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VALUE-DIRECTED REMEMBERING: EVIDENCE FOR DISTINCTIVE PROCESSING OF HIGH VALUE ITEMS

A Dissertation
presented in partial fulfillment of requirements
for the degree of Doctor of Philosophy
in the Department of Psychology
The University of Mississippi

by

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ABSTRACT

A large body of literature has found that when participants are instructed to maximize their score, they reliably demonstrate better memory for information assigned high relative to low-values. This value-directed remembering effect has been replicated numerous times throughout nearly three decades of research. The most current theoretical explanation posits that high-value items disproportionately benefit from semantic processing relative to low-value items; however, this does not explain how this additional processing supports better memory for high-value items. Prior research suggests that semantic processing may benefit memory through item-specific processing or the processing of unique aspects of meaning. To this extent, the current theory argues for the role of item-specific processing; however, this ignores other research which suggests a role of relational processing in supporting memory within value-directed remembering. The current study provided evidence for a new theoretical explanation of value-directed remembering in which high-value items are thought to benefit from distinctive processing to a greater extent than low-value items. Given that distinctive processing incorporates the joint action of item-specific and relational processing, this study builds upon the current literature and, in doing so, provides a mechanistic explanation for value-directed remembering.

DEDICATION

I write this with only a general knowledge of the details, but my wife and I are ecstatic to learn that our family is growing by one. Given the joy this news has brought, it seems fitting that I dedicate this dissertation to my beautiful wife, Madison, and our first child, who we have colloquially referred to as Poppy Seed

LIST OF ABBREVIATIONS AND SYMBOLS

VDR	Value-directed Remembering
M	Mean value
SD	Standard deviation
SE	Standard error of the mean
η_p^2	Partial Eta squared effect size

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Finally, I would like to thank my incredibly kind and patient wife, Madison, for her love and support. I cannot imagine going through this journey without her by my side, and I am forever grateful for all that she does.

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I. INTRODUCTION

On a typical day, we are often bombarded with more information than we can process, we are therefore forced to process information selectively. This selective processing can take many forms, such as choosing to direct our efforts towards more important or goal-relevant information. For instance, students preparing for their final exam are likely to prioritize material that the instructor explicitly mentions will be on the exam relative to anything the instructor did not specifically mention. Likewise, a detective is likely to prioritize remembering information they view as most critical to the crime when writing their final report, relative to less critical information gathered during their investigation.

Within laboratory settings, the value-directed remembering paradigm provides one way to study the relationship between importance and memory. In this paradigm, participants are presented lists of unrelated concrete nouns, each of which is arbitrarily assigned either a low or high point value. Participants are instructed to study the words with the goal of maximizing their score on an upcoming memory test. Numerous studies have found that people reliably demonstrate substantially better memory for high-value information in comparison to low-value information, a phenomenon deemed value-directed remembering (Robison & Unsworth, 2017; Festini, Hartley, Tauber, & Rhodes, 2013; McDonough, Bui, Friedman, & Castel, 2015; Middlebrooks, Murayama, & Castel, 2016; Middlebrooks & Castel, 2018; Middlebrooks, Kerr, & Castel, 2017).

The current study is intended to investigate the underlying mechanism of the effect. In doing so, a new theoretical explanation is proposed and evidence for this approach is examined.

Following an introduction to the literature using the value-directed remembering paradigm, prior explanations of the effect are reviewed before introducing the new theoretical explanation of the effect. This is followed by two pilot studies and the current study.

Value-Directed Remembering

The value-directed remembering paradigm examines the influence of value on subsequent memory by assigning point values to often unrelated words contained within a series of word lists. At encoding, participants are informed that their goal is to maximize their score on an upcoming memory test. This basic paradigm is used in the studies discussed in this paper, but a large degree of variation occurs within the methodology employed. For instance, some studies employ free recall measures (Festini et al., 2013; Ariel, Price, & Hertzog, 2015; McDonough et al., 2015; Middlebrooks et al., 2016; Robison & Unsworth, 2017; Middlebrooks & Castel, 2018), whereas others utilize recognition measures (Castel, Farb, & Craik, 2007; DeLozier & Rhodes, 2015; Middlebrooks et al., 2017; Hennessee, Patterson, Castel, & Knowlton, 2019). The majority of recent studies have utilized free recall measures, as they are more sensitive to value-directed remembering (Middlebrooks, Murayama, & Castel, 2017). In part, recall measures are more sensitive because recognition performance is typically at or near ceiling, which would be difficult to detect any differences between high and low-value information if it were to occur.

Studies vary in how value is assigned to the to-be-remembered words. Some studies have used a continuous range of values (Castel, Murayama, Friedman, McGillivray, & Link, 2013; Friedman & Castel, 2013; Ariel & Castel, 2014). Others have used a more dichotomous approach in which the value of the items is marked by a difference in range of values (Festini et al., 2013; DeLozier & Dunlosky, 2015); but these too can differ, with some studies assigning a range of values to delineate between high and low-value items (Cohen, Rissman, Suthana, Castel, & Knowlton, 2016), while others have used a single number (Festini et al., 2013). For example, Cohen and colleagues (2016) used one to three-point values to denote low-value items and ten to twelve-point values to denote high-value items. Other studies, such as Festini and colleagues (2013), have used a single digit to denote low-value items (i.e., 1) and high-value items (i.e., 10). The use of a dichotomous value scheme is more frequent in the literature.

The number and length of study lists also vary considerably. Some researchers have opted for a single list (Festini et al., 2013), while others have used multiple lists (Robison & Unsworth, 2017; Middlebrooks et al., 2017; Middlebrooks and Castel, 2018). More recent studies have utilized multiple study lists as value effects are usually not fully potentiated until list three or four (Castel, Benjamin, Craik, Watkins, 2002; Castel et al., 2007). This is particularly important to note as the value-directed remembering effect is often not found within the first list. This finding may be driven by the lack of feedback provided to the participant and an opportunity to improve performance on future lists.

Numerous studies within the value-directed remembering paradigm have opted to use performance feedback after each memory test (Castel et al., 2002; Castel, Humphreys, Lee, Galvan, Balota, & McCabe, 2011; DeLozier & Dunlosky, 2015; Cohen et al., 2016) whereas others have opted not to provide feedback at all (Soderstorm & McCabe, 2011; Bui, Friedman, McDonough, & Castel et al., 2013; Festini et al., 2013; McDonough et al., 2015). It is important to include feedback as prior literature suggests that metacognitive processes may influence value-directed remembering (Soderstorm & McCabe, 2011; Castel et al., 2013). Without feedback, these metacognitive processes are not likely to be engaged, and, as such, the absence of feedback may negatively impact value-directed performance on subsequent recall tests.

Numerous other methodological variations occur, but the ones discussed above have been argued to be the most crucial to examining value-directed remembering (Castel, 2008). It is interesting to note that although a large degree of variation occurs, value-directed remembering has been extensively replicated. Over several decades, participants across dozens of studies have exhibited substantially better memory performance for high-value items relative to low-value items. Despite the widespread replication of the effect, only a handful of studies have aimed to understand the underlying mechanism driving value-directed remembering.

Theoretical Explanations

A total of four theories have been proposed and subsequently assessed within the literature. All of these make the fundamental argument that memory for high-value items benefits from an increase in some type of processing, while low-value items suffer from a decrease in the same processing.

Low-Value Items Ignored

The earliest explanation of value-directed remembering argued that participants were simply ignoring the low-value items at encoding. Castel and colleagues (2002) directly tested this assumption by presenting the value cue after the to-be-remembered word. The study was conducted using a computer program that presented the words sequentially, followed by a fixation cross and the value cue. Since the value cue appeared after the word was presented, the participant had no way of selectively ignoring the low-value items, as they were indistinguishable at the initial time of encoding. Despite this manipulation, the results demonstrated that the value effect persisted regardless of when the value cue was presented, which led them to conclude that participants were not simply ignoring the low-value items.

