analyze the relationship between WMC or inhibition with the outcome variable. To note, response type was included as a moderator variable with WMC and inhibition because it was a between-subjects variable. Because focality was a within-subjects variable, it could not be included as a moderator variable. Thus, to assess focality in this design, both overall, focal, and nonfocal outcome variables were included in separate moderator regression analyses as outcome variables.

Further hierarchical regression analyses were conducted to examine the relationship between commission errors and aftereffects. Specifically, separate hierarchical regression analyses were conducted for the group of participants that made 0 commission errors and those that made 1 or more errors. First, the relationships between WMC and 2nd block focal and

nonfocal aftereffects were tested for the 0 commission error group, with the interaction between response type and WMC tested for moderation. Second, the relationships between inhibition and 2nd block focal and nonfocal aftereffects were tested for the 0 commission error group. Third and fourth, the same hierarchical regression analyses were conducted to test the relationships between inhibition and WMC with 2nd block focal/nonfocal aftereffect and the potential moderation of response type for those that made at least 1 commission error (commission error group).

2.3. Measures

2.3.1. Working Memory Capacity. Three complex span tasks, OSPAN, RSPAN, SSPAN, measured WMC. A composite WMC score was created based on participants' performance on one block of each complex span task. In a complex span task, participants are given a sequence of items to-be-remembered while also engaged in a distractor task between presentations of each to-be-remembered item. The sequence length of to-be-remembered items were randomized and ranged from two to seven items. Participants must maintain at least 85% accuracy on the distractor task (Foster, Shipstead, Harrison, Hicks, Redick, & Engle, 2015). However, Unsworth et al. (2009) examined the relationship between the processing (e.g., solving math problems) and storage components (e.g., the serial order of letters presented in the OSPAN task) and found by including those with lower percentage correct on the processing component, the fit of their model examining the relationship between accuracy, processing time, and general fluid intelligence (gF) did not change. Thus, for the present study, those that earned 82% or higher on the distractor task were included. Eighty-two percent was chosen as the cut-off value because this was the lower end of 2.5 standard deviations below the mean for distractor task performance across all three complex span tasks. The OSPAN used letters as the to-be-

remembered items and math problems for the distractor task (Unsworth et al., 2009). The RSPAN used arrows of short or long length pointing in one of eight different directions as the to-be-remembered items and determining whether a rotated letter is correct or a mirror image as the distractor task. The SSPAN used the location of red squares in a 4x4 grid of potential locations as the to-be-remembered items and the distractor task entails judging whether a shape is symmetrical along its vertical axis. OSPAN scores ranged from 0-25 (30-31 distractor task trials), RSPAN ranged from 0-14 (20 distractor task trials), and SSPAN ranged from 0-14 (20 distractor task trials). See Figure 2.1.

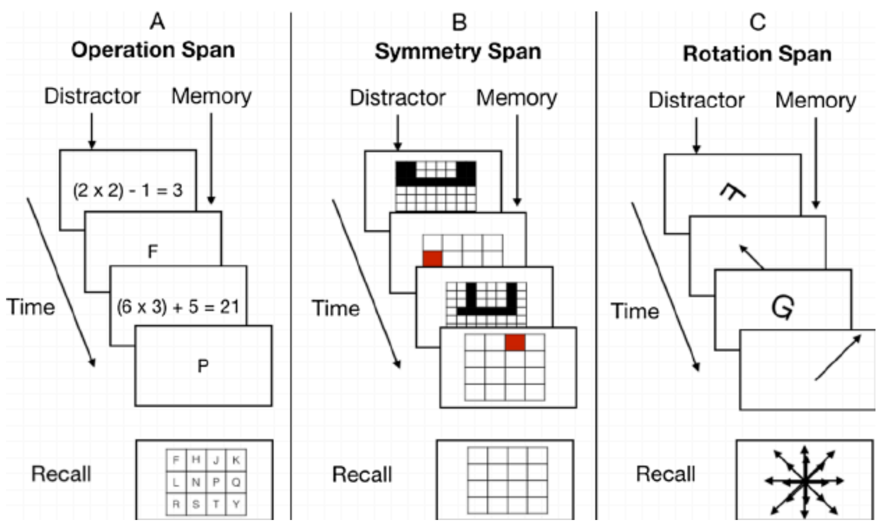

Figure 2.1 Complex Span Tasks (Foster et al., 2015). Participants completed one block of each complex span task, OSPAN, SSPAN, and RSPAN.

2.3.2. Inhibition. Three measures of inhibition were used to create a composite measure of inhibition. For the Antisaccade task (adapted from Friedman & Miyake, 2004), a fixation cross appeared for a variable amount of time (one of nine times between 1,500 and 3,500 ms in 250-ms intervals) in the center of the computer screen, on which participants were instructed to fixate. A brief flash (150 ms) of an '=' stimulus (5/16-in.) appeared on one side of the screen and participants were instructed to look away from the stimulus. The target (P, B, or R) appeared on

the opposite side of the screen from the stimulus for 175 ms and was masked with an ‘8’ and remained on the screen until the participant made their response on the keyboard of the target letter shown (P = left arrow, B = middle arrow, R = right arrow keys) (Friedman et al., 2008). Participants completed 10 practice trials and then 96 test trials (scores ranged from 0-96). The dependent measure was the proportion of correct responses. See Figure 2.2.

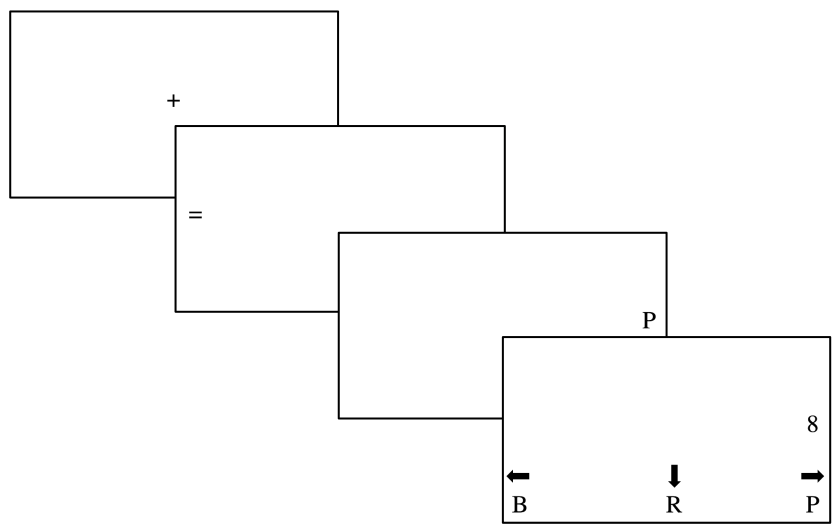

Figure 2.2 The Antisaccade Task (Kane et al., 2016). Participants identify a target letter (*B, P, R*) on one side of the screen that is cued by a flash (‘=’) on the opposite side.

The no go task adapted here required a response selection between either executing or inhibiting a pre-potent motor response, which was based on whether a sound was presented or not with the stimulus (Logan, 1994). Participants were required to respond by pressing the right or left arrow key in response to the quick presentation of the stimuli of a circle (left) or square (right). Seventy-five percent of the trials were ‘go’ trials that were not presented with an auditory beep and required a response (72 trials), while 25% of the trials were randomly ‘stop’ trials that were presented with an auditory beep (a tone approximately 100 ms long) and required the participant to inhibit their response (24 trials) (Rubia et al., 2001). Each participant received

auditory signals that occurred 50 ms before the onset of the stimulus before their average RT (long stop signal delay), 225 ms before their average RT (medium stop signal delay), or 50 ms after the onset of the trial (short stop signal delay). Each delay occurred equally often in the task. For each trial, participants viewed a fixation cross for 500 ms and were then allowed up to 1500 ms to respond. The stop signal task is similar to the go/no-go task, but the former has a higher load on response inhibition because the 'stop' signal (auditory beep) occurred shortly after the go signal (presentation of a circle or square). The dependent measure was the accuracy to no go trials (scores ranged from 0-30). See Figure 2.3.

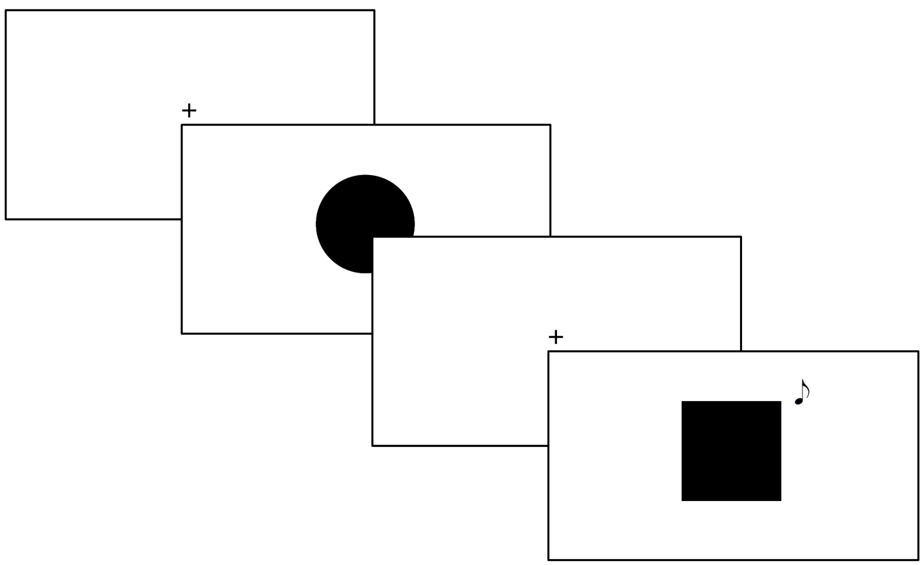

Figure 2.3 No Go Task (Li et al., 2006). Participants make responses to trials with no auditory beep (pressing right arrow key in response to a circle, left arrow key in response to a square) and inhibit their response when presented with an auditory beep (music notes).

The last measure of inhibition was the multi-source interference task (MSIT), which is a measure of cognitive control and interference in the realm of inhibition (Bush, Shin, Holmes, Rosen, & Vogt, 2003). The MSIT combines three types of interference into one task: Flanker, Simon, and Stroop interference. Specifically, the dissonance between an automatic and desired response in the Stroop task, the interference of incongruent flankers in the Erikson task, and the

spatial incongruence in the Simon Task (Bush et al., 2003). The MSIT was comprised of 20 practice trials (10 control, 10 interference) and 200 experimental trials – 100 control trials (e.g., 100, 020, 003) and 100 interference trials (e.g., 322, 221, 131). Participants were presented with an array of three numbers (0, 1, 2, or 3) on each trial, two of which were the same. Participants responded by identifying the one number that is different from the other two with keyboard responses (the number pad 1, 2, 3 keys). On a control trial, there was no interference (the one different number was presented with two 0s and was presented in the congruent stimulus-response position) and on an interference trial the one different number was presented with other numbers besides 0 and was presented in an incongruent position. Control and interference trials were presented randomly in one test block. The dependent measure was interference trial accuracy (0-50). See Figure 2.4.

Behavioral research has not been done examining the relationship between all three of these measures of inhibition/task interference. However, a meta-analysis did examine the relationship between the Antisaccade and no go tasks and found while each task was reliable, the correlation between these two measures of inhibition, as well as the correlations between the 9 other inhibition measures, was not significant (Rey-Mermet et al., 2017). Rey-Mermet et al. (2017) concluded that inhibition can be subdivided into two parts, 1) the ability to stop dominant responses (e.g., stop signal task) and, 2) the ability to ignore distracting information (e.g., Antisaccade task). Based on the conclusions of Rey-Mermet et al. (2017), the MSIT would fall under the second part of inhibition – the ability to ignore distracting information. While behavioral research has not been done examining the relationship among these three measures, neuroimaging research has shown that the Antisaccade task, the stop signal task, and the MSIT all activate the same regions of the brain that is believed to be involved in inhibition and task

interference – the ACC and the insula (Deng, Wang, Wang, & Zhou, 2018). Thus, the present study will examine the relationship amongst these three measures of inhibition.

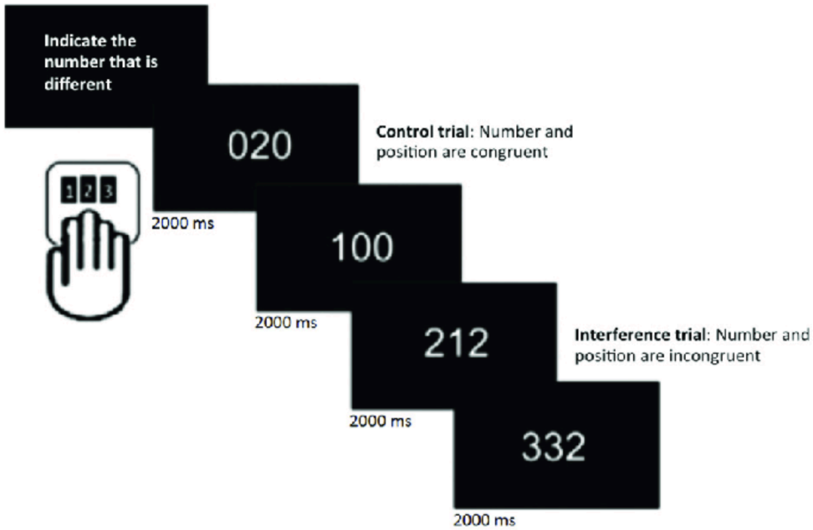

Figure 2.4 Multisource Interference Task (Bush et al., 2003). MSIT scores are determined by comparing interference and control trials.

2.3.3. Prospective Memory. The present study used the repeated PM cue paradigm created by Walser et al. (2012). The repeated PM cue paradigm was developed to measure aftereffects of completed intentions, while participants have to perform new intentions across a series of test blocks. The OGT is categorizing digits as odd or even (1-9). The PM task requires participants to make a different response (press the '?' key) whenever a PM cue appears, which is different from the OGT because of various deviant features (e.g., color, font size, location, font style). The feature defining a PM cue changed across each test block. Two other types of trials in this paradigm were PM repeated trials and oddball trials, both of which also changed from block to block. PM repeated trials were PM cues from the previous test block, which provided a measure of aftereffects. If participants have a longer RT to a PM repeated trial then this indicates the intention from the previous test block was not fully deactivated. Oddball trials are different

from the standard OGT trials because of a specific deviant feature (e.g., color of background), but do not have an associated intention. Because deviant features capture attention, oddball trials should show longer RT compared to OGT trials. RT to standard OGT, PM, PM repeated, and oddball trials are then compared. If the intention from the previous test block was successfully deactivated, then the RT to PM repeated trials should be faster than oddball trials (negative value aftereffects). Alternatively, if the intention from the previous test block was not fully deactivated, then RT to PM repeated trials should be longer than RT to oddball trials because the deviant feature associated with the PM repeated trial was still easily accessible.

Participants completed three practice blocks of trials (each 12 trials long). At the beginning of each trial, a black fixation cross was presented for 500ms. This was followed by a digit and participants made an odd or even judgment (shown for a maximum of 3,000 ms), followed by pressing the spacebar on the transition screen (e.g., Press the spacebar to continue…). In the three practice blocks, participants receive feedback of 'Correct' or 'Incorrect' for their digit categorization and transition screen responses. In the first practice block, participants practiced making the OGT response. In the second practice block, half of the participants received a focal PM instruction (e.g., if you see the number 5 with a pink background, press the '?' key), while the other half of participants received a nonfocal PM instruction (e.g., if you see an odd number with a pink background, press the '?' key). In the third practice block, because focality was a within-subjects variable, participants received the focality instruction they did not complete in the second practice block. Participants were exposed to all 13 deviant features across the second and third practice blocks, which were interspersed amongst the remaining test blocks. See Table 2.1 for these deviant features.

Subsequently, the experimental test blocks began. At the start of each experimental block, participants received a new PM intention instruction. The focality of the first test block instruction was counterbalanced across participants to either be focal or nonfocal. Participants were randomly assigned to either press the '?' key instead of performing the digit categorization task (task switch response) or to make their OGT response first and to press the '?' key for the PM response second on a transition screen (dual-task response).

Table 2.1 Experiment 1 Deviant Features

Practice	Pink background
Block 1	
PM cue	**Bold**
PM repeated	Pink background
Oddball	Small font
Block 2	
PM cue	Left side
PM repeated	**Bold**
Oddball	Black background
Block 3	
PM cue	*Italicized*
PM repeated	Left side
Oddball	~~Strikethrough~~
Block 4	
PM cue	<u>Underline</u>
PM repeated	*Italicized*
Oddball	Right side
Block 5	
PM cue	Blue background
PM repeated	<u>Underline</u>
Oddball	Green background
Block 6	
PM cue	Yellow background
PM repeated	Blue background
Oddball	Red font

The PM experiment consisted of six test blocks each 208 trials long, resulting in a total of 1248 trials. Digits were randomly drawn to serve as an OGT trial, PM trial, PM repeated trial, or oddball trial. Digits were not repeated across two OGT trials, digits for PM trials were different for each block, and the same digit was not used across PM, PM repeated, and oddball trials in the

same test block. Each test block consisted of 190 OGT, 6 PM, 6 PM repeated, and 6 oddball trials. In each block of trials, a new deviant feature was selected to be associated with the PM trials and the oddball trials. The deviant features were randomly chosen from Walser et al. (2012). PM, PM repeated, and oddball trials were chosen to be presented on trial 11, 22, 33, 44, 55, 66, 77, 88, 99, 110, 121, 132, 143, 154, 165, 176, 187, and 198 within each block.

2.4. Procedure

The order of WMC tasks were randomized as the first 3 tasks, followed by the order of the inhibition tasks randomized as the fourth, fifth, and sixth tasks. Participants completed the PM experiment last and were debriefed.