Furthermore, surprise recognition tasks have demonstrated that participants can perform well for both high and low-value information (Castel et al., 2007). If it were the case that low-value items were ignored in their entirety, then subsequent performance on a surprise recognition task would be relatively low. Although evidence such as this indicates that low-value items are not ignored, it does not eliminate the possibility that high-value items are processed differently than low-value items.

Study Time

Several studies have found that participants selectively study high-value items more frequently and for more extended periods of time than low-value items (Castel et al., 2013; DeLozier & Dunlosky, 2015). For example, Castel and associates (2013) used a self-regulated study design in which participants were able to select items to study from an array of point values. They found that participants selected to study the high-value items longer and more frequently compared to low-value items. They also found that memory performance was substantially better for high-value items compared to low. These patterns might suggest that value-directed remembering is driven by the disproportionate amount of study time and restudy selection; however, evidence from other studies utilizing experimenter-controlled presentations invalidate this idea.

For example, Soderstrom and McCabe (2011) presented both high and low-value items for equal durations and did not allow items, regardless of value, to be restudied. They found that value-directed remembering persisted despite study time and restudy selection being held constant. If differential study time was the driving mechanism behind value-directed remembering, controlling for that variable should have eliminated the memory advantage for the high-value information. Other studies using an experimenter controlled presentation provide additional evidence against the differential study time explanation (Ariel & Castel, 2014; Delozier & Dunlosky, 2015; Eich & Castel, 2016; Festini et al., 2013; Friedman & Castel, 2013;

McDonough, et al., 2015; Middlebrooks et al., 2016; Middlebrooks, Kerr, & Castel, 2017; Robison & Unsworth, 2017).

Attentional Resources

Differential allocation of attentional resources may be one variable that influences superior memory for high-value information relative low. This point was raised within the work done by Castel and Ariel (2014), which applied eye-tracking technology to the value-directed remembering paradigm. The authors were primarily interested in determining if pupil diameter changed as a function of the value assigned to the studied material. Typically, an increase in pupil dilation is thought to correspond to an increase in the allocation of attentional resources (Goldinger & Papesh 2012; Bijleveld, Custers, & Aarts, 2009). Castel and Ariel (2014) also recorded fixation time, which has been used as an index of moment-to-moment attentional resources (Just & Carpenter, 1980; Rayner 1998). They found that participants fixated on high and low-value information equally; however, there was a difference in pupillary response as a function of value. Pupil diameter increased as a function of value such that high-value information on average was associated with increased pupil diameter compared to low-value information. The equal fixation time between high and low-value information further suggests that low-value items are not ignored and provides additional justification to reject the explanation of differential study time. More importantly, pupil dilation patterns suggest that high and low-value items are processed differently, with an increase in the allocation of attentional resources for high-value information. Although interesting, the allocation of attentional resources is severally limited as an explanation. Stating that high-value items benefit from an increase in attentional resources does not then explain how that increased attention influences memory performance. The findings from Ariel and Castel (2014) and the suggestion of differential processing further set the stage for the most recent explanation of value-directed remembering.

Differential Semantic Engagement

Several studies have used differential processing as a potential explanation for the results obtained, but little work has provided evidence beyond speculation (Cohen, Rissman, Suthana, Castel, & Knowlton, 2014; Cohen et al., 2016; Festini et al., 2013; Middlebrooks et al., 2016; Hennessee, Castel, & Knowlton., 2017; Middlebrooks et al., 2017; Hennessee, Knowlton, & Castel, 2018). Although a couple of early studies suggested the role of differential processing, the majority of the groundwork was done by Cohen and Colleagues (2014). Their study used fMRI technology to examine the activation of brain regions while participants engaged in an adapted value-directed remembering task. Of interest to the authors was the potential role of verbal rehearsal. To hold this variable constant, they asked participants to engage in a vowel-consonant judgment task immediately following the word's presentation. With this exception, all other design details closely mimicked the design used by Castel and colleagues (2002). Overall recall performance indicated superior memory for high-value words relative to low-value words. More importantly, they found differential patterns of brain activation in regions associated with semantic processing as a function of value. Scans showed greater activation in the left inferior frontal gyrus and left posterior-lateral temporal cortex during the encoding of high-value items relative to low-value items. The authors concluded that their data suggest differential engagement of semantic processing as a function of value, such that high-value items benefit from more semantic processing than low-value items. This work was later replicated and extended to older adults by Cohen and colleagues (2016) and is referred to from here on as the semantic engagement explanation.

The idea of differential semantic processing was adopted to explain patterns found in subsequent studies examining the value-directed remembering effect. For example, Hennessee and colleagues (2017) sought to examine the roles of familiarity and recollection in recognition-based value-directed remembering. More specifically, the authors in their first two experiments compared differences in recollection and familiarity as a function of value. Participants were asked to study 90 word-value pairs immediately before administering a 180 item recognition task, which consisted of 90 studied and 90 unstudied words. Using a modified remember/know design, participants were asked to determine if each word was new or old and then report if their decision reflected remembering or knowing the word. Further instruction was provided stating that a "remember" response should only be used if the participant could consciously recollect an experience with the word (i.e., recollection); however, a "know" response should be made if they recognize the word but were unable to recollect an experience with it (i.e., familiarity). Across both experiments, they found that value influenced recollection but not familiarity. The authors argue that "remember" responses are likely the byproduct of sufficient processing, whereas "know" responses are likely due to insufficient processing. In this example, the authors explained their results in terms of differential processing, arguing that high-value items benefitted from increased elaborative processing compared to low-value items. The work of Hennessee and colleagues (2017) argued for the potential of differential elaborative processing but fell short of directly testing their assumption.

The work of Cohen and Colleagues (2014) laid the foundation for a further investigation on the role of differential semantic processing, but the explanation would largely go untested until the work of Hennessee and colleagues (2019). Their second and third experiments sought to test the theory by holding semantic processing constant between high and low-value information. If differential semantic processing is the underlying mechanism of value-directed remembering, then forcing equal semantic processing between high and low-value items should eliminate any memory advantage for the high-value items. In both studies, participants were asked to study words arbitrarily associated with either high or low point values while simultaneously engaging in orienting tasks designed to induce differential levels of processing. The second experiment consisted of three conditions with different orienting tasks. The control condition provided no additional instructions beyond the typical value-directed remembering design. The other two conditions were designed to facilitate either non-semantic processing through the use of rote rehearsal or semantic processing through the use of mental imagery. Although slightly reduced in the mental imagery condition, overall memory performance was substantially better for high-value items in relation to low-value items across all three conditions. These findings seem at odds with the theory of differential semantic processing as holding semantic processing constant should have eliminated the effect, but the design of the study was inherently flawed. The assigned orienting tasks did not provide a mechanism to directly control adherence to the assigned orienting task, thus allowing participants to employ different processing tasks at their discretion. This idea is substantiated by the self-report data collected at the end of the study, which indicated that participants engaged in multiple types of encoding strategies above and beyond the one instructed (i.e., rote rehearsal or imagery). To this end, it is possible that participants in the mental imagery condition selectively ignored the orienting task instructions and engaged in other encoding strategies making it impossible to infer the role of holding semantic processing constant.

This design flaw was corrected in the third experiment conducted by Hennessee and colleagues (2019) by changing the orienting tasks. The control condition remained the same; however, non-semantic processing was facilitated by a constant counting task, while semantic processing was facilitated by a sentence generation task. The two new orienting tasks required verbal responses from participants, which provided an index of adherence to the assigned orienting task. Beyond these modifications, the approach was the same as the second experiment. The value-directed remembering effect persisted in the control condition but was eliminated in the conditions that facilitated either non-semantic or semantic processing equally between high and low-value items. Holding semantic processing constant eliminated value-directed remembering, which Hennessee and colleagues (2019) argued provided support for the notion of differential semantic processing as the underlying mechanism of value-directed remembering. The issue, however, is that it does explain why engagement in differential semantic processing yields better memory for high-value information.