CHAPTER 3. EXPERIMENT 1 RESULTS

3.1. PM Accuracy and RT

For all analyses, alpha level was set at .05. Data trimming was conducted by only including data that was more than 2.5 standard deviations from the mean. For the first goal of Experiment 1, response type and focality were analyzed in relation to overall PM accuracy. The first block of trials was excluded prior to analyses because it did not contain PM repeated trials. To make equal comparisons between focal (2 blocks) and nonfocal intentions (2 blocks), data were included only for blocks 2-5. There were 55 participants in the dual-task response type group and 59 participants in the task switch response type group. PM accuracy was analyzed by block in a 2 (response type) x 2 (focality) x 4 (blocks 2-5) mixed factors ANOVA. An interaction was found between focality and block $F(3, 330) = 13.51$, $p < .05$, $\eta_p^2 = .11$. The interaction was driven by a larger difference between focality in block 3 ($M_{diff} = .18$) compared to blocks 2 ($M_{diff} = .08$), 4 ($M_{diff} = .09$), and 5 ($M_{diff} = .04$). An interaction between response type and focality was found, $F(3, 330) = 5.45$, $p < .05$, $\eta_p^2 = .05$, driven by higher dual-task focal accuracy ($M = .91$) compared to dual-task nonfocal accuracy ($M = .84$), but the difference for task switch focal ($M = .83$) and nonfocal accuracy ($M = .87$) not being significantly different. A main effect of block was found, $F(3, 110) = 36.27$, $p < .05$, $\eta_p^2 = .25$. Block 3 accuracy ($M = .71$) was significantly lower than blocks 2 ($M = .92$), 4 ($M = .90$), and 5 ($M = .91$). See Figure 3.1. To further analyze the interaction between response type and focality, a 2 x 2 mixed factors ANOVA between response type (between-subjects) and focality (within-subjects) was conducted and revealed a main effect of focality, $F(1, 112) = 31.51$, $p < .05$, $\eta_p^2 = 22$. PM accuracy was significantly higher with a focal intention ($M = .91$) than a nonfocal intention ($M = .81$). There were no other significant main effects or interactions. See Figure 3.2.

RT to different trial types (PM, OGT, PM repeated, oddball) was analyzed between focality and response type in a 2 x 2 x 4 mixed factors ANOVA and revealed an interaction between trial type and response type, $F(7, 721) = 5.06, p < .05, \eta_p^2 = .05$, driven by a significant difference between dual-task (M = 1215.01 ms) and task switch (M = 1081.05 ms) response type for PM RT, but a null difference for the other trial types. A main effect of trial type was found, $F(3, 103) = 206.65, p < .05, \eta_p^2 = .67$. PM RT ($M$ = 1148.03 ms) was significantly longer than OGT (M = 612.33 ms), PM repeated (M = 881.78 ms), and oddball RT (M = 878.19 ms). OGT RT was significantly lower than PM repeated and oddball RT, while there was a null effect between PM repeated and oddball RT. The main effect of response type was not significant. See Figure 3.3.

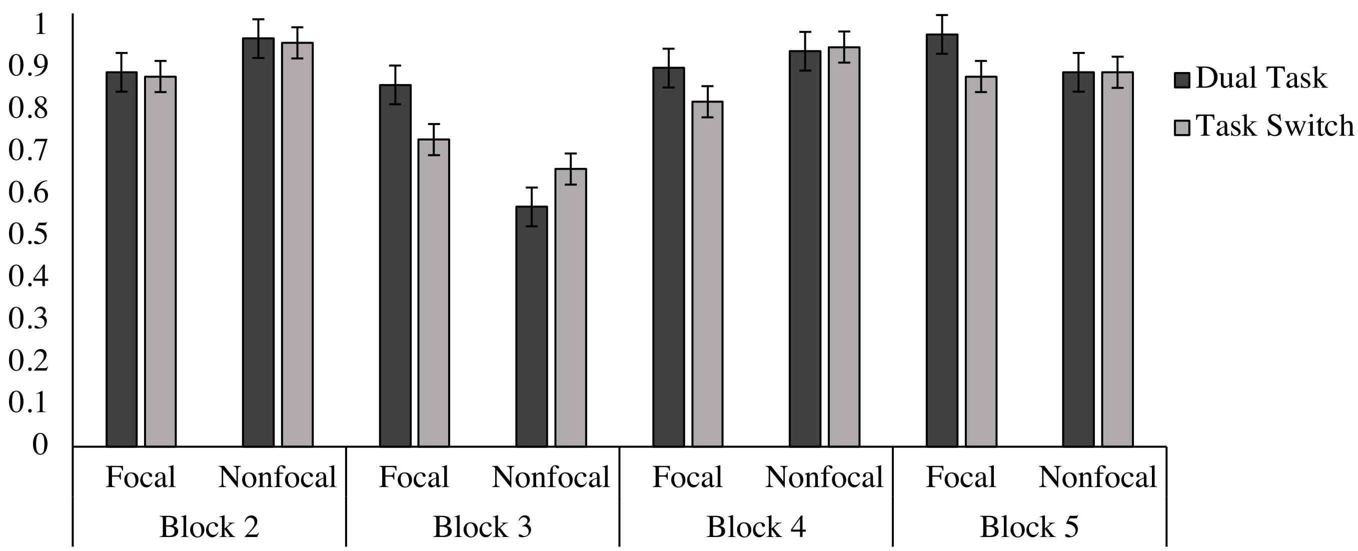

Figure 3.1 PM Accuracy Across Block. Interaction between focality and block. Interaction between response type and focality. Main effect of block.

3.2. Commission Errors Proportions and by Person

The second goal of Experiment 1 was to analyze response type and focality in relation to commission errors. There were 6 opportunities to make a commission error per block (six presentations of PM repeated trials per block), thus the proportion of commission errors was

calculated by dividing the number of PM responses to PM repeated trials divided by 6. As was done for PM accuracy analyses, only blocks 2-5 were included in the following analyses of commission errors across block. A 2 x 2 x 4 mixed factors ANOVA was calculated to examine the proportion of commission per across focality, response type, and blocks 2-5 and revealed a main effect of focality with a small effect size, $F(3, 336) = 3.00$, $p < .05$, $\eta_p^2 = .02$. There was higher proportion of commission errors with focal intentions ($M = .06$) compared to nonfocal intentions ($M = .03$). No other significant results were found. See Figure 3.4.

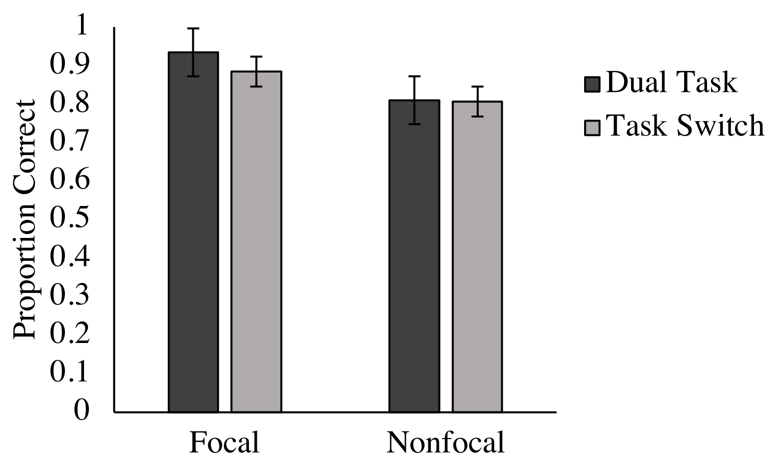

Figure 3.2 PM Accuracy Across Response Type and Focality. Main effect of focality.

A different way to analyze commission errors in previous PM research was to compare groups of commission error ‘people,’ that is, people who made at least one commission error. Because focality was a within-subjects variable, limited conclusions could be drawn because a given person might have a commission error in a focal block, a nonfocal block, or in both. In addition, the nature of the design was such that a focal intention was canceled and then shown in the following test block with a new nonfocal intention and vice-versa. Thus, while the PM repeated trial was *focal,* the attentional allocation strategy for a test block with a new *nonfocal* intention (e.g., monitoring for the PM intention, thus slowing to OGT trials) was confounded. So,

the number of commission errors per person were collapsed over focality and the following subgroups were created: those with 0 errors, 1-7 errors, and 8 or more errors. A Chi-Square test was conducted to analyze the relationship between these 3 subgroups of commission error people and response type and did not find a significant difference, $X^2(8, N = 114) = 13.57$, $p = .09$. This finding suggests that the relative proportion of participants in each commission error subgroup was not dependent on response type, even though a visual trend suggests more people in the task switch group making between 1-7 commission errors and the opposite trend for those making no commission errors. See Figure 3.5.

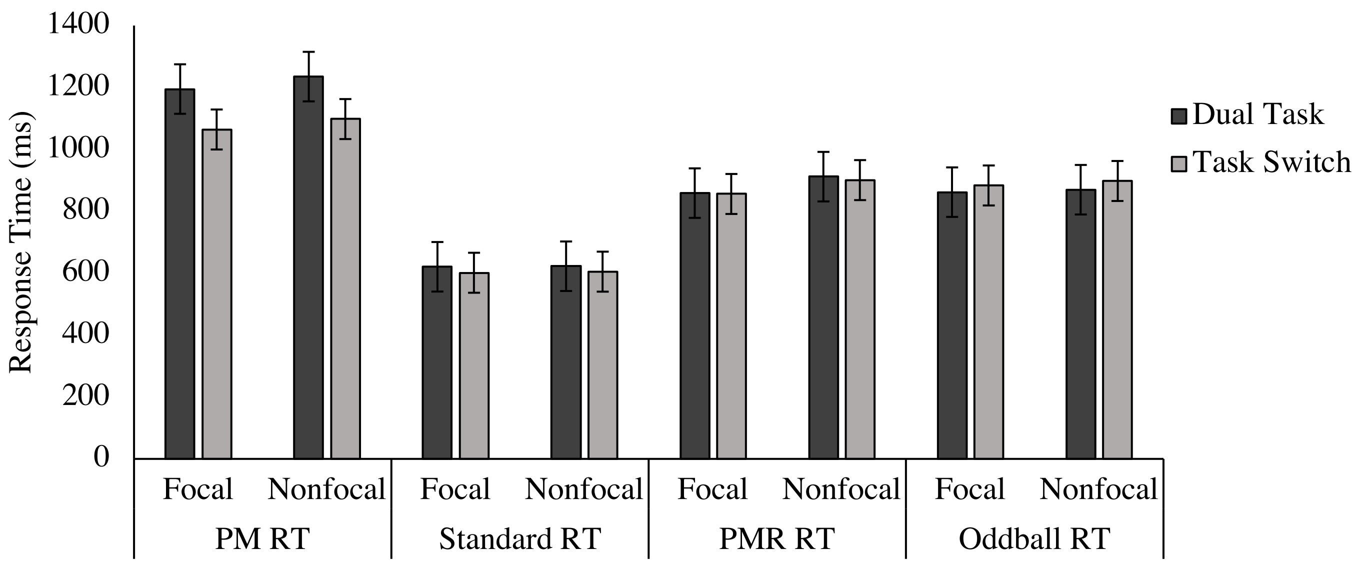

Figure 3.3 RT Across trial type. Interaction between trial type and response type. Main effect of trial type.

To further delineate between these different subgroups of commission errors, specifically, the 0 commission error group and 1-7 commission error group (the 8 or more error group could not be analyzed due to 0 people in the task switch), RT across response type was analyzed for each trial type in separate 2 x 4 mixed factors ANOVA. For the zero commission error group (dual-task $N = 32$, task switch $N = 33$), a main effect of trial type was found, $F(3, 63) = 148.60$, $p < .05$, $\eta_p^2 = .77$, because of longer PM RT ($M = 1174.64$) compared to OGT ($M = 615.93$), PM

repeated (M = 866.53), and oddball (M = 887.10) RT. No other significant main effects or interactions were found. See Figure 3.6.

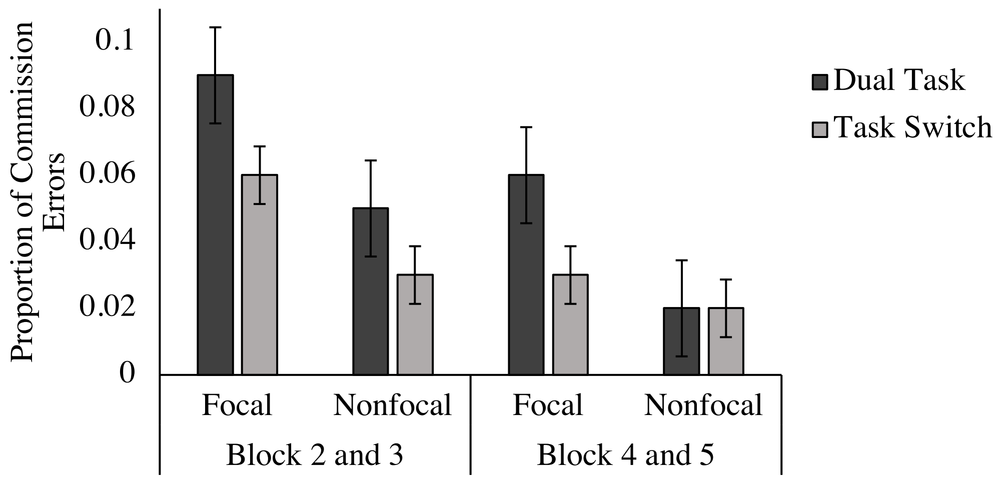

Figure 3.4 Commission Errors Across Block. Main effect of focality.

For the 1-7 commission errors group (dual-task N = 16, task switch N = 24), the 2 x 4 mixed factors ANOVA revealed a significant interaction between response type and trial type, $F(7, 245) = 6.04$, $p < .05$, $\eta_p^2 = .31$, driven by a significant difference between dual-task (M = 1299.60 ms) and task switch (M = 929.83 ms) response type for PM RT, a significant difference between dual-task (M = 633.63 ms) and task switch (M = 592.08 ms) OGT RT, but null differences between response type for PM repeated and oddball trial types. A main effect of trial type was found, $F(3, 35) = 64.88$, $p < .05$, $\eta_p^2 = .77$, with PM RT significantly longer (M = 1088.29 ms) compared to other trial types – PM repeated RT (M = 936.80 ms), oddball RT (M = 889.43 ms), and OGT RT (M = 607.74 ms). A main effect of response type was not found. See Figure 3.7.

3.3. Aftereffects

The third goal of Experiment 1 was to analyze how response type and focality impact aftereffects. Aftereffects are measured by the difference in RT to PM repeated trials and oddball

trials. Thus, a positive aftereffects value indicates the intention was still activated because of longer RT to PM repeated trials, while a negative aftereffects value indicates the intention was deactivated because RT to oddball trials where deviant features are shown, but no prior intention was associated with the feature, are similar to or longer than PM repeated trials. To note, PM repeated trials are included in analyses for correct responses only (i.e., no commission errors on these trials but correct parity decisions). A 2 x 2 x 4 mixed factors ANOVA across response type, focality, and block found a main effect between focal and nonfocal overall aftereffects, $F(1, 112) = 79.52$, $p < .05$, $\eta_p^2 = .43$. Nonfocal aftereffects were significantly longer (positive) (M = 27.87) compared to focal aftereffects (M = -34.51). No other significant effects were found. See Figure 3.8.

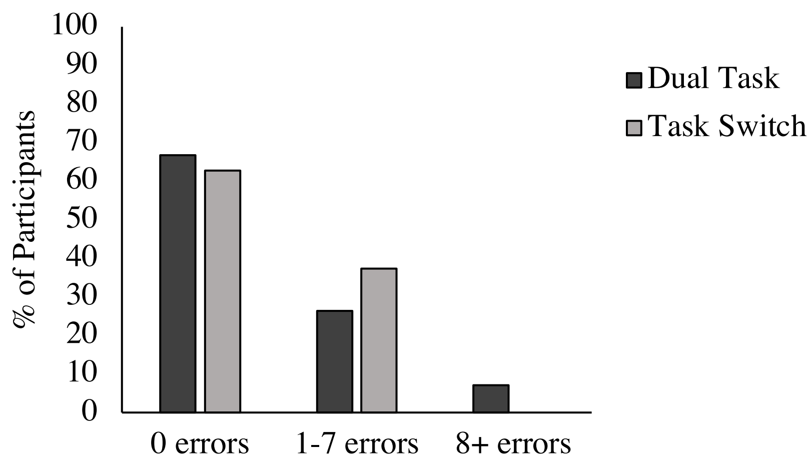

Figure 3.5 Percentage of Participants for Commission Errors. $X^2(8, N = 114) = 13.57$, $p = .09$.

3.4. Correlations

To analyze the relationship between the latent variables for WMC (OSPAN, RSPAN, SSPAN) and inhibition (Antisaccade, MSIT, No Go tasks), Pearson correlations were calculated amongst these individual differences measures. For the OSPAN (M = 16.68, SD = 4.69), scores ranged from 7-25, for RSPAN (M = 8.40, SD = 3.07), 2-14, for SSPAN (M = 9.47, SD = 2.77),

3-14, for the Antisaccade (*M* = 57.80, *SD* = 15.35), 30-90, MSIT (*M* = 70.42, *SD* = 14.67), 29-94, and for No Go task (Go accuracy, *M* = 79.09, *SD* = 19.19; No Go accuracy, *M* = 27.99, *SD* = 7.75), 10-43. Significant correlations at an alpha level of .01 were found between OSPAN and RSPAN (*r* = .38), OSPAN and SSPAN (*r* = .31), RSPAN and SSPAN (*r* = .31), between the Antisaccade and MSIT (*r* = .29) and the MSIT and No Go task (*r* = .24). But, the Antisaccade and no go tasks did not significantly correlate (*r* = .12). See Table 3.1.

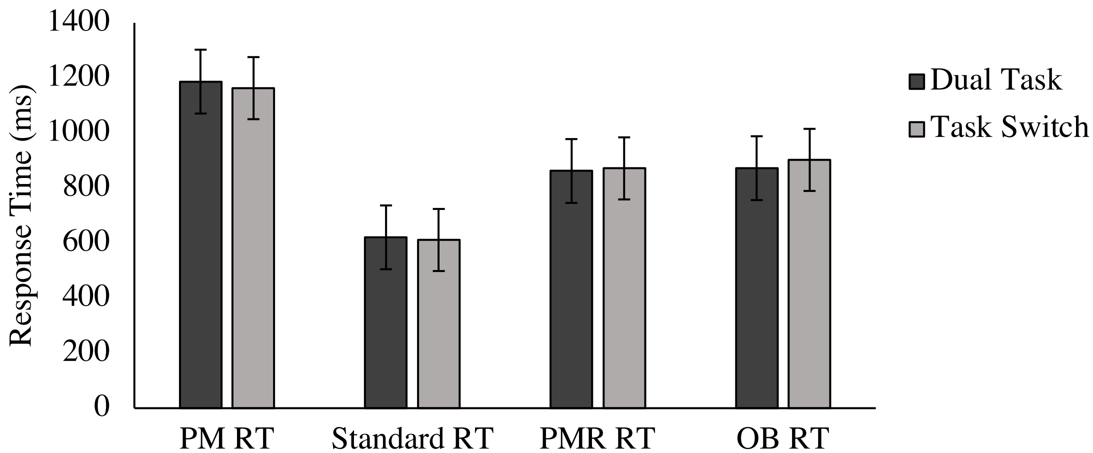

Figure 3.6 Zero Commission Errors RT. Main effect of trial type.