The Role of Item-Specific Processing. It has been argued that semantic processing induces increased processing of unique aspects of meaning (i.e., item-specific processing), making the items more discernable at retrieval and boosting memory performance (Jacoby & Craik, 1979; Lockhart, Craik, & Jacoby, 1976). McDonough and Colleagues (2015) made a similar argument for the role of item-specific processing in value-directed remembering, but they framed it in terms of the distinctiveness heuristic. According to the distinctiveness heuristic, some aspect of an event is perceived as distinct, which induces a metacognitive judgment that the information will be better remembered, the retrieved information is then monitored for the existence or absence of this judgment (Schacter, Israel, & Racine, 1999; but also see Hunt, 2012). In this account, retrieval monitoring is the key component, but as McDonough and colleagues (2015) proposed, the facet of perceived distinctiveness is derived from the processing of item-specific details. To test this notion, the authors varied the degree of retrieval monitoring while also examining the impact of value-directed remembering on false recognition across three experiments. In their first experiment, they used a criterial recollection task. They introduced words not paired with values to serve as lures during the familiarization phase, which proceeded the value-study phase. In the value-study phase, to-be-remembered target words paired with points were presented in lists associated with either high, medium, or low values. Three separate recognition tests were administered to assess memory for high, medium, and low-value items following the study phases. In each test, the participant was tasked with identifying the presented word as either belonging or not belonging to the tested category (i.e., High-value test: was this item a high-value word?). Each test consisted of 16 items with an equal number of items belonging to the high, medium, low, no-value, or both categories (i.e., both the familiarization and the value phases). Participants were instructed to make a "yes" response only if they recalled the word as being studied in the specific category of the test. For example, if the item was studied in the high-value list, the participant should make a "yes" response for that item if it were to appear on the high-value test, otherwise, a "no" response was most appropriate.

The data from the first study conducted by McDonough and colleagues (2015) indicate an increase in correct source attribution and a decrease in source misattribution to lures as a function of value. Participants were more accurate in identifying targets and rejecting distractors for high-value items than for either medium or low-value items. The data seemingly suggest that compared to medium or low-value items, high-value items are monitored more effectively. The authors also suggest that the increased monitoring was the by-product distinctiveness derived from the processing item-specific details (i.e., the distinctiveness heuristic). The work done by McDonough and Colleagues (2015) is intriguing and seemingly provides support for the role of item-specific processing, but it fails to establish item-specific processing as the sole driving mechanism of value-directed remembering. Furthermore, it did not precisely exert control of item-specific processing and required the assumption that high-value items, but not medium or low-value items, benefit from item-specific processing and thus distinctiveness. This approach also completely disregards other research that has highlighted the potential role of other processes, such as relational processing (Bui et al., 2013). The design employed by McDonough and colleagues (2015) across all three experiments did not directly control for or assess the potential role of relational processing. Therefore, relational processing cannot be entirely dismissed.

The Role of Relational Processing. The semantic engagement explanation proposed by Cohen and colleagues (2014; 2016) and nearly all subsequent work that followed has ignored the potential role of relational processing. Despite this, there is some evidence within the literature suggesting that relational processing plays an important role within value-directed remembering. One such study was conducted by Bui and colleagues (2013), who aimed to explore the underlying mechanism driving the accuracy cost associated with value-directed remembering (i.e., value-directed remembering often induces an increase in false alarms relative to control conditions). The authors based their approach upon the basic ideas of the Fuzzy Trace Theory (FTT) and the activation/monitoring framework, which suggest that item-specific and relational processing should have different effects on false memory (Reyna & Brainerd, 1995; Roediger, Balota, & Watson, 2001). Bui colleagues (2013) argued that item-specific processing, as introduced in the previous section, will reduce false memory. Conversely, the authors argue that the processing of similarity amongst to-be-remembered items, or relational processing, would increase false memory. These predictions are largely supported by the literature, which indicates that facilitating relational processing often yields a substantial increase in false memory relative to conditions in which item-specific processing is facilitated (McCabe, Presmanes, Robertson, &

Smith, 2004).

To test this theory, Bui and colleagues (2013) employed a modified DRM paradigm with two different conditions. Participants in both conditions were told to maximize their score on an upcoming memory test. The control condition received no further instruction, but the authors facilitated item-specific processing in the item-specific condition by asking participants to think about the distinctive features of the items that distinguished them from one another. The authors reasoned that facilitating item-specific processing should hinder relational processing, and such, they expected to see a decrease in false memory in the item-specific condition relative to the control condition. In contrast, the authors argued that facilitation of item-specific processing should have no impact on true memory, and thus value-directed remembering would persist. In line with their predictions, the results indicated that facilitating item-specific processing had no impact on true memory or value-directed remembering. The facilitation of item-specific processing and value both influenced false memory. False memory increased as a function of value in the control condition but not the item-specific condition. Although no difference in false memory rates for low or medium-value items occurred between the conditions, false memory rates were substantially greater for high-value items in the control condition relative to the item-specific condition. To explain the patterns found, Bui and colleagues (2013) argued that facilitating item-specific processing hindered relational-processing, which subsequently reduced false memory rates as a function of value. They argued that the data suggest that relational processing plays a critical role in value-directed remembering.

At its core, relational processing, or the processing of similarity amongst items, is a mechanism by which items can be grouped into categories. According to Hunt (2012), this process is thought to be mostly spontaneous when a sufficient number of exemplars from a category are presented, lending credence to the notion that the nature of the study materials can influence or facilitate relational processing. The value-scheme most often employed within value-directed remembering explicitly categorizes items into high or low-value group membership. The materials used, in this case, the value scheme, may induce or facilitate the use of relational processing as participants try to organize the to-be-remembered items at encoding. Although it was not a primary point of their study, Middlebrooks and Castel (2018) noted that participants clustered their recall responses by value, often recalling clusters of high-values items before recalling clusters of low-value items. The authors conducted no further analysis, and beyond the short note, no additional details were provided. Nonetheless, Middlebrooks and Castel (2018) highlight the potential role of some form of underlying organization within value-directed remembering. More specifically, it could be the case that items are organized in groups by their assigned value and later recalled in a similar fashion, leading to value-directed clustering in recall. It is also important to note that relational processing has been found to be beneficial to memory performance (Epstein, Phillips, & Johnston, 1975; Begg, 1978), and since both high and low-value information is seemingly supported by relational processing, it seems logical that it would benefit overall memory for both. Universal relational processing seems well equipped to explain other phenomena within value-directed remembering, more specifically, why participants were able to perform well on surprise recognition tasks for both high and low-value information (Castel et al., 2007). In this case, both high and low-value items may have benefited from relational processing, which in turn influenced recognition performance.

The potential role of relational processing in value-directed remembering has mostly been overlooked, and the most recently published theory ignores it entirely. The semantic engagement explanation proposed by Cohen and colleagues (2014; 2016) and nearly all subsequent work that followed has failed to provide a mechanistic explanation of value-directed remembering, as these explanations do not address how the additional semantic processing results in better memory for the high-value items. Furthermore, none of these most recent studies have considered the potential role of relational processing, much less how relational processing and item-specific processing may jointly influence value-directed remembering. Exploring the potential joint action of relational and item-specific processing may provide a mechanistic explanation of value-directed remembering.