3.5. Regression Analyses

3.5.1. Commission Errors. Since OSPAN, RSPAN, and SSPAN were found to significantly correlate, a composite measure of WMC was calculated. First, to test the hypothesis that response type moderates the relationship between WMC and commission errors, a hierarchical multiple regression analysis was conducted. In the first step, response type and WMC variables were entered. These variables did not account for a significant amount of variance in commission errors, R^2 = .010, $F(2, 111) = .537$, $p = .586$. To avoid potentially problematic high levels of multicollinearity with the interaction term, variables were centered and an interaction term was created between response type and WMC (Aiken & West, 1991).

Next, the interaction term between response type and WMC was added to the regression model, which did not account for a significant proportion of variance in commission errors, $\Delta R^2 = .031$, $\Delta F(1, 110) = 3.52$, $p = .063$, b = 1.877, $t(107) = 1.88$, $p = .063$. Thus, WMC was not found to predict commission errors and response type did not moderate this relationship.

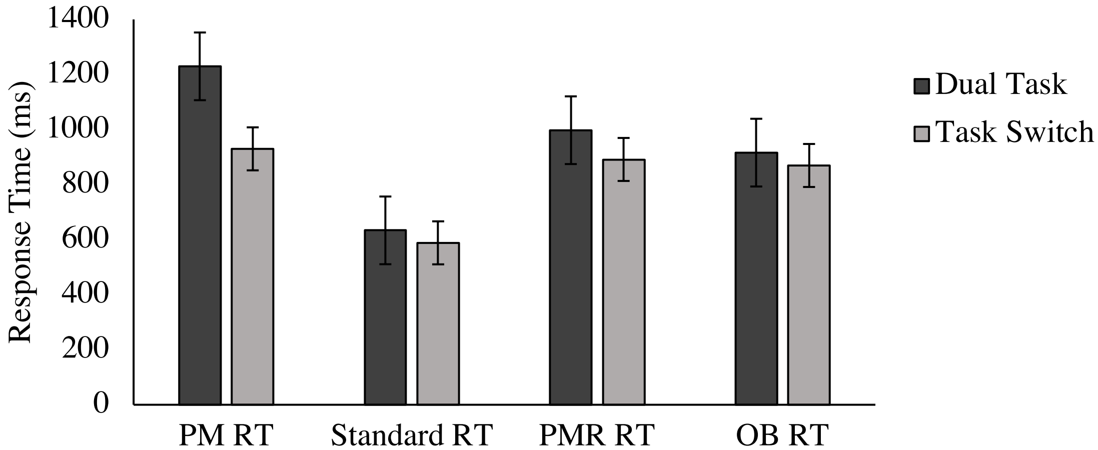

Figure 3.7 1-7 Commission Errors RT Interaction between response type and trial type. Main effect of trial type.

To test the hypothesis that response type moderates the relationship between inhibition and commission errors, a composite measure of inhibition (Antisaccade and MSIT) was created. In the first step, response type and inhibition (Antisaccade and MSIT) were entered and accounted for a significant amount of variance, $R^2 = .054$, $F(2, 111) = 3.157$, $p = .046$. Specifically, inhibition (Antisaccade and MSIT) was found to significantly predict commission errors, $t(107) = -3.019$, $p = .003$. See Figure 3.9. However, the addition of the interaction term between response type and inhibition (Antisaccade and MST) did not account for a significant amount of variance, $\Delta R^2 = .027$, $\Delta F(1, 110) = 3.259$, $p = .074$, b = .232, $t(107) = 1.805$, $p = .074$. See Table 3.2. A second composite measure of inhibition (MSIT and no go) was analyzed to test the hypothesis that inhibition (MSIT and no go) predicts commission errors. In the first step, response type and inhibition (MSIT and no go) were entered and accounted for a significant

amount of variance, R^2= .098, F(2, 111) = 6.006, p = .003. Specifically, inhibition (MSIT and no go) was found to account for a significant amount of variance, t(107) = -3.407, p = .001. See Figure 3.10. However, the addition of interaction term between response type and inhibition (MSIT and no go) was not found to account for a significant amount of variance, ΔR^2 = .028, ΔF(1, 110) = 3.577, p = .061, b = -.244, t(107) = -1.891, p = .061. See Table 3.3. Inhibition (MSIT and no go) was found to predict commission errors, but response type was not found to moderate this relationship. Thus, while the prediction that inhibition would predict commission errors was supported, response type moderating this relationship was not supported.

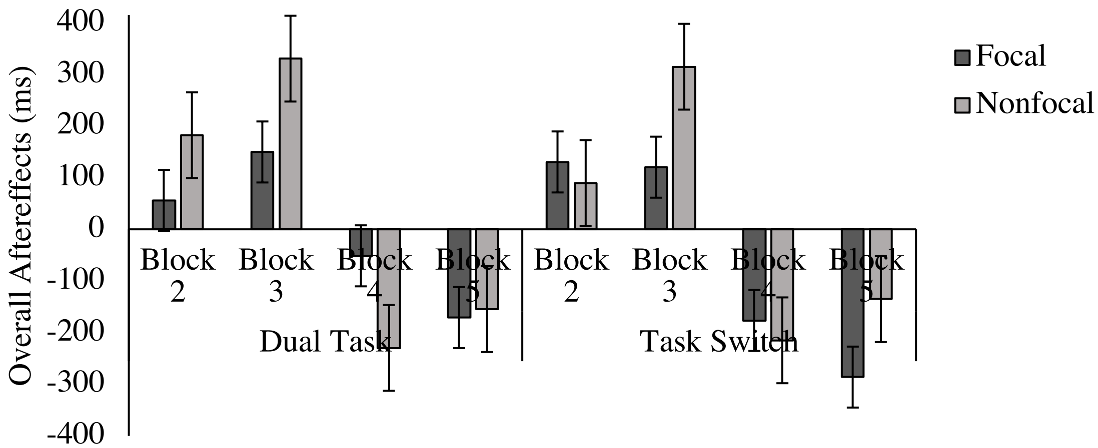

Figure 3.8 Overall Aftereffects. Main effect of focality.

To test the hypothesis that response type moderates the relationship between WMC and focal commission errors, a hierarchical multiple regression analysis was conducted. In the first step, response type and WMC variables were entered. These variables did not account for a significant amount of variance in focal commission errors, R^2= .007, F(2, 111) = .379, p = .685. Variables were again centered and the interaction term between response type and WMC was added to the regression model, which did not account for a significant proportion of variance in focal commission errors, ΔR^2 = .03, ΔF(1, 110) = 3.128, p = .080, b = .238, t(107) = 1.769, p =

.080. Thus, WMC did not predict focal commission errors and response type did not moderate this relationship.

Table 3.1 Pearson Correlations

	1	2	3	4	5	6
1. OSPAN	---					
2. RSPAN	.38**	---				
3. SSPAN	.31**	.31**	---			
4. ANTI	.38**	.22*	.17	---		
5. MSIT	.13	.21*	.11	.29**	---	
6. NO GO	.04	.13	.12	.12	.24**	---

Source: * .05 significance, ** .01 significance

The relationship between inhibition (Antisaccade and MSIT) and focal commission errors was tested and the potential moderation of response type. In the first step, response type and inhibition (Antisaccade and MSIT) were entered and did not account for a significant amount of variance, R^2= .004, $F(2, 111) = .197$, $p = .821$. With the interaction term between response type and inhibition (Antisaccade and MSIT) added to the model, a significant amount of variance was not accounted for, $\Delta R^2 = .011$, $\Delta F(1, 110) = 1.258$, $p = .264$, b = .149, $t(107) = 1.122$, $p = .264$. Inhibition (Antisaccade and MSIT) was not found to predict focal commission errors and response type did not moderate this relationship. The relationship between inhibition (MSIT and no go) and focal commission errors was also tested. In the first step, response type and inhibition (MSIT and no go) were entered and did not account for a significant proportion of variance, R^2= .005, $F(2, 111) = 2.197$, $p = .116$. With the addition of the interaction term between response type and inhibition (Antisaccade and MSIT), a significant proportion of variance was not accounted for, $\Delta R^2 = .005$, $\Delta F(1, 110) = .554$, $p = .116$, b = -.100, $t(107) = -.745$, $p = .458$. This

second composite measure of inhibition (MSIT and no go) was also not found to predict focal commission errors and response type did not moderate this relationship.

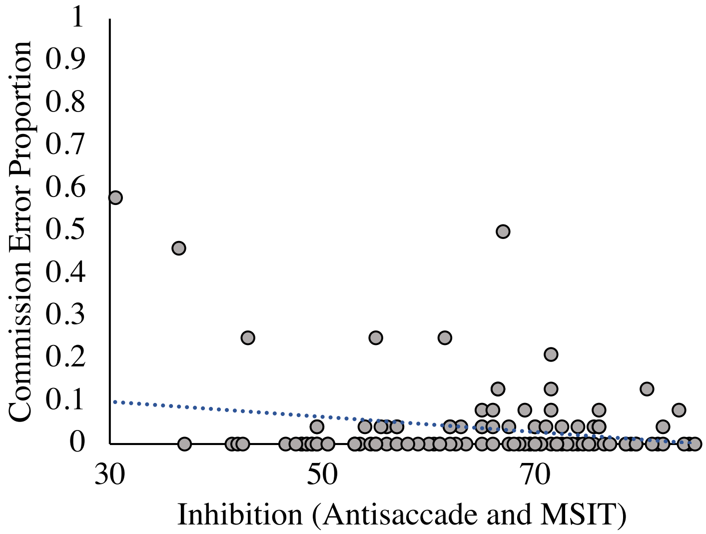

Figure 3.9 Inhibition (Antisaccade and MSIT) x Commission Error Proportion

Table 3.2 Commission Errors: Inhibition (Antisaccade and MSIT) x Response Type Moderator Analysis

	B	*SE B*	95% CI	β	ΔR^2
Step 1					
Response Type	.01	.02	-.03, .04	.04	
Inhibition*	-.00	.00	-.00, .000	-.23	.05
Step 2					
Response Type	.01	.02	-.03, .04	.04	
Inhibition	-.00	.00	.01, -.00	-.39	
Response Type x Inhibition	.00	.00	.00, .01	.23	.03

Source: * .05 significance

A hierarchical regression analysis was conducted to determine if response type moderates the relationship between WMC and nonfocal commission errors. The same steps were taken, with response type and WMC entered in the first step, and these variables did not account for a significant amount of variance, $R^2 = .03$, $F(2, 111) = 1.40$, $p = .25$. With the addition of the centered interaction term between response type and WMC, a significant amount of variance was not accounted for, $\Delta R^2 = .006$, $\Delta F(1, 110) = .629$, $p = .429$, b = .107, $t(107) = .793$, $p = .429$.

Thus, WMC did not predict nonfocal commission errors and response type was not found to moderate this relationship.

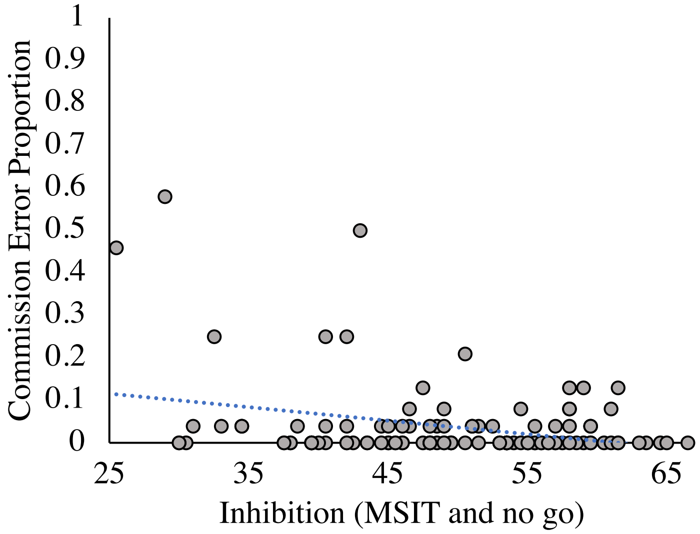

Figure 3.10 Inhibition (MSIT and No Go) x Commission Error Proportion

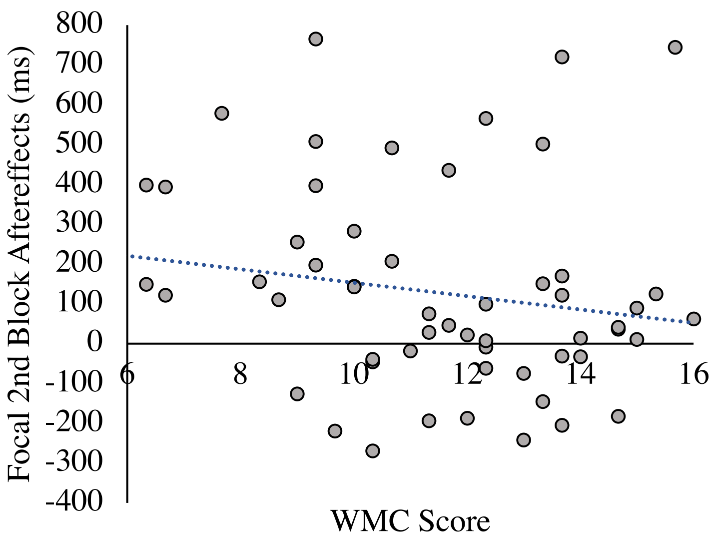

Figure 3.11 Dual-task: WMC x 2nd Block Focal Aftereffects

Hierarchical regression analysis was conducted to analyze the relationship between inhibition (Antisaccade and MSIT) and nonfocal commission errors, and the potential moderation of response type between this relationship. In the first step, response type and inhibition (Antisaccade and MSIT) were added to the model and did not account for a significant

amount of variance, $R^2 = .02$, $F(2, 111) = .927$, $p = .399$. With the addition of the interaction term between response type and inhibition (Antisaccade and MSIT), a significant amount of variance was not accounted for, $\Delta R^2 = .012$, $\Delta F(1, 110) = 1.413$, $p = .237$, b = .157, $t(107) = 1.189$, $p = .237$. A second hierarchical regression analysis was done to test the relationship between inhibition (MSIT and no go) and nonfocal commission errors. In the first step, response type and inhibition (MSIT and no go) were added to the model and a significant amount of variance was not accounted for, $R^2 = .02$, $F(2, 111) = .927$, $p = .399$. With the addition of the interaction term between response type and inhibition (MSIT and no go) added to the model, a significant proportion of variance was not accounted for, $\Delta R^2 = .010$, $\Delta F(1, 110) = 1.115$, $p = .293$, b = -.144, $t(107) = -1.056$, $p = .293$. Inhibition (MSIT and no go) was also not found to predict nonfocal commission errors and response type did not moderate this relationship.

Table 3.3 Commission Errors: Inhibition (MSIT and no go task) x Response Type

	B	*SE B*	95% CI	β	ΔR^2
Step 1					
Response Type	.01	.02	-.02, .04	.06	
Inhibition*	-.00	.00	-.01, -.00	-.31	.110
Step 2					
Response Type	.01	.02	-.02, .04	.05	
Inhibition	-.00	.00	-.00, .00	-.13	
Response Type x Inhibition	-.00	.00	-.01, .00	-.24	.03

Source: * .05 significance

3.5.2. Aftereffects. Since overall aftereffects were found to be around 0 ms, WMC and both measures of inhibition were included as predictors in separate hierarchical moderator regression analyses to test whether these individual difference measures predict 2nd block aftereffects (focal and nonfocal) *only*. Second block aftereffects were included as the outcome variable because Walser et al. (2012) found aftereffects to be higher earlier in the repeated PM cue paradigm. Importantly, hierarchical moderator regression analyses were conducted to test if

response type moderates the above relationships. were conducted to examine the relationship between WMC and overall aftereffects (focal and nonfocal).

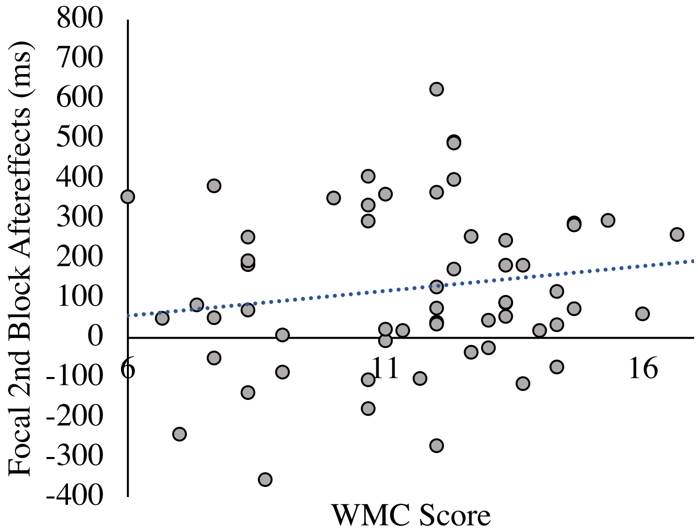

Figure 3.12 Task Switch: WMC x 2nd Block Focal Aftereffects

Table 3.4 Second Block Focal Aftereffects: WMC x Response Type Moderator Analysis

	B	*SE B*	95% CI	*β*	**Δ**R^2
Step 1					
Response Type	20.08	40.87	-60.91, 101.08	.05	
WMC	-3.36	7.87	-18.96, 12.24	-.04	.00
Step 2					
Response Type	14.59	40.25	-65.19, 94.37	.03	
WMC	-21.62	11.35	-44.11, .87	-.26	
Response Type x WMC*	34.13	15.51	3.38, 64.88	.30	.04

Source: * .05 significance

To test the relationship between WMC and 2nd block aftereffects, hierarchical regression analysis was conducted and the potential moderation of response type between this relationship was tested. Response type and WMC were entered in the first step, but did not account for a significant proportion of variance, R^2= .000, F(2,112) = .009, p = .991. With the addition of the centered interaction term in the seconds step, again, a significant amount of variance was not accounted for, **Δ**R^2 = .003, **Δ**F(1,111) = .318, p = .574, b = .075, t(111) = .564, p = .574.

Therefore, WMC was not found to predict 2nd block aftereffects and response type did not moderate this relationship.