A New Theoretical Approach

The prior two sections discussed the potential roles of item-specific and relational processing in value-directed remembering; however, these two types of processing have so far been treated as separate if not competing mechanisms. The following section aims to explore how these two types of processing may jointly influence value-directed remembering. The joint action of relational and item-specific processing is not a new concept to memory research; this joint action is often referred to as distinctive processing. By definition, distinctive processing is simply the processing of differences (i.e., item-specific processing) in the context of similarity (i.e., relational processing) and has been found to improve memory (Hunt, 2003; Hunt, 2012). Several studies have suggested a benefit of either relational or item-specific processing; however, memory performance is often optimized when both types of processing are engaged simultaneously (Epstein et al., 1975; Begg, 1978, but see Hunt, 2012, for further explanation).

Reexamining the value-directed remembering literature in terms of joint relational and item-specific processing highlights a logical flaw that has been repeated several times. For instance, Bui and colleagues (2013) argued that facilitating item-specific processing inhibited relational processing; however, a large body of literature has demonstrated that facilitating item-specific processing has no impact on relational processing (Hunt & Einstein, 1981; Hunt & Seta, 1984; Hunt & McDaniel, 1993). To this extent, it is clear that Bui and colleagues (2013) failed to control for relational processing. Furthermore, the design employed by the authors did not directly control for item-specific processing either. The authors argued that they facilitated item-specific processing by asking participants to think about the distinctive features of the items that distinguished them from one another. No part of this manipulation provides a measure of adherence to item-specific processing, and therefore it is possible that participants did so selectively or perhaps not at all.

A similar logical flaw was employed by Hennessee and colleagues (2019), which is currently the only published test of the semantic engagement explanation provided by Cohen and colleagues (2014; 2016). As discussed earlier, Hennessee and colleagues' (2019) second experiment was flawed in that it failed to measure adherence to the assigned orienting task and did not directly control for relational processing. The authors corrected the former issue in their third experiment by changing the orienting task to require a verbal response but failed to address the later issue. Given that facilitating item-specific processing does not inhibit relational processing (Hunt & Einstein, 1981; Hunt & Seta, 1984; Hunt & McDaniel, 1993), it is plausible that participants across all conditions engaged in both types of processing.

The joint action of relational and item-specific processing has not been directly tested within the value-directed remembering paradigm. The semantic engagement explanation, as proposed by Cohen and colleagues (2014; 2016), argues for differential semantic processing (i.e., the processing of unique aspects of meaning), which disproportionately benefits high-value items relative to low-value items. In contrast, the work of Bui and colleagues indicates that all items benefit from relational processing. To this extent, it is plausible that low-value items only benefit from relational processing, but high-value items benefit from the joint action of item-specific and relational processing (i.e., distinctive processing).

Distinctive processing, in which item-specific and relational processing play separate but important roles to support better memory performance, provides an explanation for why high-value items are better remembered. More specifically, relational processing restricts the search to a smaller subset of targets, and item-specific processing makes the targets within that subset more discernable (Hunt, 2012). The semantic engagement explanation provided by Cohen and colleagues (2014; 2016) only addresses the item-specific component and fails to address the relational processing component; however, even the original fMRI data collected by the authors seemingly suggest the role of distinctive processing in value-directed remembering. Participants reliably demonstrated increased activity in both the left dorsolateral and left ventrolateral prefrontal cortices while engaging in a value-directed remembering task. Increased activity within the left ventrolateral prefrontal cortex has been linked to item-specific processing (Ragland et al., 2011; Badre & Wagner, 2007; Blumfenfield & Ranganath, 2006); however, the dorsolateral prefrontal cortex has been linked to relational processing (Hartogsveld, Bramson, Vijayakumar, Campen, Marques, Roelofs, Toni, Bekkering, & Mars, 2018; D'Esposito, Postel, Ballard & Lease, 1999; Wagner, Pare-Blagoev, Clark, Poldrack, 2001). From this data alone, Cohen and colleagues (2014; 2016) would be unable to disentangle the roles of relational and item-specific processing in value-directed remembering, much less dismiss the potential role of relational-processing.

Furthermore, Cohen and associates (2016) specifically mentioned increased activity in the ventrolateral prefrontal cortex during the encoding of high-value items but no value-related differences in activation within the dorsolateral prefrontal cortex. To this extent, it is plausible that relational processing occurs for both high and low-value items, whereas item-specific processing occurs differentially based on item value. Based on the data, it is reasonable to suggest that low-value items only benefit from relational processing. In contrast, high-value items benefit from the joint action of item-specific and relational processing (i.e., distinctive processing).

II. PILOT STUDIES

Before examining the role of distinctive processing in value-directed remembering, it is first necessary to address some of the logical flaws incorporated within the early studies. As discussed below, the first and second experiments conducted by Hennessee and colleagues (2019) employed a methodology that has been found to be less than conducive to value-directed remembering. Therefore, it is necessary first to establish that the patterns found by the authors were not merely an artifact of their design. This is addressed in the first pilot study. The second pilot study examines the independent roles of relational and item-specific processing.

Pilot Study 1

This study aimed to re-examine the semantic explanation by adjusting the methodologies employed by Hennessee and colleagues (2019) to ensure the authors' results were not an artifact of their design. The procedure for this study was a close replication of that used by Hennessee and associates (2019) and included conditions designed to facilitate equal semantic or non-semantic processing, as well as a control condition. These conditions did not differ from Hennessee and colleagues' (2019) third experiment; however, three significant revisions were made to the overall study design. First, multiple study lists were used as compared to a single study list. Prior research has shown that value effects are not fully potentiated until after list 3 (Castel et al., 2002; Castel et al., 2007). It remains possible that the lack of a value effect in Hennessee and colleagues' (2019) third experiment for the sentence generation condition was partially due to the presentation of only one list in which value effects were likely not fully potentiated.

Second, performance feedback was not provided at the end of each list by Hennessee and associates (2019). A great deal of research examining value-directed remembering has highlighted the importance of metacognitive monitoring afforded by intermittent feedback on memory selectivity (Castel et al., 2002; Castel et al., 2011). The use of a single list with no performance feedback may have limited the participant's ability to engage in metacognitive monitoring that might have hindered the utilization of effective encoding strategies. To this extent, it is possible that the value effect may have persisted in the sentence generation condition on later lists if participants were provided performance feedback.

Finally, the memory test was changed from a recognition measure to a free recall measure. Middlebrooks and associates (2017) compared recall and recognition measures in relation to value-directed remembering. They concluded that although overall performance was higher in the recognition task, evidence of value-directed remembering was greatest when a recall task was used. Furthermore, the third experiment by Hennessee and colleagues (2019) yielded performance levels close to ceiling in the sentence generation condition, which would have made the detection of any potential value-effects very difficult. The use of a free recall task instead of a recognition-based task may help reduce performance levels from ceiling while simultaneously encouraging increased selectivity.

Methods

Participants and Design. The sample (N = 119) consisted of younger adults (M_{Age} = 18.86 (Min: 18; Max: 33), *SD* = 1.73; 74.4% female; 94.9% non-Hispanic; 77.8% Caucasian) enrolled at the University of Mississippi recruited from undergraduate psychology courses. Two participants were excluded from the study, one for not signing the consent form and the other for continuously failing to provide verbal responses during the assigned orienting task. A G*Power

3.1.9 software analysis (Faul, Erdfelder, Lang, & Buchner, 2007) was conducted, which indicated that a sample size larger than 117 would provide a power of 0.90 for a medium effect size of 0.25. Participants received course credit for participation. This study was approved by the Institutional Review Board at the University of Mississippi.

Orienting task was manipulated between subjects, while value and list were manipulated within subjects. There were a total of three conditions in this study, and random assignment yielded 40 participants in the control, 38 in the consonant counting, and 39 in the sentence generation conditions. All participants in all conditions studied the same word-value pairs across all seven lists, and all received value-directed remembering instructions. The control condition received no additional instructions, the other two conditions received additional task instructions as described below. The primary dependent variables were participants' overall recall performance and value-directed remembering as measured by the proportion of items recalled from each value category.