The relationship between WMC and 2nd focal block aftereffects was tested. First, response type and WMC variables were entered. These variables did not account for a significant amount of variance in 2nd focal block aftereffects, $R^2 = .004$, $F(2,110) = .206$, $p = .82$. Second, the interaction term between response type and WMC was added to the regression model, which did account for a significant proportion of variance in 2nd block focal aftereffects, $\Delta R^2 = .042$, $\Delta F(1,109) = 4.84$, $p = .03$, b = .302, $t(110) = 2.200$, $p = .03$. See Table 3.4. Thus, because the interaction between response type and WMC was found to be a significant predictor for 2nd block focal aftereffects, separate scatter plots were created for dual-task (Figure 3.11) and task switch (Figure 3.12) response type to further analyze this relationship. In the dual-task group, the relationship between 2nd block focal aftereffects and WMC was *negative* ($R^2 = .03$), indicating the higher WMC, the lower 2nd block focal aftereffects were, while in the task switch group, the relationship was *positive* ($R^2 = .03$). Thus, for the task switch group, the higher WMC, the higher 2nd block focal aftereffects were. The relationship between WMC and 2nd block nonfocal aftereffects was then tested in a hierarchical regression analysis. Response type and WMC were entered in the first step, and did not account for a significant amount of variance, $R^2 = .020$, $F(2,113) = 1.135$, $p = .325$. The addition of the centered interaction term between WMC and response type did not account for a significant proportion of variance, $\Delta R^2 = .000$, $\Delta F(1,112) = .002$, $p = .626$, b = -.005, $t(111) = -.042$, $p = .967$.

The relationship between each measure of inhibition (Antisaccade and MSIT, MSIT and no go task) and 2nd block aftereffects (focal and nonfocal) was then tested, as well as the potential moderation of response type within these relationships. In the first hierarchical regression

analysis, inhibition (Antisaccade and MSIT) and response type were entered in the first step and did not account for a significant amount of variance in 2nd block aftereffects, R^2= .029, $F(2,111)$ = 1.662, p = .194. With the addition of the centered interaction term in the second step between inhibition (Antisaccade and MSIT) and response type, a significant amount of variance was not accounted for, ΔR^2 = .013, $\Delta F(1,110)$ = 1.460, p = .230, b = .158, $t(107)$ = 1.208, p = .230. The same hierarchical regression analysis was conducted with the second measure of inhibition (MSIT and no go task) and this measure of inhibition did not account for a significant amount of variance, R^2= .045, $F(2,111)$ = 2.602, p = .079 and a significant amount of variance was not accounted for with the addition of the interaction term, ΔR^2 = .013, $\Delta F(1,110)$ = 1.568, p = .213, b = -.167, $t(107)$ = -1.252, p = .213. Thus, neither measure of inhibition was found to predict 2nd block aftereffects and response type was not found to moderate these relationships. These null relationships between each measure of inhibition and 2nd block aftereffects were also found for the outcomes of 2nd block focal and 2nd block nonfocal aftereffects.

Lastly, to further explore the potential relationship between commission errors and 2nd block aftereffects, further hierarchical regression analyses were conducted separately for those that made 0 commission errors and those that made at least 1 commission error. Specifically, each group was separately analyzed to test the relationship between WMC and 2nd block aftereffects (focal and nonfocal), and each measure of inhibition (Antisaccade and MSIT, MSIT and no go task) and 2nd block aftereffects (focal and nonfocal). However, these further hierarchical regression analyses were not found to be significant.

CHAPTER 4. EXPERIMENT 1 DISCUSSION

4.1. PM Accuracy and RT

The first goal of Experiment 1 was to determine how focality and response type impact PM accuracy. It was predicted that PM accuracy would be higher with focal intentions, and this was supported – focality was found to replicate previous research because of higher focal PM accuracy compared to nonfocal PM accuracy. It was predicted that PM accuracy would be higher with a task switch response type based on Hicks et al. (2020). But, an alternative prediction was made based on the repeated PM cue paradigm possibly being faster paced since the OGT is to make an odd/even judgment in response to digits 1-9. Experiment 1 did not find a significant difference between response type. But, the main effect of response type was trending towards higher PM accuracy with a dual-task response compared to a task switch response, which does not replicate our previous research (Hicks et al., 2020). This finding is somewhat consistent with Gilbert et al. (2013) and supports the alternative prediction, albeit a nonsignificant one. In our previous research, we used Scullin et al.'s (2009) paradigm, while the present study used the repeated PM cue paradigm. In Gilbert et al. (2013), RT to OGT trials was about 600 ms, while in Hicks et al. (2020), RT to OGT was about 700-750 ms. Thus, the nature of the repeated PM cue paradigm may be faster and the dual-task response allocated more time for participants to make their PM response because of the PM response being second, compared to the task switch response type that requires a switch cost (Rogers & Monsell, 1995; Bisiacchi et al., 2009). For trial type, the present study error rates were relatively equal compared to Walser et al. (2012): Standard trials (5%), PM repeated trials (approximately 10%), and oddball trials (7-8%). This finding indicated the repeated PM cue paradigm is reliable in creating these error rates overall (PM error rates were not reported in Walser et al., 2012, but were approximately 14% here).

RT to PM trials across response type reflected that a dual-task response required a higher cost (slowing) compared to task switch response type (replicates Hicks et al., 2020), but not for other trial types. OGT RT replicated Walser et al. (2012) because OGT RT was significantly faster than other trial types. However, there was a negligible difference between PM repeated trials compared to oddball trials, while Walser et al. (2012) found about a 120 ms difference with PM repeated trials longer than oddball trials, representing positive aftereffects. It appears that while PM repeated RT was about the same in Walser et al. (2012) and in the present study, that RT to oddball trials in Walser et al. (2012) was reliably faster compared to the present study. But, this could be the result of the fixed nature of the deviant features in the present study. Oddball trials had small font, black background, strikethrough, right side, green background, and red font as deviant features. PM repeated trials had pink background, bold, left side, italicized, underline, and blue background deviant features. These were assigned to particular blocks of the experiment and fixed in those assignments for all participants. In the present experiment, PM accuracy was lower in block 3 with the italicized cue, compared to the block 3 oddball deviant feature of strikethrough. Thus, it appears that a strikethrough feature captures attention more than an italicized cue, which could then result in longer RT to the strikethrough oddball cue compared to the italicized PM cue.

4.2. Commission Errors

The second goal of Experiment 1 was to determine how focality and response type impact commission errors. It was predicted that there would be a higher proportion of focal commission errors compared to nonfocal commission errors, and this was supported. For response type, it was predicted that a higher proportion of commission errors would be found with a task switch response type compared to a dual-task response type, which would replicate

Hicks et al. (2020). Alternatively, because Hicks et al. (2020) has found dual-task response type PM accuracy to be significantly lower than task switch response type PM accuracy, that deactivating a PM intention associated with a dual-task response type is potentially more difficult because it is not fulfilled as often. Thus, an alternative prediction was there would be a higher proportion of commission errors with a dual-task response type. Experiment 1 found, while not significant, a trend towards a higher rate of commission errors with a dual-task response type, which supports the alternative prediction. However, looking at the percentage of people that made 1-7 or 8 or more commission errors across response type, this 'trending' difference in response type shows that a higher percentage of participants in the task switch group made 1-7 errors (37%) compared to the dual-task group (26%), which is similar to Hicks et al. (2020) and the first prediction for how response type would impact commission errors. Importantly, a small percentage of participants in the dual-task group made 8 or more errors (7%), while 0% made 8 or more errors in the task switch group, which could account for the trending difference of a higher proportion of commission errors in the dual-task compared to the task switch group overall. Lastly, the commission error rate in the present study (M = 35%) was much higher than Walser et al. (2012), which reported 3.4%. The present study introduced both focal *and* nonfocal intentions for participants, which may have created general confusion and reliance on the deviant feature only instead of the digit for the trial type. Thus, this may have resulted in a higher percentage of commission errors.

RT to different trial types across response type for each commission error group revealed interesting results. While there was no interaction between response type and trial type for the 0 error group, an interaction was found for the 1-7 error group, which was driven by shorter PM RT in the task switch group compared to the dual-task group. Specifically, comparing these two

groups, those that made at least 1 commission error in the task switch group were found to respond faster to PM trials compared to the 0 error group. Moreover, RT to PM repeated trials in the 1-7 group, while not significantly different, show a trend with slower RT in the dual-task group compared to the task switch group. This slowing to PM repeated trials in the 1-7 error dual-task group is longer compared to the 0 error group, thus reflecting strategic slowing to make ultimately a correct PM repeated decision (not making a commission error) and that this is requiring more effort in the 1-7 error dual-task group. But, this slowing to PM repeated trials is not found in the task switch group, which may be why there is a higher proportion of commission errors in the task switch and 1-7 error group because participants are not able to slow down to make the correct task response, representing that the intention is not completely deactivated.

4.3. Aftereffects

The third goal of Experiment 1 was to examine aftereffects across response type and focality in Walser's repeated PM cue paradigm. Overall aftereffects were not found collapsed across both independent variables (M = -3 ms), which does not replicate Walser et al. (2012; M = 126 ms). There are two reasons why this may have occurred, 1) focality and 2) deviant features. In the present study, focality was manipulated within-subjects, where alternating blocks had a focal intention then a nonfocal intention. Because of this manipulation, participants may have relied more heavily on the deviant feature to make their decision over time, as opposed to the particular nature of the PM cue definition. After the first 2 blocks of trials, participants would be aware that the deviant feature associated to each trial type was a reliable cue that did not change across digits (e.g., the PM cue of a pink background would only be shown with a PM digit). Thus, participants would only need to rely on the deviant feature to make their decision. Which

leads to the second point of deviant features. As discussed earlier, since deviant features were fixed, it could be that the deviant features used for oddball trials were more salient compared to PM repeated deviant features, which would explain why oddball RT here is longer and comparable to PM repeated RT, while in Walser et al. (2012) oddball RT was shorter. To conclude, focality and deviant features being fixed could explain the null aftereffects results.

Thus, the third goal of Experiment 1 was tested by analyzing 2^{nd} block aftereffects. Larger focal aftereffects were predicted compared to nonfocal aftereffects because if participants experience spontaneous retrieval with the former, this will result in longer RT to PM repeated trials in order to make the correct decision (i.e., to avoid a commission error). Alternatively, because participants are unaware they will continue to see PM repeated cues in earlier test blocks, that participants will allocate a monitoring attention strategy after seeing the first inactive *nonfocal* PM cue, which would result in slower RT. Second block nonfocal aftereffects were found to trend towards being significantly longer than 2^{nd} block focal aftereffects, which supports the alternative prediction. However, because focality was a within-subjects variable, 2^{nd} block nonfocal aftereffects represented a deactivated *nonfocal* PM cue in a new *focal* PM intention test block. Thus, because the new PM intention is focal, spontaneous retrieval of deactivated intentions could have occurred and this spontaneous retrieval is responsible for the slower response time to PM repeated nonfocal intentions. Future research should further explore focality in the repeated PM cue paradigm to delineate these results of monitoring or spontaneous retrieval being responsible for longer 2^{nd} block nonfocal aftereffects. For response type and aftereffects, it was predicted that a task switch response type would result in longer aftereffects compared to a dual-task response type because participants must immediately inhibit their previously active PM response in order to not make a commission error with a task switch response type. However,

significant differences were not found across response type in Experiment 1. Significant differences were not found across response type for PM accuracy. Thus, this null difference between response type for aftereffects could reflect that within the repeated PM cue paradigm, differences are not as strong as was found within the Scullin et al. paradigm used by Hicks et al. (2020). Alternatively, because overall aftereffects were quite low, it could be that there was not enough variance within aftereffects to detect any difference across response type.

4.4. Regression Analyses

Pearson correlations found the automated span measures to reliably correlate, but the three measures of inhibition, Antisaccade, MSIT, and no go task, did not all correlate. Specifically, the Antisaccade and MSIT tasks correlated, and the MSIT and no go tasks correlated. Moreover, Pearson correlations did not reveal a significant correlation between commission errors and aftereffects. Based on these Pearson correlational analyses, hierarchical regression analyses were conducted with the composite measure of WMC and composite measures of inhibition to test the predictive power of these individual difference measures for commission errors (focal and nonfocal) and 2nd block aftereffects (focal and nonfocal) since overall aftereffects were low.

It was predicted for WMC and commission errors that since previous research has found significant differences in nonfocal PM accuracy across those with low or high WMC that this could extend to canceled intentions as well. Specifically, WMC could predict nonfocal commission errors because those with lower WMC may have a more difficult time allocating their attention to cancel nonfocal intentions. However, Experiment 1 did not find WMC to predict focal or nonfocal commission errors and response type did not moderate this relationship. Yet because focality was a within-subjects variable though, a canceled focal intention was shown

in the context of a new nonfocal intention block. Therefore, focal and nonfocal intentions could not be truly separated within one test block, which is potentially why attentional control was not found to predict commission errors, whether they be focal or nonfocal.

It was hypothesized that inhibition would predict focal commission errors because focal intentions rely on spontaneous retrieval and previous research has stated that commission errors are the result of poor inhibitory control and spontaneous retrieval (Scullin et al., 2011). Alternatively, it was predicted because focality was a within-subjects variable that inhibition would not differentially predict focal or nonfocal commission errors because, for example, a canceled focal intention was shown in a new nonfocal test block. Experiment 1 found both composite measures of inhibition to predict overall commission errors – those with a higher inhibition score made fewer or no commission errors (Scullin et al., 2011), thus supporting the alternative prediction. Response type was predicted to moderate the relationship between inhibition and commission errors because it is presumed that a task switch response type requires a higher level of inhibitory control and Hicks et al. (2020) has found a higher rate of commission errors with a task switch response type. But response type was not found to moderate this relationship, which is surprising since the nature of these two response types should require different levels of inhibitory control (e.g., a task switch response requires an immediate response, thus should require more inhibitory control). This is likely because a significant difference was not found between response type for overall commission errors.

Tentative predictions were made in terms of the relationships between WMC, inhibition, and 2nd block aftereffects because previous research has not explored the predictive power of attentional or inhibitory control in relation to aftereffects. Since focal intentions rely on spontaneous retrieval, which does not require attentional control, it was predicted that inhibition

would predict focal aftereffects. However, neither measure of inhibition was found to predict 2^{nd} block aftereffects (focal or nonfocal), and response type did not moderate this relationship. This is likely because of low aftereffects, even in the 2^{nd} block, compared to Walser et al. (2012), which as discussed previously, is likely because of focality being a within-subjects variable and deviant features being fixed across test blocks for each trial type.

Lastly, it was predicted that since attentional control has been found to influence nonfocal PM accuracy, that WMC would then predict when nonfocal PM intentions are canceled with lower WMC participants having longer nonfocal aftereffects compared to higher WMC participants. In terms of response type moderating this relationship between WMC and 2^{nd} block nonfocal aftereffects, it was predicted that because a dual-task response type is potentially more difficult to execute, that a higher level of attentional control is needed to correctly make this response. Thus, those with lower attentional control would have longer 2^{nd} block aftereffects with a dual-task response type compared to a task switch response type. In Experiment 1, response type was found to moderate the relationship between WMC and 2^{nd} block *focal* aftereffects. This interaction is the result of a *negative* relationship between WMC and 2^{nd} block focal aftereffects with a dual-task response and a *positive* relationship with a task switch response. First, because a focal intention does not require attentional control, WMC predicting 2^{nd} block focal aftereffects is surprising. But, again, this is likely because focality was a within-subjects variable. Second, as was predicted, better attentional control led to lower 2^{nd} block focal aftereffects with a dual-task response. This is likely because a dual-task response type is more difficult and those with lower attentional control needed to take longer to ultimately make a correct PM repeated response compared to their higher attentional control counterparts. But, with a task switch response, those with better attentional control were found to have higher 2^{nd} block focal aftereffects when a

correct PM repeated response had to be made first. Thus, it appears that better attentional control actually slowed participants down when the no longer active PM intention had to be deactivated on the first response. This finding indicated that those with higher attentional control may have a more difficult time deactivating the intention or that it takes them longer to do so when the correct PM repeated response has to be made immediately (task switch group).

CHAPTER 5. EXPERIMENT 2 INTRODUCTION

In the first experiment, inhibition was found to predict commission errors and response type was found to moderate the relationship between WMC and 2nd block focal aftereffects. In the second experiment, the following changes were made to better examine this relationship between WMC, inhibition, commission errors, and aftereffects in the repeated PM cue paradigm. First, in Experiment 1, PM repeated trials were presented in the first test block, where the PM trials presented in the practice blocks were shown. By having PM repeated trials shown in the first test block based on two PM cues shown in the practice blocks, an equal comparison could not be made to the other test blocks where the PM cue was presented six times in each block. Thus, in the first block of the second experiment, participants were presented with a new PM cue six times and PM repeated trials were not shown until the second test block. Aftereffects in the first experiment were found to significantly decrease by the fourth block of trials. Thus, in the second experiment, participants completed 5 blocks of trials since aftereffects were found to be negligible in the 6th block in the first experiment.

In the first experiment, deviant features associated to PM, PM repeated, and oddball cues were fixed and not random across test block. Thus, interpretations of the main dependent variables, commission errors and aftereffects, could not be accurately interpreted because the results could be because of the deviant features presented in the test block. Therefore, in Experiment 2, five different versions of the experiment were created for the task switch and dual-task programs with the deviant features randomly assigned to the trial types across test blocks. Deviant features that resulted in poor PM accuracy in Experiment 1 were determined to not be salient enough to capture attention (e.g., italicized) and were not used in the second experiment test blocks. Moreover, the deviant features of showing the cue on the left or right side of the

screen were removed. Participants were instructed to look at the fixation cross in the center of the screen before each trial - by having to divert attention to the left or right side of the screen could confound with RT to these trials. Thus, in Experiment 2, the following deviant features were randomly assigned across block: Pink background, strikethrough, green background, underline, small font, purple background, blue background, black background, and large font. The italicized feature was used for the practice block for each version of the paradigm. See Table 5.1.

Table 5.1 Experiment 2 deviant features across block

	One	Two	Three	Four	Five
Practice	*Italicized*	*Italicized*	*Italicized*	*Italicized*	*Italicized*
Block 1					
PM cue	Pink background	Blue background	Green background	Underline	Large font
Block 2					
PM cue	Strikethrough	Underline	Black background	Large font	Small font
PM repeated	Pink background	Blue background	Green background	Underline	Large font
Oddball	Green background	Large font	Pink background	Small font	Underline
Block 3					
PM cue	Underline	Small font	Blue background	Strikethrough	Pink background
PM repeated	Strikethrough	Underline	Black background	Large font	Small font
Oddball	Small font	Purple background	Strikethrough	Black background	Green background
Block 4					
PM cue	Purple background	Green background	Underline	Pink background	Blue background
PM repeated	Underline	Small font	Blue background	Strikethrough	Pink background
Oddball	Blue background	Black background	Large font	Purple background	Strikethrough
Block 5					
PM cue	Black background	Strikethrough	Small font	Green background	Purple background
PM repeated	Purple background	Green background	Underline	Pink background	Blue background
Oddball	Large font	Pink background	Purple background	Blue background	Black background

Importantly, focality was not manipulated in the second experiment. In the first experiment, focality was a within-subjects variable (e.g., an active focal intention in the first block and an active nonfocal intention in the second block, etc.), which made interpretations limited. For commission errors, a focal commission error occurred when participants made an

erroneous PM response to a PM repeated trial in the following test block. But, the *focal* PM repeated cue was in the context of a new *nonfocal* PM intention for that test block. Thus, the focality of the commission error was different from the context of the test block. So, it could not be determined whether it was the focal commission error or the new nonfocal intention that resulted in the erroneous response. Moreover, aftereffects were considered focal based on the focality of the PM repeated cue. Thus, even though the *focal* PM repeated cue was in a *nonfocal* test block, aftereffects were considered focal. However, oddball RT was in a nonfocal context. Thus, delineating between focal and nonfocal aftereffects was not clear in the Experiment 1 paradigm. Also, in the repeated PM cue paradigm, focality was difficult to manipulate. Focal processing entails the OGT incites processing of the target because there is high degree of overlap between the OGT and PM task (e.g., identify the number 3), the intention is specific, and relies on spontaneous retrieval of the intention. Nonfocal processing has a lower degree of overlap between the OGT and PM task (e.g., identify any odd number), the intention is not specific, and relies on monitoring for the PM cue while engaged in the OGT, resulting in a cost to OGT trials (Einstein & McDaniel, 2005). But, creating a distinction between a focal and nonfocal intention in the repeated PM cue paradigm was not clear in comparison to the Scullin et al. (2009) method. The salient or deviant features used in the repeated PM cue paradigm across blocks used to capture attention could negate any effect of focality because the salient feature captures attention and participants may not properly encode the digit shown (which, is needed to distinguish between focal and nonfocal intentions). Future research should further explore ways in which to manipulate focality in the repeated PM cue paradigm.

Experiment 2 explored response type within the repeated PM cue paradigm. WMC and inhibition were again measured to test the relationship between these attentional and inhibitory

control measures with commission errors and aftereffects. While the inhibition measures were not found to all correlate in the first experiment, this could be the result of low power because of the small sample size. Thus, PM accuracy, commission errors, and aftereffects were examined across response type. The potential moderation of response type was tested in the relationships between WMC and inhibition with the outcome variables of commission errors and aftereffects.

CHAPTER 6. EXPERIMENT 2 METHOD

6.1. Participants

Participants were Louisiana State University undergraduate students and received class or extra credit in exchange for participation. A power analysis was conducted using G*Power 3 (Faul et al., 2007) to determine the sample size needed to detect if, response type, WMC, or inhibition will influence commission errors or aftereffects in Walser's paradigm. Based on these three predictors, a statistical power of .90, an alpha level of .05, and a small to moderate effect size (**d** = .05), an estimated 213 participants were required to determine this small effect. Two-hundred and twenty-nine participants (M_{age} = 19.60, 155 females) participated. For accuracy below 60% on a given trial type, 12 participants were removed for PM accuracy, 1 participant for OGT accuracy, and 3 participants for oddball accuracy. Further data trimming was conducted with the removal of participants with performance 2.5 standard below the mean. This resulted in one participant removed for 2nd block aftereffects, 6 participants for OSPAN partial scores, 3 participants for a RSPAN partial scores, and 2 participants for SSPAN partial scores. This data trimming resulted in 201 participants (M_{age} = 19.60, 136 females).

6.2. Design

Response type was a between-subjects variable (Dual-task, N = 101; Task switch, N = 100). PM accuracy was analyzed across response type and block in a 2 x 5 mixed factors ANOVA. Trial accuracy across response type and trial type (PM, ongoing, PM repeated, oddball) in a 2 x 4 mixed factors ANOVA. RT to trial type across response type was analyzed in a 2 x 4 mixed factors ANOVA. The proportion of commission errors across block and response type were analyzed in a 2 x 4 mixed factors ANOVA. Groups based on the number of commission errors were created to analyze the number of commission errors across response

type. RT to the different trial types and across response type were analyzed based on these groups of commission error people to evaluate attention allocation to different trial types based on how many commission errors were made in separate 2 x 4 mixed factors ANOVA. To examine overall aftereffects across response type, a 2 x 4 mixed factors ANOVA was conducted.

For correlational and regression analyses, Pearson correlational analyses were done to analyze the relationship between the latent variables of OSPAN, RSPAN, and SSPAN as a measure of WMC, and the latent variables of the Antisaccade, MSIT, and no go tasks as a measure of inhibition. Moreover, the dependent variables of commission errors and aftereffects were included in the correlation matrix. Composite measures of WMC and inhibition were created with the mean scores on each construct based on correlational analyses. Hierarchical regression analyses were conducted to determine if response type moderates the relationship between, 1) WMC and commission errors, 2) Inhibition and commission errors, 3) WMC and overall aftereffects and, 4) Inhibition and overall aftereffects. Moreover, to examine the relationship between commission errors and aftereffects more closely, separate hierarchical regression analyses were conducted based on those that made 0 commission errors and those that made 1 or more errors to test the relationship between WMC and aftereffects, and inhibition and aftereffects. If moderation is found to be significant, scatter plots were created to examine the interaction between response type and the predictor.

6.3. Measures

The same WMC (OSPAN, RSPAN, SSPAN) measures were included for the second experiment. For the Antisaccade task, participants completed 84 trials compared to 96 in Experiment 1 because only one participant scored higher than 84 in the first experiment. For the no go task, participants completed 100 trials compared to 96 in Experiment 1, 30% of which

were no go trials. This was done to increase the number of no go trials – in the first experiment, no go task accuracy was on average high, thus more trials were added to possibly have more variability in no go accuracy. Participants completed 100 trials for the MSIT task, which did not change from Experiment 1.

The repeated PM cue paradigm created by Walser et al. (2012) was used for the second experiment with a few modifications. First, 5 blocks of trials were used instead of 6, each consisting of 208 trials. This was done because of general fatigue observed in the first experiment in the 6th block of trials, as well as a higher rate of commission errors and aftereffects being found in earlier test blocks, thus making the 6th test block less relevant to the goals of the present experiment. Second, the first block in the PM paradigm only contained 6 PM cues and 202 OGT (digit categorization task, digits 1-9) to address the confound of PM repeated trials from the practice block active PM cues in the first experiment. Third, in the first experiment, the deviant features associated with PM, PM repeated, and oddball trials were fixed across block for all participants. Thus, interpretations of PM accuracy, commission errors, and aftereffects could be associated to the specific deviant feature used for each trial type in each block. To address this potential confound, for the second experiment, five different versions of the PM paradigm were created with deviant features randomized across trial type and block.

Participants completed two practice blocks of trials (each 12 trials long). Participants received feedback of 'Correct' or 'Incorrect' for their digit categorization response and the transition screen response. In the first practice block, participants practiced making the OGT response. In the second practice block, participants received a focal PM instruction (e.g., if you see the number 3 italicized, press the '?' key). All participants were exposed to the 9 deviant features in the second practice block. Subsequently, the experimental test blocks begin.

6.4. Procedure

The order of WMC tasks were randomized as the first 3 tasks, followed by the order of the inhibition tasks randomized as the fourth, fifth, and sixth tasks. Participants then completed the PM experiment last and were debriefed.

CHAPTER 7. EXPERIMENT 2 RESULTS

7.1. PM Accuracy and RT

To test the first goal of the present experiment, response type was analyzed across block and response type. A 2 x 5 mixed factors ANOVA between response type (between-subjects) and block (within-subjects) found a main effect of block, $F(4, 199) = 4.00$, $p < .05$, $\eta_p^2 = .02$. Post hoc analyses revealed significantly lower PM accuracy in block 3 ($M = .90$) compared to blocks 1 ($M = .94$), 2 ($M = .94$), and 4 ($M = .95$). Block 5 ($M = .92$) was significantly lower than block 4 ($M = .95$). No other significant effects were found. See Figure 7.1. A 2 x 4 mixed factors ANOVA between response type and trial type (within-subjects) found a main effect of trial type, $F(3, 199) = 17.45$, $p < .05$, $\eta_p^2 = .08$. Planned comparisons revealed OGT accuracy ($M = .94$) to be significantly higher than all other trial types, PM ($M = .93$), PM repeated ($M = .88$). and oddball accuracy ($M = .93$). PM repeated accuracy was significantly lower than PM and oddball accuracy. No other significant effects were found. See Figure 7.2. A 2 x 4 mixed factors ANOVA between response and trial type RT revealed an interaction, $F(3, 567) = 24.71$, $p < .05$, $\eta_p^2 = .12$. There was a significant difference between response type for PM RT, ($M_{diff} = 145$ ms) with longer PM RT for the dual-task response type. A significant difference was found between response type for PM repeated RT, ($M_{diff} = 91.82$ ms) with longer RT for the task switch response type. Null differences were found between response type for OGT and oddball RT. A main effect of trial type was found, $F(3, 189) = 344.62$, $\eta_p^2 = .65$, with each trial type found to be significantly different across trial type, PM ($M = 1067.02$ ms), PM repeated ($M = 907.10$ ms), oddball ($M = 766.64$ ms), and OGT ($M = 608.01$ ms). Response type was not found to be significantly different. See Figure 7.3.

7.2. Commission Errors Proportions and by Person

For the second goal, the proportion of commission errors was analyzed across response type and block. A 2 x 4 mixed factors ANOVA between response type and blocks 2-5 for the proportion of commission errors found a main effect of block, $F(3, 199) = 4.26$, $p < .05$, $\eta_p^2 = .02$. Planned comparisons revealed a larger proportion of commission errors in block 2 ($M = .09$) compared to blocks 4 ($M = .05$) and 5 ($M = .05$). No other significant effects were found. See Figure 7.4. A second 2 x 4 mixed factors ANOVA between response type and block was conducted with the removal of participants that made 8 or more commission errors because a high proportion of commission errors can indicate poor encoding of the cancelation instruction. An interaction was found, $F(3, 567) = 2.97$, $p < .05$, $\eta_p^2 = .02$. In the third block, a larger proportion of commission errors were found in the task switch group compared to the dual-task group ($M_{diff} = .05$). Blocks 2 ($M = .04$) and 3 ($M = .03$) had a significantly higher proportion of commission errors compared to blocks 4 ($M = .02$) and 5 ($M = .02$). A main effect of block was found, $F(3, 189) = 3.93$, $p < .05$, $\eta_p^2 = .02$. Blocks 2 ($M = .04$) and 3 ($M = .03$) had a larger proportion of commission errors compared to blocks 4 and 5 ($M = .01$). The main effect of response type was found to be significant, $F(1, 189) = 5.55$, $p < .05$, $\eta_p^2 = .03$ with task switch ($M = .033$) commission larger than dual-task ($M = .01$) commission errors. See Figure 7.5.

Frequency of commission errors across participants resulted in the following subgroups, 0 errors ($N = 142$), 1-7 errors ($N = 41$), and 8 or more errors ($N = 10$). A Chi-Square test was conducted to analyze the relationship between these 3 subgroups of commission errors and response type, which was significant, $X^2(11, N = 201) = 26.80$, $p < .05$. This indicated that the proportion of people in a given subgroup depended on response type, with more people making 1-7 commissions in the task switch condition as compared to the dual-task condition. The

opposite trend occurred for people making zero commission error – a higher proportion in this subgroup were in the dual-task response type. See Figure 7.6. Separate 2 x 4 mixed factors ANOVAs between response type for each trial type by response type were conducted for each group. For the 0 commission error group, a significant interaction was found, $F(3, 402) = 11.37$, $p < .05$, $\eta_p^2 = .08$. For PM trials, dual-task RT was trending to be longer than task switch response (M_{diff} = 88.01 ms). But, the opposite trend was found for PM repeated (M_{diff} = 113.31 ms) and oddball trials (M_{diff} = 62.04 ms). A main effect of trial type was found, $F(3, 134) = 263.66$, $p < .05$, $\eta_p^2 = .66$. Planned comparisons revealed longer RT to PM trials (*M* = 1097.53 ms) compared to PM repeated (*M* = 899.87 ms), oddball (*M* = 770.45 ms) and OGT trials (*M* = 609.56 ms). Main effect of response type was not significant. See Figure 7.7.

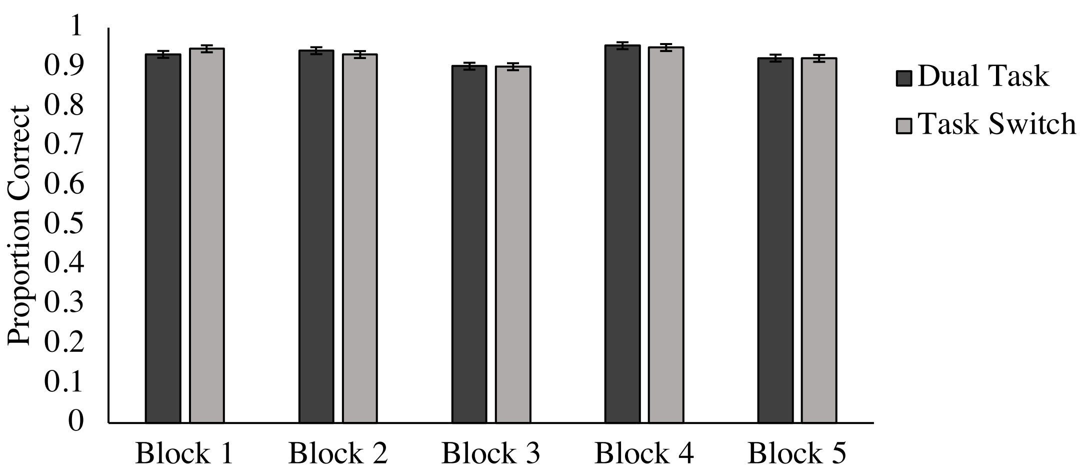

Figure 7.1 PM Accuracy Across Block. Main effect of block.

For the 1-7 error group, an interaction was found, $F(3, 135) = 11.43$, $p < .05$, $\eta_p^2 = .20$. A significant difference between response type was found for PM only with longer RT in the dual-task group (M_{diff}= 261.13 ms), but null differences for other trial types. A main effect of trial type was found, $F(3, 45) = 77.42$, $p < .05$, $\eta_p^2 = .63$. Planned comparisons revealed significant differences across trial type, PM (*M* = 1007.07 ms), PM repeated (*M* = 937.10 ms), oddball (*M* =

752.20 ms), and OGT (*M* = 604.16 ms). Main effect of response type was not significant. See Figure 7.8. For the 8 or more commission error group, a main effect of trial type was found, $F(3, 6) = 16.23$, $p < .05$, $\eta_p^2 = .73$. Planned comparisons revealed PM RT (*M* = 1033.00 ms) to be significantly longer than OGT (*M* = 600.38 ms) and oddball trials (*M* = 855.25 ms), but not from PM repeated trials (*M* = 1020.75 ms). Moreover, OGT RT was significantly shorter than other trial types. No other significant effects were found. See Figure 7.9.

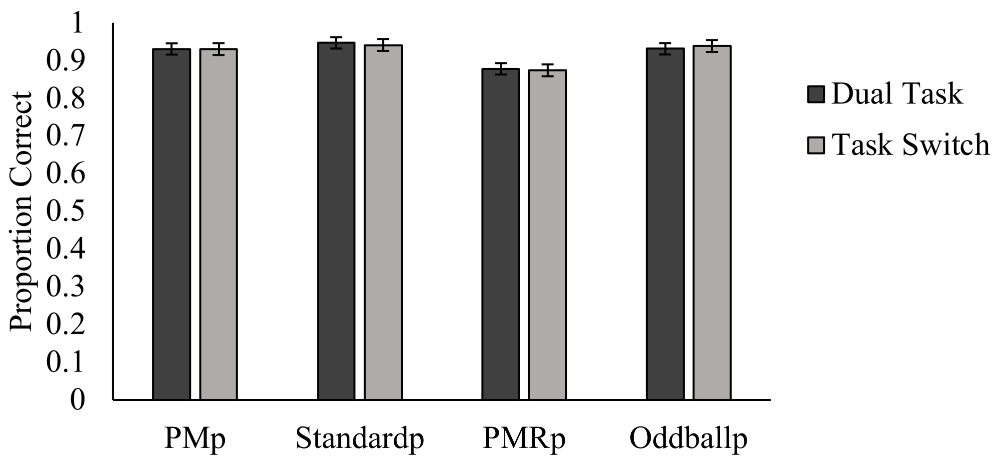

Figure 7.2 PM accuracy across trial type. Main effect of trial type.

7.3. Aftereffects

To test the relationship between response type and aftereffects, aftereffects were again calculated by subtracting oddball ball RT from PM repeated RT. A 2 x 4 mixed factors ANOVA to compare response type across blocks 2-5 found a main effect of block, $F(3, 555) = 6.61$, $p < .05$, $\eta_p^2 = .04$. Planned comparisons revealed 2nd block aftereffects (*M* = 209.14 ms) to be significantly longer than blocks 3 (*M* = 110.81 ms), 4 (*M* = 76.06 ms), and 5 (*M* = 92.20 ms). A main effect of response type was found, $F(1, 185) = 4.59$, $p < .05$, $\eta_p^2 = .02$, with longer aftereffects in the task switch group (*M* = 144.65 ms) compared to the dual-task group (*M* = 100.16 ms). No other significant effects were found. See Figure 7.10.

7.4. Correlations

To analyze the relationship between the latent variables for WMC (OSPAN, RSPAN, SSPAN), inhibition (Antisaccade, MSIT, no go tasks), commission errors, and aftereffects, Pearson correlations were calculated amongst these individual differences measures. Specifically, only those with a commission error proportion less than .60 were included. For OSPAN (*M* = 18.64, *SD* = 4.36), scores ranged from 7-25, for RSPAN (*M* = 8.99, *SD* = 2.84), 2-14, for SSPAN (*M* = 9.96, *SD* = 2.61), 4-14, for the Antisaccade task (*M* = 53.43, *SD* = 13.13), 23-79, MSIT (*M* = 35.45, *SD* = 8.40), 10-50, and for no go task (Go accuracy, *M* = 70.01, *SD* = 13.54); No Go accuracy, *M* = 17.61 *SD* = 5.66), 6-29.