Materials. Stimuli consisted of 174 concrete nouns drawn from clusters 6 and 7 of the Toglia and Battig (1978) word norms. All words were 4-8 letters long and have been rated on several dimensions using a 1-7 scale such as familiarity (range 5.5-7), concreteness/imagery (4-6.5), and pleasantness (2.5-5.5). These exact words were found to be reliable in numerous studies examining the value-directed remembering effect (Cohen et al., 2014; 2016). A total of six words were used as a practice trial. The remaining 168 words were divided into seven lists of 24 words. Each word was arbitrarily paired with either a high point value (10, 11, or 12) or a low point value (1, 2, or 3). Half of the words in the list were high-value words, and half were low-value words. The experiment was programmed in e-prime 3.0 (Psychology Software Tools, Pittsburgh, PA), and stimuli were displayed on a desktop computer. The experimenter recorded responses for the recall tests. Other responses were collected via the computer keyboard.

Procedure. Participants completed the study individually in a research lab. After providing consent, participants were given task instructions. The instructions for the practice trial and the main task were the same. All participants were told that they would be presented with a list of words, each paired with a point value they could earn for correctly remembering the word, with the goal of maximizing their score on an upcoming recall test. The control condition received no further instructions; however, the consonant counting and sentence generation conditions received additional instructions. In addition to the value instructions, participants in the consonant counting condition were instructed to mentally tally up the number of consonants in the word and then verbally report if that number was even or odd. Participants in the sentence generation condition were instructed to verbally generate a sentence using the presented word. When necessary, the experimenter reminded the participant to engage in the appropriate orienting task. The experimenter kept a record of these instances. All conditions completed a 6 item practice run before the main task and were provided an opportunity to ask any questions about the procedure.

Except for the additional task in the consonant counting and sentence generation conditions, the general procedure was the same between all conditions. After the practice trial, participants were presented the same instructions again before beginning the encoding phase of the first list. Each word-value pair was presented for 4s, with a fixation cross appearing for 1s between words. Once all 24 words in the list were presented, a screen appeared instructing the participant to begin the free recall portion of the task. The instructions asked participants to recall as many words from the previously studied list as possible in 60 seconds. Following the allotted amount of time for recall, the experimenter scored the recall performance for that list and informed the participant how many words they correctly recalled and their total point value earned. Once feedback was provided, the experimenter advanced the screen, which remained blank for 3s before the next list of 24 words was presented. This encoding, recall, and feedback cycle was repeated until the 7th, and final list was completed. After all lists were presented, participants completed a post-task questionnaire asking questions about their experience with the task. In addition, they were asked to complete a vocabulary task and a health and demographics questionnaire. Once all of these additional tasks were completed, the participant was debriefed and released.

Results

In some instances, a violation of sphericity occurred, as measured by Mauchly's Test. To address this, a Greenhouse-Geisser correction was performed to adjust the degrees of freedom.

Overall Recall. Initial analyses were conducted on overall recall performance. Independent of assigned value, the total number of correctly recalled words was calculated for each list. A 3 (Condition) x 7 (List) analysis of variance (ANOVA) revealed a significant main effect of condition, $F(2, 114) = 18.74$, $p < 0.001$, $\eta_p^2 = 0.25$. Additionally, a main effect of list was found, $F(5.30, 603.80) = 6.77$, $p < 0.001$, $\eta_p^2 = 0.06$. These main effects were qualified by an interaction between list and condition, $F(10.59, 603.80) = 2.91$, $p = 0.001$, $\eta_p^2 = 0.05$, as can be seen in the data in Figure 1. Follow-up analyses indicated that no difference between the lists occurred within the control condition, $F(2, 34) = 2.51$, $p = 0.062$, $\eta_p^2 = 0.284$. A significant main effect of list occurred within the non-semantic condition, $F(4.02, 148.71) = 3.38$, $p = 0.011$, $\eta_p^2 = 0.08$, with significant differences occurring between list two and four ($p = 0.006$) and lists two and five ($p = 0.019$), all other comparisons were non-significant. Likewise, a significant main effect of list occurred within the semantic condition, $F(6, 33) = 5.98$, $p < 0.001$, $\eta_p^2 = 0.52$.

Within the semantic condition, recall performance on the first list significantly differed from all other lists (ps <0.047) except for the fourth list ($p = 0.499$). No other comparisons were significant.

Proportion Recalled. To examine the influence of value on memory performance, proportions were calculated for high and low-value items on each list. These proportions were calculated by taking the number of high or low-value items recalled on a list and dividing each by the overall recall described in the paragraph above. For instance, to calculate the high-value proportion for list one, the total number of high-value words recalled on that list would be divided by the overall recall on the same list. A 3 (Condition) x 2 (Value) x 7 (List) mixed ANOVA revealed a significant main effect of value, $F(1, 114) = 106.21$, $p < 0.001$, $\eta_p^2 = 0.48$. This was qualified by an interaction between value and condition, $F(1, 114) = 23.43$, $p < 0.001$, $\eta_p^2 = 0.29$. The effect of value was further qualified by an interaction between list and value, $F(5.39, 614) = 5.26$, $p < 0.001$, $\eta_p^2 = 0.04$. The main effects and interactions were qualified by a three-way interaction between list, value, and condition, $F(10.79, 614) = 2.28$, $p = 0.01$, $\eta_p^2 = .04$. The three way interaction was investigated with separate 2 (value) x 7 (list) ANOVAs for each of the three conditions. This revealed a significant list by value interaction in the control condition, $F(6, 34) = 3.91$, $p = 0.004$, $\eta_p^2 = 0.41$, such that a greater proportion of high-value items were recalled relative to low-value items across all lists (ps <0.05); however, the effect of value was small for List 1 relative to the other lists. Similarly, a significant list by value interaction was found in the non-semantic condition, $F(4.66, 172.29) = 4.84$, $p = 0.001$, $\eta_p^2 = 0.12$. There was no effect of value on List 1 ($p = 0.966$) or List 2 ($p = 0.067$), but a greater proportion of high-value items relative to low-value items were recalled on all other lists in the non-semantic condition (ps ≤ 0.034). No list by value interaction was found within the semantic condition, $F(6, 33) = 1.30$, $p = 0.286$, $\eta_p^2 = 0.19$ and no other comparisons were significant (ps > 0.067). These results are depicted in Figure 2.

Discussion

This study aimed to reexamine the semantic engagement explanation while correcting some of the methodological limitations of the second and third experiments conducted by Hennessee and colleagues (2019). The current study employed multiple study lists, free recall measures, and performance feedback, all of which have been shown to play pivotal roles within value-directed remembering (Castel et al., 2002; Castel et al., 2007; Castel et al., 2011; Middlebrooks et al., 2017). Adjusting the study design to incorporate these considerations allows for a more robust examination of differential semantic processing within value-directed remembering.

If differential semantic processing is the driving mechanism of value-directed remembering as argued by Cohen and associates (2014; 2016), holding it constant should eliminate the effect. When semantic processing was facilitated for all items within the current study, as it was in the semantic processing condition, value-directed remembering was inhibited. The patterns found within the current study replicated the main finding of Hennessee and colleagues' (2019) third experiment and lent additional support for the role of differential semantic processing within value-directed remembering.

The current study replicated the pattern found within the non-semantic condition of Hennessee and colleagues' (2019) third experiment. Using a single list, the authors found no evidence of value-directed remembering when non-semantic processing was held constant. Likewise, the current study also showed no effect of value on List 1, however, the effect of value was significant on subsequent lists and followed a similar trajectory in the non-semantic condition as the control condition. From this pattern, it is clear that facilitating equal non-semantic processing was not sufficient to eliminate value-directed remembering, providing additional support for the specific role of differential semantic processing.