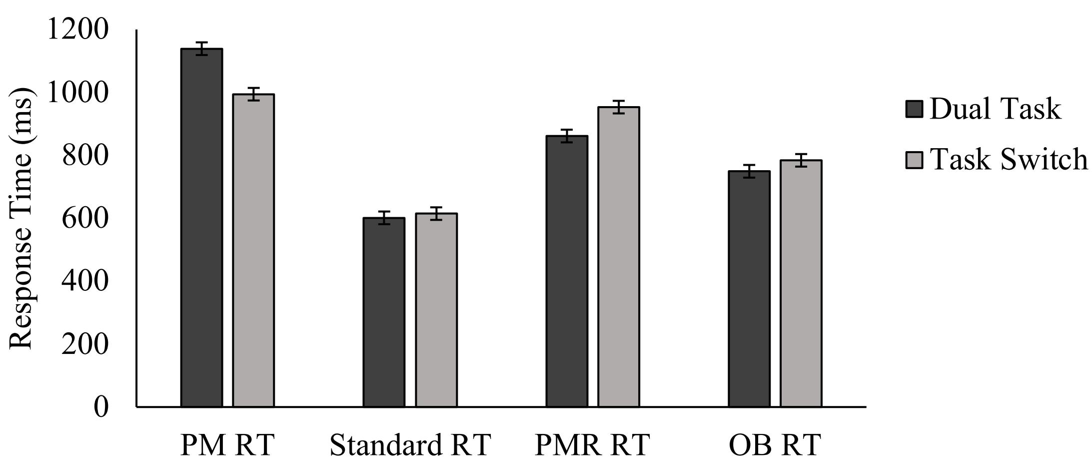

Figure 7.3 RT across trial type. Interaction between response type and trial type. Main effect of trial type.

For WMC, significant correlations at an alpha level of .01 were found between OSPAN and RSPAN (*r* = .20) and RSPAN and SSPAN (*r* = .35). OSPAN and SSPAN (*r* = .20) were found to correlate significantly at an alpha level of .05. For inhibition, significant correlations at an alpha level of .01 were found between the Antisaccade task and MSIT (*r* = .33) and the Antisaccade and no go task (*r* = .30). However, a significant correlation was not found between

the MSIT and no go task (*r* = .10). Commission errors and aftereffects were not found to significantly correlate (*r* = .13). See Table 7.1.

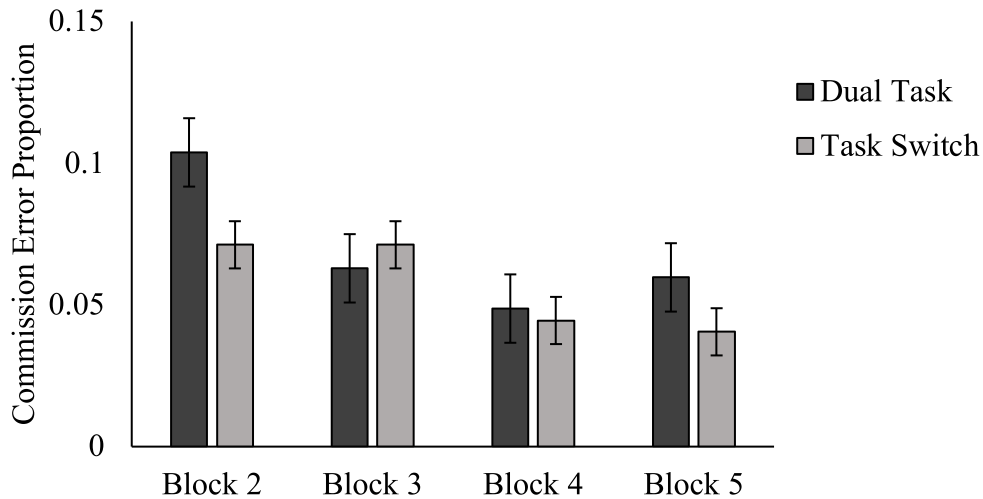

Figure 7.4 Commission Errors Across Block. Main effect of block.

7.5. Regression Analyses

7.5.1. Commission Errors. To analyze commission errors in the following regression analyses, analyses were conducted only for those with a commission error proportion lower than .60. Because OSPAN, RSPAN, and SSPAN were found to significantly correlate, a composite measure of WMC was calculated. First, to test the hypothesis that response type moderates the relationship between WMC and commission errors, a hierarchical multiple regression analysis was conducted. In the first step, response type and WMC variables were entered. These variables did account for a significant amount of variance in commission errors, $R^2 = .039$, $F(2, 190) = 3.883$, $p < .05$. Specifically, response type was found to significantly predict the proportion of commission errors, $t(188) = -2.751$, $p < .05$, which is the result of a higher proportion of commission errors in the task switch group compared to the dual-task group. To avoid potentially high levels of multicollinearity with the interaction term, variables were centered and

an interaction term was created between response type and WMC (Aiken & West, 1991). Next, the interaction term between response type and WMC was added to the regression model, which was not found to account for a significant proportion of variance in commission errors, ΔR^2 = .000, $\Delta F(1, 189) = .048$, $p = .827$, b = .088, $t(186) = .218$, $p = .827$. Thus, WMC was not found to predict commission errors and response type was not found to moderate this relationship.

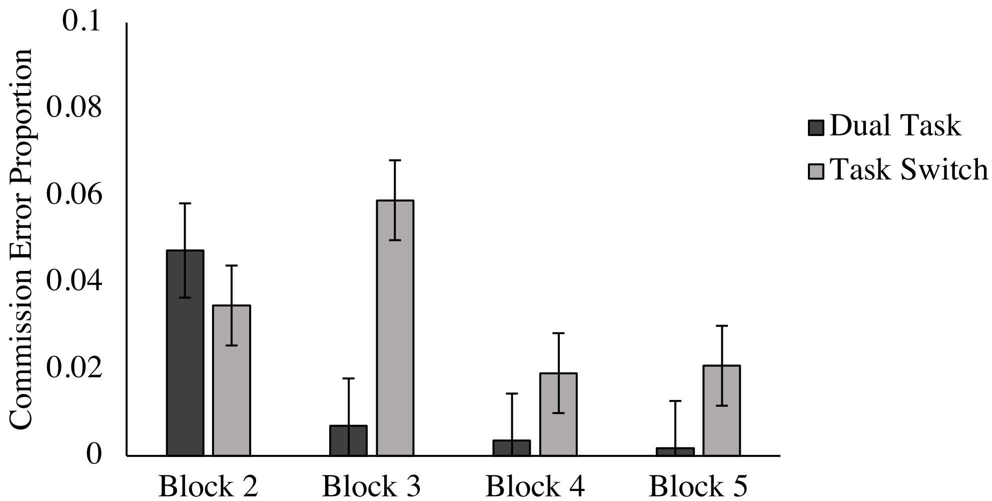

Figure 7.5 Commission Errors (7 or fewer). Interaction between response type and block. Main effect of block. Main effect of response type.

A composite measure of inhibition was created with the Antisaccade and MSIT tasks to test the hypothesis that response type moderates the relationship between inhibition (Antisaccade and MSIT) and commission errors. The same steps were conducted in a hierarchical multiple regression analysis. The first step with inhibition (Antisaccade and MSIT) and response type was found to be significant, $R^2 = .042$, $F(2, 190) = 4.113$, $p = .02$. Specifically, response type was found to significant predict commission errors, $t(188) = -2.710$, $p < .05$. A higher proportion of commission errors were found in the task switch group compared to the dual-task group. Next, the interaction term between response type and inhibition (Antisaccade and MSIT) was added to the regression model, which did not account for a significant proportion of variance in

commission errors, $\Delta R^2 = .000$, $\Delta F(1, 189) = .006$, $p = .937$, b = -.030, $t(186) = -.080$, $p = .937$. A separate hierarchical regression analysis was done to test the relationship between a second composite measure of inhibition (Antisaccade and No Go) and commission errors and if response type moderates this relationship. In the first step, inhibition (Antisaccade and No Go) and response type were found to account a significant proportion of variance, $R^2 = .044$, $F(2, 190) = 4.350$, $p = .014$. Specifically, response type was found to predict commission errors, $t(188) = -2.758$, $p < .05$. A higher proportion of commission errors were found in a task switch group compared to a dual-task group. With the addition of the interaction term between response type and inhibition (MSIT and no go), a significant amount of variance was not accounted for, $\Delta R^2 = .002$, $\Delta F(1, 189) = .451$, $p = .503$, b = -.070, $t(186) = -.672$, $p = .503$.

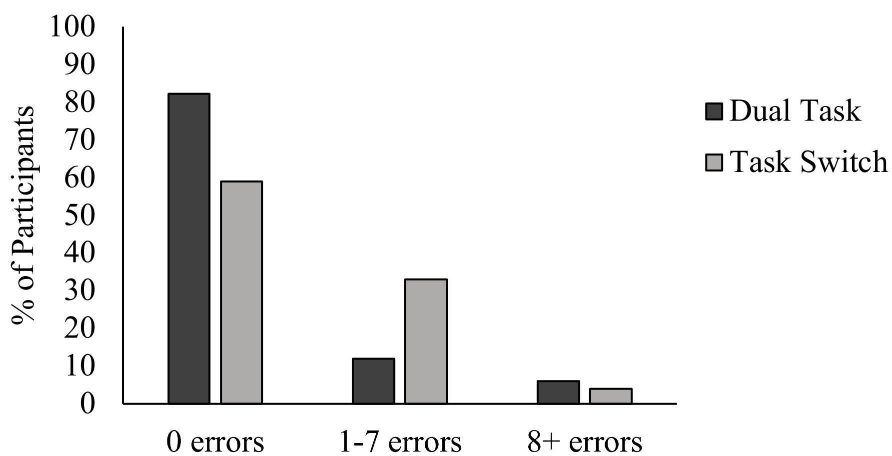

Figure 7.6 Percentage of Participants for Commission Errors. $X^2(11, N = 201) = 26.80$, $p < .05$.

7.5.2. Aftereffects. To analyze overall aftereffects, separate hierarchical regression analyses were conducted to examine the relationship between WMC and aftereffects, inhibition (Antisaccade and MSIT) and aftereffects, and inhibition (Antisaccade and No Go) and aftereffects. Importantly, hierarchical moderator regression analyses were done to test if response type moderates the above relationships. First, to test the hypothesis that response type moderates

the relationship between WMC and aftereffects, response type and WMC were entered in the first step. These variables did account for a significant amount of variance in aftereffects, R^2= .05, F(2, 198) = 4.95, p = .01. Specifically, response type was found to significantly predict overall aftereffects, t(196) = -3.03, p < .05, because of longer overall aftereffects in the task switch group compared to the dual-task group. Variables were centered and an interaction term was created between response type and WMC and added to the regression model, which did not account for a significant proportion of variance in commission errors, ΔR^2 = .001, $\Delta F(1, 197)$ = .229, p = .633, b = .186, t(194) = .478, p = .633. Thus, WMC was not found to predict overall aftereffects and moderation was not found with the addition of the interaction term between response type and WMC for overall aftereffects.

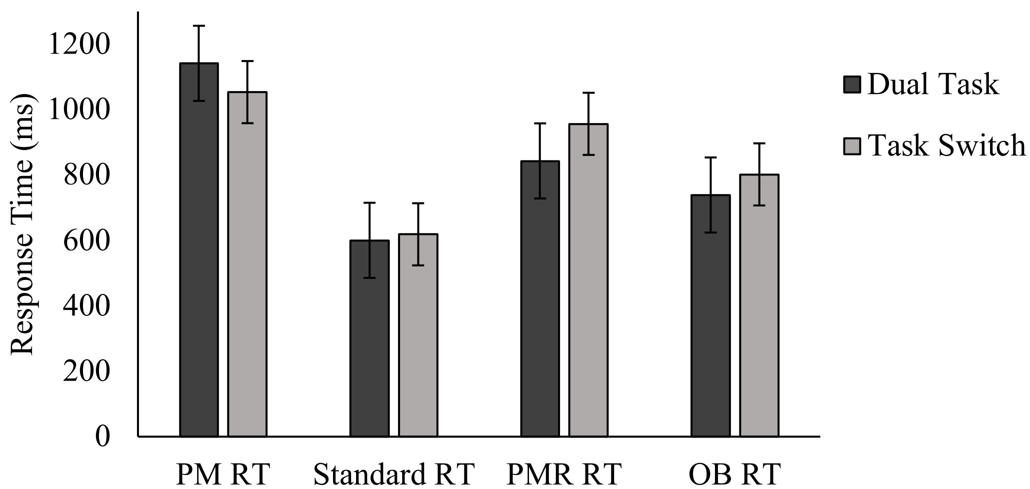

Figure 7.7 Zero commission errors RT. Interaction between response type and trial type. Main effect of trial type.

A hierarchical regression analysis was conducted to test the relationship between inhibition (Antisaccade and MSIT) and aftereffects and the potential moderation of response type. In the first step, response type and inhibition (Antisaccade and MSIT) were entered and did account for a significant amount of variance, R^2= .095, F(2, 198) = 10.825, p < .001. Specifically, inhibition was found to significantly predict overall aftereffects, t(204) = -3.256, p

< .05. See Figure 7.11 for further examination of this relationship between inhibition and aftereffects. Variables were centered and the interaction term between response type and inhibition was added to test for potential moderation, and this did not account for a significant amount of variance, $\Delta R^2 = .003$, $\Delta F(1, 197) = .689$, $p = .408$, b = -.294, $t(194) = -.830$, $p = .408$. Thus, inhibition (Antisaccade and MSIT) predicted overall aftereffects, but response type did not moderate the relationship between inhibition and overall aftereffects. See Table 7.2.

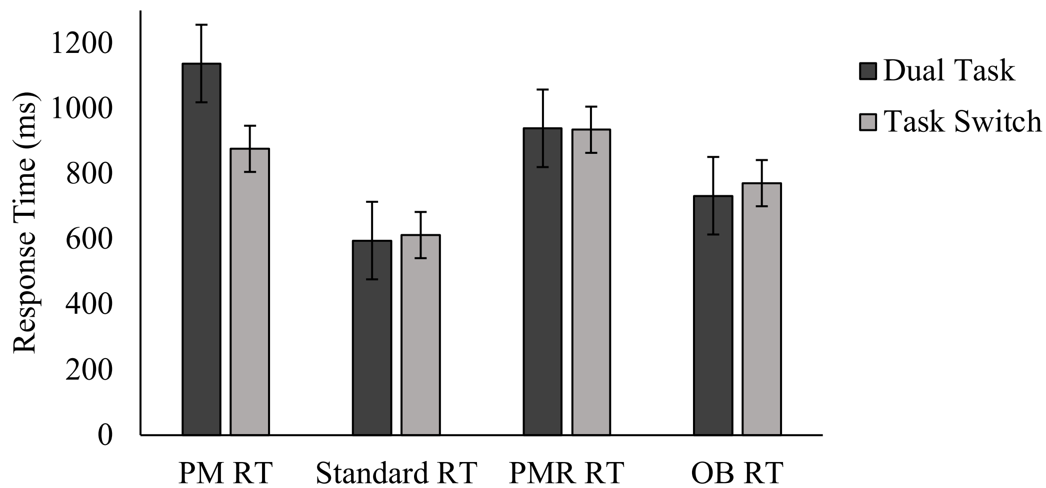

Figure 7.8 1-7 Commission Errors RT. Interaction between response type and trial type. Main effect of trial type.

Next, hierarchical regression analysis was done to test the relationship between the second composite measure of inhibition (Antisaccade and No go) and aftereffects and the potential moderation of response type. In the first step, response type and inhibition (Antisaccade and No go) were entered and did account for a significant amount of variance, $R^2 = .086$, $F(2, 194) = 9.17$, $p = .000$. Response type was found to significantly predict overall aftereffects, $t(196) = -2.70$, $p < .05$ because of longer aftereffects in the task switch group compared to the dual-task group. Importantly, inhibition (Antisaccade and No go) was found to significantly predict overall aftereffects, $t(196) = -3.18$, $p < .05$, indicating higher inhibition (Antisaccade and No go) scores resulted in lower aftereffects. See Figure 7.12. Variables were centered and the

interaction between inhibition (Antisaccade and No go) and aftereffects was added to test for potential moderation, and this did not account for a significant amount of variance, ΔR^2 = .005, ΔF(1, 193) = 1.007, *p* = .317, b = -.329, *t*(193) = -1.00, *p* = .317. See Table 7.3.

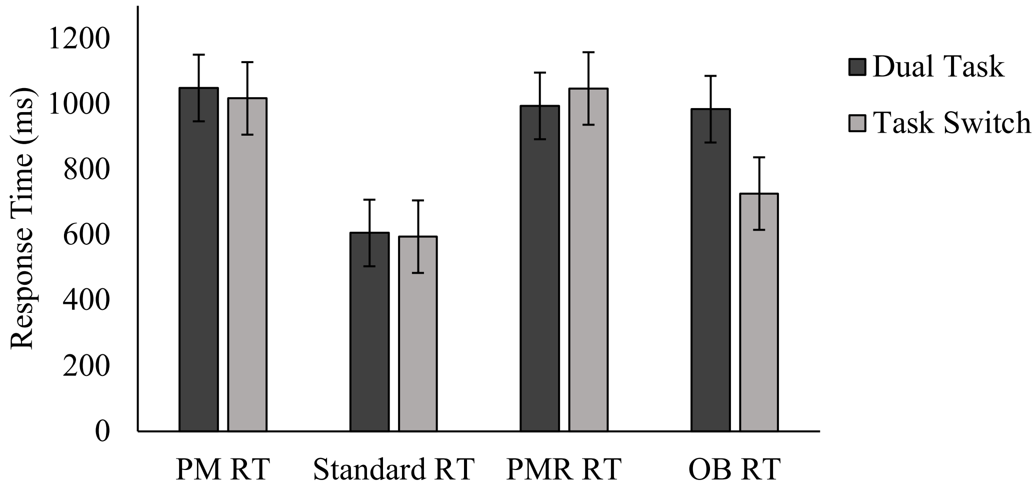

Figure 7.9 Eight or more Commission Errors RT. Main effect of trial type.