Pilot Study 2

The first study addressed some of the methodological limitations of prior research and found support for the role of differential semantic processing; however, it did not directly assess how semantic processing leads to better memory performance. The second pilot study examined the roles of item-specific and relational processing within value-directed remembering by directly facilitating both types of processing using different orienting tasks. In line with work done by Hunt and Seta (1984), independent indices of relational processing and item-specific processing were assessed (i.e., clustering and items per category, respectively).

Study 2 employed six conditions that differed as a function of instruction type (value or no value) and orienting task (control, pleasantness rating, or category sorting. A pleasantness rating orienting task facilitated equal item-specific processing for all items. Equal relational processing was facilitated for all items using a category sorting task. No additional orienting tasks were required in the control conditions. Half of the participants completing each orienting task were given value instructions, while the other half were not given value instructions (e.g., control with value, control no value). Conditions provided value instructions were told to remember as many words as possible while also maximizing their score on an upcoming memory test. Conditions without value instructions were only told to remember as many words as possible. In total, participants were presented with five different lists of to-be-remembered words, each of which was followed by a free recall test. More detail about the different conditions can be found within the participants and design section below.

Predictions

Proportion of Items Recalled.

With Value Instructions. If item-specific processing is the underlying mechanism of differential semantic processing, then holding it constant across high and low-value items through the use of a pleasantness rating task applied to all list items should eliminate value-directed remembering. This leads to the prediction that the effect of value on the proportion of items recalled will not be significant for participants in the pleasantness rating value condition. In contrast, when item-specific processing is not held constant in the control value and category sorting with value conditions, the effect of value on the proportion of items recalled is predicted to be significant, with a greater proportion of high-value relative to low-value items recalled[1].

Without Value Instructions. When value instructions are not provided, value-directed remembering, as indicated by the recall of a greater proportion of high relative to medium or low-value items, is not expected to occur. Because the orienting tasks are applied to both high and low-value items, memory for high and low values items will not differ within each of the three no value conditions.

Items Per Category.

With Value Instructions. Item-specific processing is held constant in the pleasantness rating conditions thus the effect of value on the number of items recalled per category should not be significant for the pleasantness rating value condition. Item-specific processing is not held constant in the control value and category sorting value conditions and the number of items recalled per category is predicted to vary as a function of value, with a greater number of items

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[1] As in Study 1, multiple lists are studied and recalled by each participant. When an effect of value is predicted, it is understood that the effect of value may not be present on earlier lists, but will emerge as additional lists are studied and recalled.

recalled from the high relative to low-value category.

Without Value Instructions. Without value instructions the numbers associated with each word have no special meaning in this context. Therefore, we would not expect any specific value category to repeatedly benefit from an increase in item-specific processing and there should be no effect of value on items recalled per category in the no value conditions. As argued by Einstein and Hunt (1980), the processing of inter-item relationships among items of an unrelated list of words likely obligates item-specific processing, thus making its facilitation through the pleasantness rating task superfluous. If this is true, then facilitating item-specific processing through the pleasantness rating task within the current study should not produce differences in the overall number of items recalled per category relative to the control and category sorting conditions.

Category Clustering.

With Value Instructions. The patterns of brain activation found by Cohen and associates (2014; 2016) further suggest the role of relational processing. Based on their data, it seems likely that all items in the value conditions benefit from relational processing. If this is true, then holding relational processing constant through the use of a category sorting task should have no influence on clustering relative to other value conditions. Specifically, this leads to the prediction that clustering will not vary between the control, category sorting, or pleasantness rating conditions that also include value instructions. Despite the absence of value instructions, the category sorting task facilitates relational processing in the same manner as the conditions with value instructions (i.e., based upon the number assigned to the words). Because of this, clustering is not predicted to differ from that of the conditions with value instructions. In contrast, the control no value condition is predicted to produce less clustering relative to the control value condition. This is because relational processing based upon the assigned numbers is not directly facilitated, and the lack of value instructions makes it unlikely that participants will spontaneously use that information to engage in relational processing in the no value control condition.

Method

Participants and Design. Due to the global pandemic, this study was conducted entirely online using Qualtrics. Two participants were excluded because over 75% of the items they recalled were intrusions (i.e., the words recalled were almost entirely non-presented items), one participant was excluded for writing the words down during encoding, and one was excluded because they failed to complete the study. Accounting for these exclusions, the final sample[2] (n = 269) consisted of undergraduate students (M_{Age} = 18.96 (Min: 18; Max: 32), *SD* = 1.40; 72% female; 89.63% non-Hispanic; 75.16% Caucasian) enrolled in introductory psychology courses at The University of Mississippi.

This study implemented a 2 (Instruction Type: Value, No Value) x 3 (Orienting Task: Control, Category sorting, Pleasantness Rating) x 3 Value (High, medium, low) x 5 (List) mixed factorial design. Instruction type and orienting task were manipulated between subjects. Conditions with value instructions were told that they would be presented with a list of words, each paired with a point value they could earn for correctly remembering the word, with the goal of remembering as many words as possible and maximizing their score on an upcoming recall test. Conditions without value instructions were told that they would be presented with a list of words, each paired with a number, with the goal of remembering as many words as possible on

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[2] The software automatically recorded a data file every time a participant clicked on the study link; however, it appears from the recorded files that some potential participants often closed their browser immediately after the study loaded. In these instances, the individual only saw the welcome screen but did not begin the study, thus no experimental data was collected. The reported sample size does not include these instances.

an upcoming recall test.

Within each instruction condition, participants were assigned to one of three orienting tasks. Participants assigned to the control conditions were provided with no additional instructions. Those in the category sorting conditions were instructed to group the presented words into one of three categories by selecting the appropriate group option presented below the word. Items paired with a 30 were to be sorted into the "H" group, while those paired with a 20 belonged to the "M" group, and those paired with a ten belonged to the "L" group. This condition was designed to facilitate relational processing. Participants in the pleasantness rating condition were instructed to rate the pleasantness of each word. Participants were provided three options to choose from, pleasant, neutral, or unpleasant, and they made their selection by clicking on the appropriate option. The computer program automatically recorded participant responses and this record was used to measure adherence to the assigned orienting task.

Materials. Stimuli consisted of 126 concrete nouns drawn from clusters 6 and 7 of the Toglia and Battig (1978) word norms. All words were 4-8 letters long and have been rated on several dimensions using a 1-7 scale such as familiarity (range 5.5-7), concreteness/imagery (4-6.5), and pleasantness (2.5-5.5). These same words were found to be reliable in numerous studies examining the value-directed remembering effect (Cohen et al., 2014; 2016). A total of six words were used as a practice trial; the remaining 120 words were divided into five lists of 24 words. Each word was arbitrarily paired with either a high (30), medium (20), or a low-value (10). The number of study lists was reduced from the first experiment to shorten the length of the study and thus reduce participant fatigue. The patterns found in the relevant measures were consistent after list five in the first study, so reducing the number of lists was not expected to alter the general patterns found. Medium value items were included to equate the number of response options between the category sorting and pleasantness rating conditions. Beyond these changes, the materials used were nearly identical to those in the first pilot study. Point values were evenly distributed within each list such that each list contained eight words from each respective point value (i.e., eight high, eight medium, and eight low-value words per list). The experiment was built and conducted using Qualtrics, with all instructions, stimuli, and tasks displayed digitally to the participant. All participant responses were collected online.

Procedure. Participants were randomly assigned to conditions by the computer program. The initial screen welcomed participants to the study; once they acknowledged that they were ready to begin, a consent form was displayed on the screen. After providing consent, participants were given task instructions. The instructions for each condition varied from one another; however, the instructions provided during the practice trial were the same as the instructions provided for the main task.