To further examine the potential relationship between those that make no commission errors and those who do make at least one commission errors and overall aftereffects, separate hierarchical regression analyses were conducted for those made 0 commission errors and those made 1-7 commission errors to examine the relationship between WMC and aftereffects and the relationship between each inhibition measure (Antisaccade and MSIT; Antisaccade and no go) and aftereffects. The first hierarchical regression analysis examined the relationship between WMC and overall aftereffects for the 0 commission error group. In the first step, response type and WMC were entered and did not find to account for a significant amount of variance, R^2= .039, *F*(2, 139) = 2.798, *p* = .064. With the addition of the centered interaction term between response type and WMC added, a significant amount of variance was not accounted for, ΔR^2 = .011, ΔF(1, 138) = 1.559, *p* = .214, b = .444, *t*(135) = .778, *p* = .440. Thus, WMC was not found to predict overall aftereffects and response type was not found to moderate this relationship.

Next the relationship between WMC and aftereffects was tested for the commission error group. In the first step, response type and WMC were entered into the model and found to account for a significant amount of variance, $R^2 = .115$, $F(2, 56) = 3.643$, $p = .033$. Specifically, WMC was found to significantly predict aftereffects, $t(52) = -2.300$, $p = .020$. See Figure 7.13.

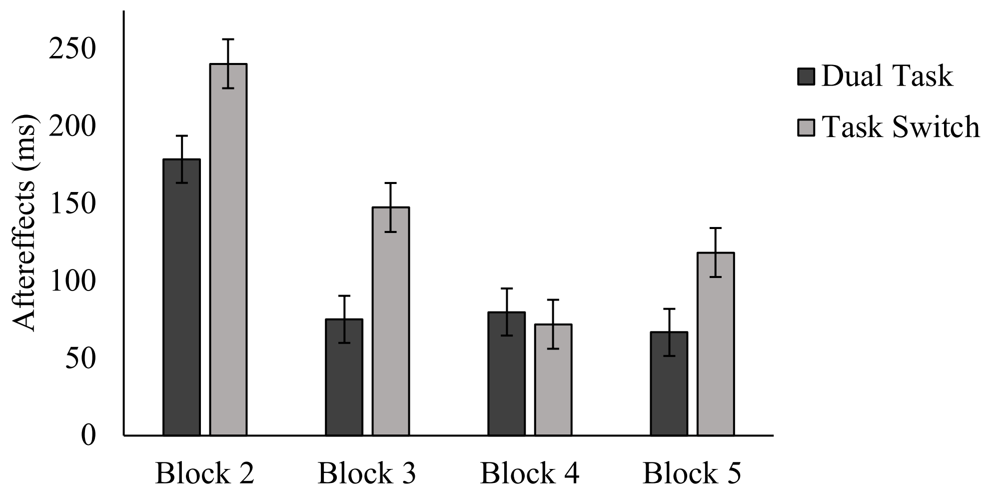

Figure 7.10 Aftereffects. Main effect of block. Main effect of response type.

Thus, those with a higher WMC score were found to have lower overall aftereffects. With the addition of the centered interaction term between response type and WMC, a significant amount of variance was not accounted for, $\Delta R^2 = .010$, $\Delta F(1, 55) = .605$, $p = .440$, b = .444, $t(52) = .778$, $p = .440$. Therefore, for the commission error group only, WMC was found to negatively predict overall aftereffects, but response type was not found to moderate this relationship. See Table 7.4.

Next, the relationship between inhibition (Antisaccade and MSIT) and aftereffects was tested for the 0 commission error group and the potential moderation of response type. First, response type and inhibition (Antisaccade and MSIT) were entered in the first step and this was found to account for a significant amount of variance, $R^2 = .101$, $F(2, 139) = 7.806$, $p = .001$. Specifically, response type was found to significantly predict aftereffects, $t(137) = -2.131$, $p <$

.05 because aftereffects were higher for the task switch group compared to the dual-task group. Also, inhibition significantly predicted aftereffects, $t(137) = -3.250$, $p < .05$ – those with higher inhibition (Antisaccade and MSIT) had lower aftereffects. See Figure 7.14 for a visual depiction of this relationship between inhibition (Antisaccade and MSIT) and aftereffects for the 0 commission error group. With the addition of the interaction term between response type and inhibition (Antisaccade and MSIT), a significant amount of variance was not accounted for, $\Delta R^2 = .000$, $\Delta F(1, 138) = .005$, $p = .942$, b = -.035, $t(135) = -.072$, $p = .942$. For the 0 commission error group, response type and inhibition separately predicted aftereffects, but response type did not moderate this relationship between inhibition and aftereffects. See Table 7.5.

Table 7.1 Pearson Correlations

	1	2	3	4	5	6	7	8
1. OSPAN	---							
2. RSPAN	.20**	---						
3. SSPAN	.17*	.35**	---					
4. ANTI	.08	.28**	.18*	---				
5. MSIT	.20**	.23**	.15*	.33**	---			
6. NO GO	.11	.38**	.10	.30**	.10	---		
7. Errors	.02	-.13	.03	-.06	-.04	-.08	---	
8. Aftereffects	-.01	-.13	.02	-.21**	-.21**	-.03	.13	---

Source: * .05 significance, ** .01 significance

The same hierarchical regression was conducted to examine the relationship between the second measure of inhibition (Antisaccade and no go) and aftereffects for the 0 commission error group. In the first step, response type and inhibition (Antisaccade and no go) were entered and found to account for a significant amount of variance, $R^2 = .081$, $F(2, 137) = 6.031$, $p = .003$. Specifically, response type was found to significantly predict aftereffects in the 0 commission error group, $t(139) = -2.306$, $p = .023$, which reflects longer aftereffects with a task switch response type compared to a dual-task response type. Importantly, the second measure of inhibition (Antisaccade and no go) was found to significantly predict aftereffects for those that

made 0 commission errors, $t(139) = -2.624$, $p = .010$. See Figure 7.15. Those with better inhibitory control (Antisaccade and no go) had lower aftereffects in this group. With the addition of the interaction term between inhibition (Antisaccade and no go) and response type, a significant amount of variance was not accounted for, $\Delta R^2 = .001$, $\Delta F(1, 136) = .151$, $p = .698$, b $= -.161$, $t(139) = -.389$, $p = .698$. Thus, both measures of inhibition significantly predicted aftereffects when participants made 0 commission errors. See Table 7.6.

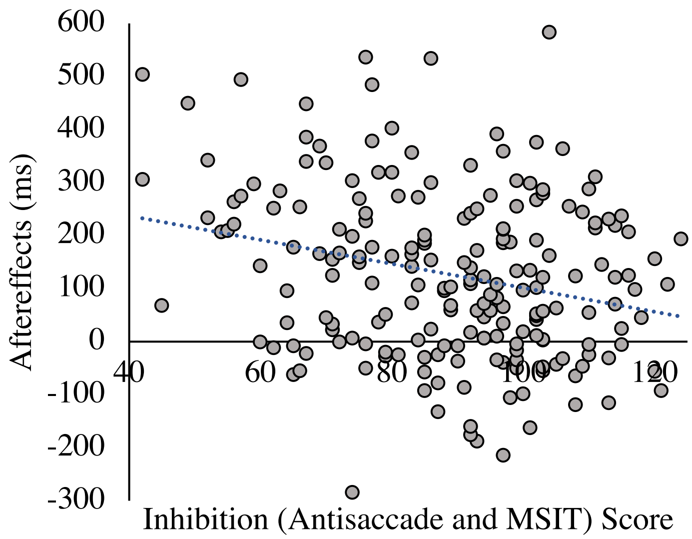

Figure 7.11 Aftereffects x Inhibition (Antisaccade and MSIT)

For the commission error group, the relationship between inhibition (Antisaccade and MSIT) was tested, as well as the potential moderation of response type. In the first step, response type and inhibition (Antisaccade and MSIT) were entered and did not account for a significant amount of variance, $R^2 = .073$, $F(2, 56) = 2.216$, $p = .119$. With the addition of the interaction term between response type and inhibition (Antisaccade and MSIT), a significant amount of variance was not accounted for, $\Delta R^2 = .015$, $\Delta F(3, 55) = .878$, $p = .353$, b = -.510, $t(52) = -.937$, $p = .353$. Thus, inhibition (Antisaccade and MSIT) was not found to predict aftereffects in the commission error group, nor did response type moderate this relationship. Lastly, the same

hierarchical regression analysis was done to examine the relationship between inhibition (Antisaccade and no go) and aftereffects for the commission error group and the potential moderation of response type. In the first step, response type and inhibition (Antisaccade and no go) were entered and did not account for a significant amount of variance, R^2= .026, F(2, 54) = 1.428, p = .249. With the addition of the interaction term between inhibition (Antisaccade and no go) and response type, a significant amount of variance was again not accounted for, ΔR^2 = .026, $\Delta F(3, 56)$ = 1.497, p = .227, b = -.667, t(56) = -1.224, p = .227. Thus, neither measure of inhibition predicted aftereffects for those that made 1-7 commission errors and response type did not moderate either of these relationships.

Table 7.2 Aftereffects: Inhibition (Antisaccade and MSIT) x Response Type Moderator Analysis

	B	*SE B*	95% CI	β	ΔR^2
Step 1					
Response Type*	-62.09	21.34	-104.18, -20.01	-.20	
Inhibition*	-2.17	.60	-3.36, -.99	-.24	.10
Step 2					
Response Type	26.97	109.43	-188.84, 242.79	.09	
Inhibition*	-1.70	.83	-3.34, -.07	-.19	
Response Type x Inhibition	-1.00	1.21	-3.38, 1.34	-.29	.00

Source: * .05 significance

CHAPTER 8. EXPERIMENT 2 DISCUSSION

8.1. PM Accuracy and RT

The first goal of Experiment 2 was to determine how response type impacted PM accuracy and it was predicted that PM accuracy would be significantly lower for the dual-task response type. However, Experiment 2 found a null difference across response type for PM accuracy. This is likely because overall PM accuracy was near ceiling. Also, participants had two practice blocks with corrective feedback to ensure participants' understood the response type, which facilitated PM accuracy. In terms of trial type, Experiment 2 found relatively similar error rates compared to Walser et al. (2012): Standard trials (5-6%), PM repeated trials (approximately 10-12%), and oddball trials (7-8%). This finding indicated the repeated PM cue paradigm is reliable in creating these error rates overall (PM error rates were not reported in Walser et al., 2012, but Experiment 2 had PM error rates of 7%, much lower than Experiment 1). RT across trial type was also similar to Walser et al. (2012) with shorter RT to OGT trials and the longest RT to PM trials. Importantly, longer PM repeated RT was found relative to oddball trial RT, which is similar to Walser et al. (2012).

8.2. Commission Errors

For the second goal of Experiment 2, the proportion of commission errors was analyzed across response type. A higher proportion of commission errors was initially predicted in Experiment 1 with the task switch response type based on Hicks et al. (2020). However, the alternative prediction that a higher rate of commission errors would be found with a dual-task response type was supported. In Experiment 2, overall, the percentage of commission errors was much lower compared to Experiment 1 (6%), and is similar to Walser et al. (2012) (3.4%). Interestingly, as was found in Experiment 1, a larger proportion of commission errors was found

with the dual-task group – but, this was only found in the second block of trials. With the removal of participants' that made 8 or more commission errors, which could reflect general confusion of the cancellation instruction, a larger proportion of commission errors were found with the task switch response type. This was also reflected in a larger percentage of participants making 1-7 commission errors in the task switch group (33%) compared to the dual-task group (11.9%). Thus for Experiment 2, with everyone included, a larger proportion of commission errors was found in the dual-task group. However, with the removal of participants that made or more errors, the initial prediction that the present study would replicate Hicks et al. (2020) that found a higher proportion of commission errors with the task switch response type was supported.

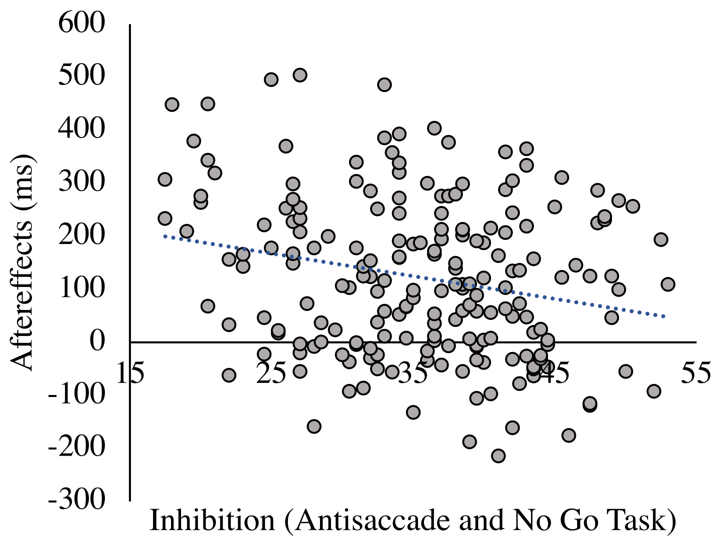

Figure 7.12 Aftereffects x Inhibition (Antisaccade and No Go)

Comparing RT to trial type across response type based on these different commission error groups, a significant difference was found between response type for PM RT in the 1-7 commission error group. For PM repeated trials, those in the 1-7 commission error and task switch group had faster RT on these trials compared to the 0 commission error and task switch

group, which could account for why more commission errors occurred in the task switch group. Thus, in general, those in the task switch and 1-7 error group responded faster to trials with both an active and inactive PM intention. For the 8 or more error group, PM repeated RT for both response types was generally longer compared to the 0 and 1-7 error group. Thus, even though multiple commission errors are made, participants are taking longer to respond to make correct decisions to PM repeated trials, which reflects participants are exerting effort to make these correct responses. Interestingly, there was a significant difference in RT for oddball trials across response type in the 8 or more error group. Those in the dual-task group had longer RT to oddball trials, which were comparable to PM repeated trials, which reflects both PM repeated and oddball trials are capturing attention similarly. But, for the task switch group, there is evidence of aftereffects because of the large difference between PM repeated and oddball RT. However, because of the small sample in the 8 or more error group, these interpretations should be drawn cautiously.

Table 7.3 Aftereffects: Inhibition (Antisaccade and No Go) x Response Type

	B	*SE B*	95% CI	β	ΔR^2
Step 1					
Response Type*	-54.88	20.35	-95.03, -14.74	-.19	
Inhibition*	-4.10	1.29	-6.64, -1.56	-.22	.01
Step 2					
Response Type	37.10	93.92	-148.14, 222.34	.13	
Inhibition	-2.80	1.83	-6.40, .81	-.15	
Response Type x Inhibition	-2.59	2.58	-7.67, 2.50	-.33	.01

Source: * .05 significance

8.3. Aftereffects

The third goal of Experiment 2 was to examine the effect of response type on aftereffects. Aftereffects were generally longer and more positive in Experiment 2 across all blocks. It was initially predicted that there would be longer aftereffects in the task switch group because this

response type requires an immediate response – this was what was found in Experiment 2 with longer aftereffects with a task switch response type in each block, except block 4. The largest aftereffects were found in the 2nd block, which is similar to Walser et al. (2012). Correlation analyses revealed span measures to significantly correlate, however the correlation between OSPAN and SSPAN was only found at an alpha level of .05. Again, two separate measures of inhibition were created based on correlational analyses. The relationship between the Antisaccade and MSIT was found to significantly correlate in Experiment 2, as was found in Experiment 1. But, while in Experiment 1 the MSIT and No Go tasks were found to significantly correlate, in Experiment 2, the Antisaccade and No Go task were found to significantly correlate.

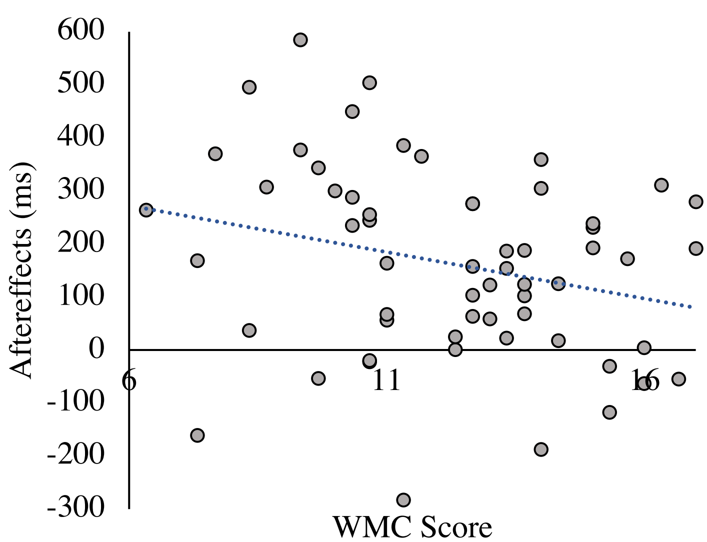

Figure 7.13 Commission Error Group: Aftereffects x WMC

8.4. Regression Analyses

The fourth goal of Experiment 2 was to analyze the relationship between WMC, the 2 measures of inhibition found, and the outcomes of commission errors and aftereffects. Moreover, if response type moderates these relationships was tested. For WMC, since Experiment 2 only included focal intentions, it was not predicted that attentional control would predict focal

aftereffects because while Experiment 1 found response type to moderate the relationship between WMC and 2nd block *focal* aftereffects, the focal PM repeated trial was in the realm of a nonfocal test block. This prediction was supported because WMC was not found to predict overall aftereffects in Experiment 2. As was predicted for Experiment 1, it was predicted that inhibition would predict overall commission errors and aftereffects with better inhibitory control resulting in fewer commission errors and lower aftereffects.

Table 7.4 Commission Errors Group – Aftereffects: WMC x Response Type

	B	*SE B*	95% CI	β	ΔR^2
Step 1					
Response Type	-85.41	49.06	-183.69, 12.87	-.22	
WMC*	-19.76	8.59	-36.98, -2.55	-.29	.12
Step 2					
Response Type	-254.59	223.00	-701.50, 192.32	-.66	
WMC	-24.59	10.62	-45.88, -3.30	-.36	
Response Type x WMC	14.15	18.19	-22.30, 50.60	.44	.01

Source: * .05 significance

While inhibition was not found to predict commission errors in Experiment 2, hierarchical regression analyses did reveal both composite measures of inhibition to predict overall aftereffects, with higher inhibition scores resulting in lower aftereffects. Thus, those with better inhibitory control were able to deactivate the intention and respond quickly to PM repeated trials compared to oddball trials, while those with poorer inhibitory control must exert more effort (take longer) to respond to PM repeated trials. While it was predicted that response type would moderate the relationship between inhibition and aftereffects because it is presumed that a task switch response requires a higher level of inhibitory control, response type was not found to moderate the relationship between either measure of inhibition and commission errors or aftereffects. For commission errors, the percentage of participants that made at least 1, but fewer than 60% of commission errors was relatively small (27%). Thus, it could be because most participants did not make a commission error that there was not enough variance to account for

in terms of inhibition predicting commission errors, thus response type would not moderate this relationship. For aftereffects, overall there was about a 45ms difference in aftereffects across response type, which is likely why response type was not found to moderate the relationship between inhibition and aftereffects.