Except for the additional task in the category sorting and pleasantness rating conditions, the general procedure was the same for all conditions. After the practice trial, participants were presented the same instructions again before beginning the encoding phase of the first list. Each word-value pair was presented for 4s. Once all 24 words in the list were presented, a screen appeared with instructions for the recall test. Participants were told that they would have 60 seconds to recall as many words as possible from the list they had just studied. Once the participant was ready to begin the recall test, they clicked an arrow to advance the screen, and they were given 60 seconds to type the words they recalled in a free response box. Once time was up, participants were reminded of the task instructions before beginning the next list. This encoding, recall, and instruction reminder cycle was repeated until the 5th, and final list was completed. After all lists were presented, participants completed a post-task questionnaire asking questions about their experience with the task. In addition, they completed a vocabulary task and a health and demographics questionnaire before being debriefed. These measures were included to further explore any potential differences between the conditions that might influence overall task performance. Unfortunately, a substantial portion of participants clicked through the vocabulary task without responding to individual items.

Results

The data were analyzed in terms of overall recall performance, proportion recalled (i.e., the index of value-directed remembering), clustering (i.e., the index of relational processing), and items per category (i.e., the index of item-specific processing). Only the key analyses related to the hypotheses outlined in the introduction of this study are detailed here. In some instances, a violation of sphericity occurred, as measured by Mauchly's Test, and in these cases a Greenhouse-Geisser correction was performed to adjust the degrees of freedom.

Overall Recall. To calculate overall recall performance, the total number of words correctly recalled on each list was summed and used as the variable of interest in the following analysis. A 2 (Instruction Type) x 3 (Orienting Task) x 5 (List) three-way ANOVA, revealed that overall recall performance did not differ as a function of instruction type, $F(1, 263) = 0.708$, $p = 0.141$, $\eta_p^2 = 0.001$. Participants in the value conditions ($M = 8.61$, $SE = 0.35$) recalled a similar number of items across all lists as participants in the no value conditions ($M = 8.43$, $SE = 0.35$). Likewise, overall recall performance did not differ as a function of orienting task, $F(2, 263) = 0.609$, $p = 0.545$, $\eta_p^2 = 0.01$. Across all lists, participants in the control conditions ($M = 8.87$, $SE = 0.43$), category sorting conditions ($M = 8.21$, $SE = 0.43$), and pleasantness rating conditions ($M = 8.48$, $SE = 0.41$) demonstrated similar overall recall performance. There was no main effect of list nor were any of the interactions significant (ps > 0.08).

Proportion Recalled. Proportions were calculated for each list and value category by taking the number of items recalled on that list for each value and dividing it by overall recall for that same list. For instance, to calculate the proportion of high-value items recalled on list one, the total number of high-value words recalled on that list would be divided by the total number of words recalled on that same list. To directly test the relevant hypotheses detailed in the introduction of this study, a series of repeated measures ANOVAs were conducted for each of the three orienting tasks both with and without value instructions. Although all relevant statistics are reported in each respective table, only the most pertinent results to the predictions detailed in the introduction to this study are discussed in the text.

Conditions with Value Instructions. The following analyses were conducted for conditions with value instructions. All relevant statistics can be found in Table 1.

To determine if value-directed remembering occurred when item-specific processing was held constant, a 3 (Value) x 5 (List) repeated measures ANOVA was conducted for the pleasantness rating with value condition. The only significant finding was a value by list interaction. This interaction was explored through a series of ANOVAs conducted for each list. As the data in Figure 3 depict, a greater proportion of low relative to high-value items were recalled on the fourth list ($p = 0.038$) and a greater proportion of high relative to medium-value items were recalled on the fifth list ($p = 0.005$). No other comparisons were significant (ps $\geq$ 0.224). As predicted, when item-specific processing was held constant, participants did not consistently demonstrate value-directed remembering.

For the control with value condition, a 3 (Value) x (5 (List) repeated measures ANOVA revealed a significant interaction between value and list. The data for this interaction can be found in Figure 4. A greater proportion of medium relative to low-value items were recalled on the second list ($p = 0.008$). A greater proportion of high relative to low-value items were recalled on the third list ($p = 0.042$) while a greater proportion of high relative to medium-value items were recalled on the fourth list ($p = 0.016$). On the final list, a greater proportion of high relative to low ($p < 0.001$) and a greater proportion of medium relative to low-value items were recalled ($p < 0.001$). No other comparisons were significant (ps ≥ 0.148). As predicted, when item-specific processing was not held constant, participants reliably demonstrated value-directed remembering.

In the category sorting with value condition, a 3 (Value) x (5 (List) repeated measures ANOVA revealed a significant main effect only for value. A greater proportion of high (M = 0.39, SE = 0.02) relative to medium-value items (M = 0.29, SE = 0.02) were recalled ($p = 0.001$). Likewise, a greater proportion of high relative to low-value items (M = 0.31, SE = 0.02) were recalled ($p = 0.017$). The difference in the proportion of medium relative to low value items recalled was not significant ($p = 447$). As predicted, participants reliably demonstrated value-directed remembering when item-specific processing was not held constant.

Conditions without Value Instructions. The following analyses were conducted for conditions without value instructions. All relevant statistics can be found in Table 2.

A 3 (Value) x 5 (List) repeated measures ANOVA was conducted for the pleasantness rating no value condition, which revealed that neither of the main effects nor the interaction were significant. As predicted, when item-specific processing is held constant and value instructions are not provided, value had no influence on the proportion of items recalled.

A 3 (Value) x 5 (List) repeated measures ANOVA was conducted for the control no value condition, which revealed a significant value by list interaction. As the data in Figure 5 depict, this interaction was driven by a greater proportion of medium relative to low-value items recalled on the second list (*p* = 0.034) and a greater proportion of high relative to low (*p* = 0.036) and medium-value items (*p* = 0.009) recalled on the third list (*p* = 0.005). No other comparisons were significant (*p*s ≥ 0.056). As predicted, a greater proportion of high relative to medium or low-value items were not reliably recalled across lists when value instructions were not provided.

A 3 (Value) x 5 (List) repeated measures ANOVA was conducted for the category sorting no value condition, which revealed a significant value by list interaction. This interaction was driven by a greater proportion of low (*M* = 0.37, *SE* = 0.02) relative to high-value items (*M* = 0.25, *SE* = 0.03) being recalled on the fourth list (p = 0.009). No other comparisons were significant (*p*s ≥ 0.172). As predicted, without value instructions participants did not reliably recall a greater proportion of high relative to low-value items and thus did not demonstrate value-directed remembering.

Items Per Category. Recall data were further analyzed to examine the role of item-specific processing, as indexed by the number of items correctly recalled from each category. The total number of high, medium, and low-value items correctly recalled on each list were recorded. A series of repeated measures ANOVAs were conducted for each of the three orienting tasks to directly assess the predictions mentioned in the introduction to this study. Only the most pertinent results are discussed in this section, but all relevant statistics can be found in each respective table.

Conditions with Value Instructions. The following analyses were conducted for conditions with value instructions. All relevant statistics can be found in Table 3.

A 3 (Value) x 5 (List) repeated measures ANOVA was conducted for the pleasantness rating with value condition to determine if item-specific processing varied as a function of value. This analysis revealed a significant interaction between value and list. A series of ANOVAs were conducted for each list, which revealed that this interaction was driven by a greater number of items recalled from the high (*M* = 3.08, *SE* = 0.31) relative to low-value (*M* = 2.45, *SE* = 0.31) category on the fifth list (*p* = 0.014). No other comparisons were significant (*p*s ≥ 0.089). As predicted, when item-specific processing was held constant, the number of items recalled did not reliably differ as a function of value.

To address the same question within the control value condition, a 3 (Value) x (5 (List) repeated measures ANOVA was conducted. This analysis revealed a significant interaction between value and list. This interaction was driven by a greater number of items from the high-value category relative to low-value category being recalled on all lists except the first (*p*s ≤ 0.04). More items from the high-value category relative to the medium-value category were recalled on the third (*p* = 0.022) and fourth lists (*p* = 0.03) and a greater number of medium relative to low-value category items were recalled on list two (*p* = 0.04) and five (*p* ≤ 0.001). All other comparisons were non-significant (*p*s ≥ 0.243). The data for this interaction is depicted in Figure 6. As predicted, when item-specific processing was not held constant, the number of items recalled per category varied as a function of value such that a greater number of high relative to low-value category items were recalled.