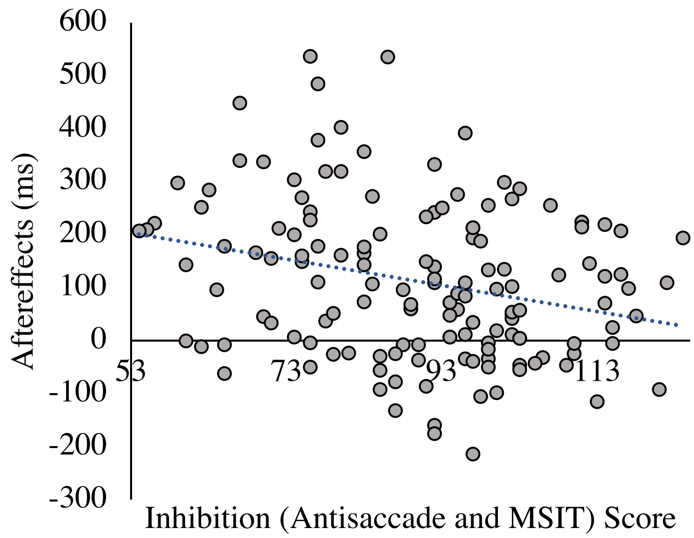

Figure 7.14 No Commission Errors Group: Aftereffects x Inhibition (Antisaccade and MSIT)

Table 7.5 No Commission Errors Group – Aftereffects: Inhibition (Antisaccade and MSIT) x Response Type

	B	*SE B*	95% CI	*β*	**Δ**R^2
Step 1					
Response Type*	-51.12	23.99	-98.55, -3.68	-.17	
Inhibition*	-2.42	.74	-3.89, -.95	-.26	.10
Step 2					
Response Type	-41.25	138.47	-315.06, 232.55	-.14	
Inhibition	-2.35	1.17	-4.66, -.04	-.25	
Response Type x Inhibition	-.11	1.52	-3.11, 2.89	-.04	.00

Source: * .05 significance

Separate hierarchical regression analyses were then conducted for those that made 0 commission errors and those that made 1-7 commission errors, to test the relationship between WMC, the two composite measures of inhibition, and aftereffects. The 8 or more commission errors group was not included in these analyses because of small sample size. WMC was found

to predict aftereffects when participants made a commission error – a higher WMC score resulted in lower aftereffects. Thus, those with better attentional control that made a commission error had lower aftereffects. This could reflect that those with better attentional control are making commission errors because of spontaneous retrieval because RT isn't longer to PM repeated trials. But, those with lower attentional control that make a commission error are not the result of spontaneous retrieval because RT to PM repeated trials is longer, reflecting effort is being exerted to make the correct response. But, for those that made no commission errors, WMC was not found to predict aftereffects, which supports that focal intentions do not rely on attentional monitoring.

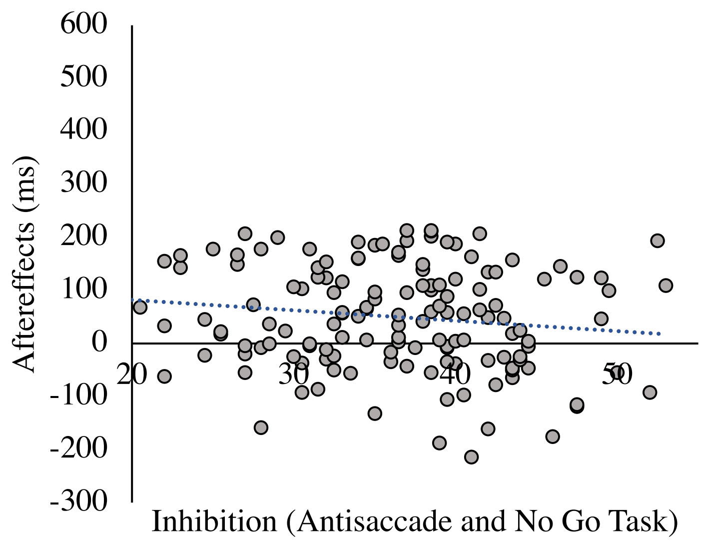

Figure 7.15 No Commission Error Group: Aftereffects x Inhibition (Antisaccade and No Go)

For the composite measures of inhibition and those that made no commission errors, a negative relationship was found between both measures of inhibition and aftereffects – those with better inhibitory control had lower aftereffects when no commission errors were committed. This represents that those with better inhibitory control who are not making a commission error have successfully deactivated the intention because RT to PM repeated trials is slower. But, for those with poorer inhibitory control, while these participants are not making any commission

errors, it does take them longer to respond correctly to PM repeated trials, which could indicate the intention is not fully deactivated. But, for the commission error group, neither measure of inhibition was found to predict aftereffects.

Table 7.6 No Commission Errors Group – Aftereffects: Inhibition (Antisaccade and No Go) x Response Type

	B	*SE B*	95% CI	β	ΔR^2
Step 1					
Response Type*	-53.25	23.10	-98.92, -7.58	-.19	
Inhibition*	-3.97	1.51	-6.95, -.98	-.22	.08
Step 2					
Response Type	-9.97	113.74	-234.90, 214.96	-.04	
Inhibition	-3.27	2.34	-7.90, 1.36	-.18	
Response Type x Inhibition	-1.19	3.07	-7.27, 4.88	-.16	.00

*Source: * .05 significance*

CHAPTER 9. GENERAL DISCUSSION

The present study was a first look at the role of attentional and inhibitory control in the realm of the repeated PM cue paradigm. The main goal of the present experiments was to analyze the relationship between both attentional and inhibitory control and two measures of PM intention deactivation: Commission errors and aftereffects. In Experiment 1, both focality and response type were manipulated with the former as a measure of attentional control (e.g., PM accuracy has been found to differ with a nonfocal intention across low/high WMC groups) and the latter as a measure of inhibitory control (e.g., a task switch response type presumably relies more on inhibitory control because it requires an immediate response). Focality was only manipulated in Experiment 1 because it was found that focality was difficult to manipulate within the repeated PM cue paradigm because of the salient nature of the deviant features used for different trial types. However, WMC was still examined in Experiment 2 based on the results of Experiment 1.

First, the relationship between WMC or inhibition with commission errors was tested. It was predicted that WMC would predict nonfocal commission errors because nonfocal intentions require attentional control, while focal intentions do not. Both in Experiments 1 and 2, WMC was not found to predict commission errors, whether focal or nonfocal, and response type did not moderate this relationship. This is likely because commission errors do not occur often in PM research and nonfocal commission errors occur even less often than focal commission errors. Second, the relationship between inhibition and commission errors was tested. For Experiment 1, it was predicted that inhibition would significantly predict focal commission errors because focal intentions rely on spontaneous retrieval and previous research has stated that commission errors are the result of poor inhibitory control and spontaneous retrieval (Scullin et al., 2011). While

both measures of inhibition (Antisaccade and MSIT; MSIT and No Go) were found to negatively predict commission errors in Experiment 1, this was not found in Experiment 2 (inhibition measures: Antisaccade and MSIT; Antisaccade and No Go). The number of participants that made at least 1 commission error compared to those that made 0 commission errors was higher in Experiment 1 compared to Experiment 2. Thus, because a large proportion of the sample in Experiment 2 did not make a commission error, inhibition was not found to be able to predict commission errors in Experiment 2.

Third, the relationship between WMC and aftereffects was tested. For Experiment 1, because nonfocal intentions rely on attentional control, it was predicted that WMC would predict 2^{nd} block nonfocal aftereffects only. However, WMC was found to interact with response type in the prediction of 2^{nd} block *focal* aftereffects. This was surprising because focal intentions do not rely on attentional control. However, this is likely because a focal PM repeated trial was shown in the context of a new *nonfocal* intention. This is supported in Experiment 2, where only focal intentions were used and WMC did not predict aftereffects (Einstein & McDaniel, 2005). Hierarchical regression analyses conducted separately for those that made 0 commission errors and those that made at least 1 commission error revealed interesting findings in Experiment 2 – WMC was found to negatively predict aftereffects for those that made 1-7 commission errors. Thus, better attentional control lowered aftereffects even though commission errors were made. But, those with lower attentional control made both commission errors and had higher aftereffects. This reflects that those with better attentional control that are making 1-7 commission errors are doing so because of spontaneous retrieval, but those with poorer attentional control that made at least one commission error are the result of possible confusion or an inability to deactivate the intention.

Fourth, the relationship between inhibition and aftereffects was analyzed. In Experiment 1, inhibitory control (Antisaccade and MSIT; MSIT and No Go) was not found to predict aftereffects. Focality and the difference in deviant features across trial type could account for this negligible relationship between inhibition and aftereffects found in Experiment 1 – repeated PM trials were different in focality compared to oddball trials. Therefore, because the attention allocation to these two trial types in the same block were different, any potential aftereffects were negated. Also, the salient nature of the deviant features used for oddball trials was likely responsible for lower aftereffects as well. In Experiment 2, both measures of inhibitory control (Antisaccade and MSIT; Antisaccade and No Go) were found to predict aftereffects – those with better inhibitory control had lower aftereffects compared to the those with lower inhibitory control. Thus, with focality removed and deviant features randomly assigned across test block, aftereffects were larger in Experiment 2 and the prediction that inhibitory control would predict aftereffects was supported. However, response type was not found to moderate this relationship between inhibition and aftereffects in Experiment 2. But, this is likely because of a small difference across response type for overall aftereffects.

The present experiments found some support for attentional control in the realm of canceled intentions – response type moderated the relationship between WMC and 2^{nd} block focal aftereffects in Experiment 1 and WMC predicted overall aftereffects in the commission error group in Experiment 2. To further understand attentional control in the repeated PM cue paradigm, future research needs to explore ways in which to manipulate focality within the repeated PM cue paradigm. The PAM theory, the Dynamic Multiprocess Framework, and the delay theory all incorporate to a degree attentional control in the realm of PM accuracy. The PAM theory and the Dynamic Multiprocess Framework focus on a limited capacity between the

OGT and PM task and attention must be allocated appropriately between the two to be accurate. Moreover, the PAM theory states that attentional control or monitoring is necessary to have successful PM, but the Dynamic Multiprocess Framework states attention can be deployed differently depending on the PM cue (e.g., a focal cue does not require attentional control, but a nonfocal cue does). In the present experiments, while WMC was found to differentially predict 2nd block *focal* aftereffects, these PM repeated cues were in the realm of a new test block with an active nonfocal intention. Moreover, WMC was only found to predict *aftereffects* in Experiment 2 (only focal PM cues) for those that made at least 1 commission error. Thus, these results lend support to the Dynamic Multiprocess Framework because attentional control was not predictive for both groups (whether participants made 0 or 1-7 commission errors) and PAM theory would state WMC should be predictive regardless of group. Also, because in Experiment 1 WMC was only found to be moderated by response type for 2nd block focal aftereffects, it shows that participants are changing their attention allocation policy since this relationship was not found for all types of aftereffects (focal *and* nonfocal).

In terms of the delay theory, it states there is a race between the OGT and PM response thresholds and PM responses are longer because attention needs to be allocated more since the OGT response is dominant. Specifically, these response thresholds are modified based on the attention allocation policy deployed at the start of the experiment (Hicks et al., 2005; Marsh et al., 2005; Loft et al., 2008). In the realm of canceled intentions though, attention allocation (WMC) was only found to predict aftereffects in Experiment 2 for those that made 1-7 commission errors. The delay theory does state that PM errors are failures that result from the difference in processing efficiency between the OGT and PM task (Loft & Remington, 2013) and that there should be fewer PM errors if participants are given more processing time for PM

trials. Actual commission errors were lower with a dual-task response type, which supports the delay theory. However, response type was not found to moderate this relationship between either measure of inhibition and aftereffects for the commission error group in Experiment 2. But, attentional control was found to reduce aftereffects for those that made 1-7 commission errors, which represents those with a 'better' attention allocation policy are better able to deactivate the intention (lower aftereffects), but that spontaneous retrieval may still occur of the focal intention resulting in commission errors.

Based on the results of Experiment 1 and 2, inhibitory control needs to be incorporated into future theoretical development of PM errors. Higher inhibition scores were found to lower commission error rates in Experiment 1 and lower aftereffects in Experiment 2. Thus, this provides evidence that inhibitory control plays a role in intention deactivation. Future research should further explore different measures of inhibition in the realm of canceled intentions to further understand the role of inhibitory control in commission errors and aftereffects. Based on future research exploring different measures of inhibition, important theoretical development can occur and integrate canceled intentions into existing theories of PM. Attentional control was also found to predict 2^{nd} block focal aftereffects in Experiment 1 with response type moderating this relationship. WMC was found to predict overall aftereffects for those that made at least 1 commission error in Experiment 2. Therefore, WMC was found to have predictive power of aftereffects in both experiments, and it also suggests an interesting relationship in Experiment 2 between commission errors and aftereffects. Specifically, for those with higher attentional control that made at least 1 commission error, aftereffects were lower, which reflects these commission errors are the result of spontaneous retrieval. Future research must further explore this relationship between those that made commission errors, aftereffects, and attentional control

to further understand the role of attentional control in PM and possibly revise present theories of PM.

9.1. Future Directions

Manipulating focality in the repeated PM cue paradigm needs further exploration. Because of the salient nature of the deviant features in the repeated PM cue paradigm, manipulating focality is difficult because participants potentially rely on these deviant features to make their response instead of focusing on the digit, which was needed to delineate between focality in Experiment 1. The PAM theory found evidence of monitoring with focal cues, but this was likely the result of multiple focal cues (Smith, 2003). Thus, one approach in future research could be to manipulate attentional load of the PM cue by having a single digit compared to multiple digits (e.g., 3, 4, 6, 9), with multiple digits creating a higher attentional load to compare canceled *focal* intentions with a low versus high attentional load to understand if monitoring is found regardless of load type. Another approach could be to divide attention in the PM test block (Pink & Dodson, 2013). Pink and Dodson (2013) found those in divided attention condition had a higher rate of commission errors. By doing so, attentional allocation could be measured across full and divided attention groups to better understand the role attentional control has. Moreover, because a higher rate of commission errors was found in the divided attention condition, this could be an important method to use to increase commission errors overall, resulting in a larger sample, and then test inhibitory and attentional control as predictors of commission errors. Lastly, participants were instructed to make odd and even judgments to single digits (1-9). Another potential moderation for a nonfocal cue would be to make a PM response when presented with a double digit – this would be different than identifying digits as odd or even, thus would be considered nonfocal.

In terms of inhibition measures, the present experiments found Antisaccade/MSIT to correlate, MSIT/No Go, and Antisaccade/No Go to correlate. Thus, these three measures were found to incorporate different aspects of inhibition. This was the first study to test the relationship systematically between inhibition and commission errors, more importantly aftereffects. Future research should further study different measures of inhibition and interference in the realm of canceled intentions to better understand this relationship.

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APPENDIX A. IRB EXEMPTION APPROVAL

ACTION ON EXEMPTION APPROVAL REQUEST

Institutional Review Board
Dr. Dennis Landin, Chair
130 David Boyd Hall
Baton Rouge, LA 70803
P: 225.578.8692
F: 225.578.5983
irb@lsu.edu
lsu.edu/research

TO: Samantha Spitler
Psychology

FROM: Dennis Landin
Chair, Institutional Review Board

DATE: February 12, 2020

RE: **IRB#** E10588

TITLE: Focality in Prospective Memory: A Thorough Examination of Cue Specificity and Task-Appropriateness

New Protocol/Modification/Continuation: Modification

Brief Modification Description: Change PI to Samantha Spitler and change the title of the study.

Review date: 2/11/2020

Approved __X__ **Disapproved** __________

Approval Date: 2/11/2020 **Approval Expiration Date:** 9/5/2020

LSU Proposal Number (if applicable):

By: Dennis Landin, Chairman DLandin

PRINCIPAL INVESTIGATOR: PLEASE READ THE FOLLOWING –
Continuing approval is CONDITIONAL on:

1. Adherence to the approved protocol, familiarity with, and adherence to the ethical standards of the Belmont Report, and LSU's Assurance of Compliance with DHHS regulations for the protection of human subjects*
2. Prior approval of a change in protocol, including revision of the consent documents or an increase in the number of subjects over that approved.
3. Obtaining renewed approval (or submittal of a termination report), prior to the approval expiration date, upon request by the IRB office (irrespective of when the project actually begins); notification of project termination.
4. Retention of documentation of informed consent and study records for at least 3 years after the study ends.
5. Continuing attention to the physical and psychological well-being and informed consent of the individual participants including notification of new information that might affect consent.
6. A prompt report to the IRB of any adverse event affecting a participant potentially arising from the study.
7. Notification of the IRB of a serious compliance failure.
8. **SPECIAL NOTE: Make sure you use bcc when emailing more than one recipient. Approvals will automatically be closed by the IRB on the expiration date unless the PI requests a continuation.**

**All investigators and support staff have access to copies of the Belmont Report, LSU's Assurance with DHHS, DHHS (45 CFR 46) and FDA regulations governing use of human subjects, and other relevant documents in print in this office or on our World Wide Web site at http://www.lsu.edu/irb*

VITA

Samantha Nicole Spitler is a seventh year student in the cognitive and brain sciences psychology program at Louisiana State University (LSU), where she anticipates earning a Doctor of Philosophy in Psychology under the mentorship of Dr. Jason Hicks. Ms. Spitler received her bachelors of Science degree from St. John Fisher College in 2011, graduating cum laude. During her senior year of St. John Fisher College, she completed her honors thesis under the supervision of Dr. Ryan Thibodeau examining the relationship between false memories and fantasy proneness using the Deese-Roediger McDermott (DRM) paradigm. Ms. Spitler received her masters of Science degree from Augusta University in 2013. Ms. Spitler received her masters of Art degree from LSU in 2016. The focus of her masters of Art degree from LSU examined multidimensional source memory and stochastic dependence across cross-modal sources. Ms. Spitler has explored her interests in the underlying cognitive mechanisms of event-based prospective memory using mouse tracking, as well as how commission errors occur in a prospective memory paradigm. Ms. Spitler's primary focus in how commission errors occur, as well as aftereffects, has focused on the role of attentional and inhibitory control as an individual difference measure.