The same approach was taken to assess the influence of value on item-specific processing in the category sorting with value condition. A 3 (Value) x 5 (List) repeated measures ANOVA revealed a significant main effect of value. A greater number of items from the high-value category (*M* = 3.21, *SE* = 0.24) were recalled relative to either medium (*M* = 2.56, *SE* = 0.23, *p* = 0.005) or low-value category items (*M* = 2.47, *SE* = 0.22, *p* = 0.008). No significant difference between high or medium-value category items occurred (*p* = 1.00).

Conditions without Value Instructions. The following analyses were conducted for conditions without value instructions. All relevant statistics can be found in Table 4. A 3 (Orienting Task) x 5 (List) repeated measures ANOVA was conducted. The only significant finding was a main effect of list. The mean number of items recalled per category on the third list (*M* = 3.21, *SE* = 0.24) relative to the second list (*M* = 2.56, *SE* = 0.23) was significantly greater (*p* = 0.018). No other comparisons were significant (*p*s ≥ 0.059).

Clustering. To examine the potential role of relational processing within-value-directed remembering, clustering within recall was measured using the List-Based Semantic Clustering Index (LBC). The LBC has been demonstrated to be a reliable index of relational processing within free recall data and has several advantages over other measures (Frender & Doubilet, 1974). The LBC is calculated by subtracting the number of clusters expected to occur by chance within recall data from the number of observed clusters that occurred. The number of clusters by chance can be calculated by computing the product of the total number of correct words recalled minus one and the number of items in each category minus one. This product would then be divided by the total number of words in the original list minus one. In this study, each list contained 24 items consisting of three categories with eight items in each category. Therefore, the number of items in each category is held constant at eight, and the total number of words in the original list is held constant at 24. For this study, the number of clusters expected by chance would be calculated by multiplying the number of words correctly recalled by seven and dividing the product by 23. An LBC score was calculated for each list and used in the following analyses.

In line with the predictions outlined in the introduction, the control value condition was compared with all others in a series of repeated measures ANOVAs. A 2 (Condition) x 5 (List) repeated measures ANOVA was conducted to determine if a difference in clustering occurred between the control value and control no value condition. This analysis revealed a significant interaction between condition and list, $F(3.37, 226.54) = 2.79$, $p = 0.035$, $\eta_p^2 = 0.03$. A series of ANOVAs were conducted for each list to tease apart this interaction. These analyses revealed a nearly significant ($p = 0.055$) difference in clustering between the control value ($M = 2.76$, $SE = 0.24$) and the control no value ($M = 2.18$, $SE = 0.19$) conditions on the fourth list. Likewise, a significant ($p = 0.025$) difference in clustering occurred between the control value ($M = 2.80$, $SE = 0.24$) and the control no value ($M = 2.11$, $SE = 0.19$) conditions on the fifth list. No other comparisons were significant (ps ≥ 0.196). As predicted, clustering did differ between the control conditions.

To determine if clustering differed as a function of list between the control value and the relational value conditions, a 2 (Condition) x 5 (List) repeated measures ANOVA was conducted. This analysis revealed that neither of the main effects, nor the interaction were significant (ps ≥ 0.143). Likewise, a 2 (Condition) x 5 (List) repeated measures ANOVA was conducted to determine if clustering differed as a function of list between the control value and relational no value conditions, which revealed no significant effects (ps ≥ 0.108). As predicted, using an orienting task to facilitate relational processing did not elicit an increase in clustering beyond that thought to occur by default within the control value condition.

A 2 (Condition) x 5 (List) repeated measures ANOVA was conducted to determine if clustering differed between the control value and pleasantness rating value condition. The interaction, nor any of the main effects were significant (ps ≥ 0.108). As predicted, when value instructions were provided no difference in clustering occurred between the control value and pleasantness rating value conditions. To address the same question between the control value and pleasantness rating no value conditions, a 2 (Condition) x 5 (List) repeated measures ANOVA was conducted. After correcting the degrees of freedom using a Greenhouse-Geisser correction to account for a violation of sphericity, this analysis revealed a significant main effect of list, $F(3.56, 305.97) = 2.84$, $p = 0.030$, $\eta_p^2 = 0.03$. Participants demonstrated significantly ($p = 0.007$) lower levels of clustering on the second list ($M = 2.25$, $SE = 0.14$) relative to the fourth list ($M = 2.67$, $SE = 0.17$). Although the main effect of condition was non-significant ($p = 0.428$), the interaction between condition and list was nearly significant, $F(4, 344) = 2.34$, $p = 0.055$, $\eta_p^2 = 0.03$. A series of ANOVAs were conducted for each list to determine where differences may exist. These analyses revealed no significant difference between the two conditions as a function of list (ps ≥ 0.078). As predicted, no difference in clustering occurred between the control value and pleasantness rating no value conditions in the absence of value instructions.

Discussion

This study sought to determine if engagement in item-specific processing differed as a function of value, with high-value items disproportionately benefitting relative to medium or low-value items. To explore this, item-specific processing was facilitated by using a pleasantness rating task. As predicted, value-directed remembering as measured by the proportion of high and low-value items recalled was eliminated when item-specific processing was held constant through the use of the pleasantness rating task, suggesting that in a standard VDR paradigm, all items do not benefit from item-specific processing. This pattern of results is largely in line with the semantic engagement explanation and further replicates the patterns found by Hennessee and colleagues' (2019) third experiment and the first pilot study reported in this paper. The data suggest that the elimination of value-directed was primarily driven by an increase in item-specific processing for medium and low-value items, as there was no apparent difference in the number of items recalled between the three value categories. In contrast, participants in the control value and relational value conditions generally recalled more high-value category items relative to low-value category items but not always medium-value category items, suggesting that high-value items disproportionately benefit from item-specific processing.

Prior research suggests that the nature of the study materials may induce spontaneous relational processing (Hunt, 2012). Value-directed remembering employs an explicit value scheme in which items are already categorized, which participants likely use to organize the to-be-remembered items at study. To this extent, it remains possible that all items benefit from relational processing. To test this idea, relational processing was held constant within the relational value condition through a category sorting task. If the default type of processing occurring within value-directed remembering is relational processing, facilitating it should be redundant and have no impact on either value-directed remembering or clustering. The data from the current study support this notion as facilitating equal relational processing did not inhibit value-directed remembering nor did it increase relational processing, as indexed by clustering scores and measured by the LBC. This pattern further suggests that all items benefit from relational processing and that facilitating it equally was redundant with the processing occurring by default. In this sense, the relational value and control value conditions are functionally equivalent in that differential item-specific processing is unhindered, and the default relational processing facilitated within the relational value condition is redundant. This point is well illustrated by the data. Participants in the control value and relational value conditions demonstrated almost identical patterns in the proportion of items recalled, overall recall performance, and the number of items recalled per category.

One of the main assumptions of the current study is that the value instructions induce relational processing for all items on the dimension of the assigned value. This assumption was supported by the difference in clustering found between the control value and control no value condition. While this difference only arose after the third list, that may be related to the fact that the value-directed remembering effect only emerges on the later lists. This pattern points to a role of relational processing in explaining that delayed emergence; namely, it is possible that processing of high and low-value items as "categories" does not occur as readily on the earlier lists. This emergence may be attributable in part to the fact that there is no inherent relationship between the words and the assigned category, in contrast to studies of relational processing that have involved semantic categories, where relational processing may occur more spontaneously.

The results from the current study directly contradict the argument made by Bui and colleagues (2013) that the two types of processing would counteract one another and work in competition. As predicted, value-directed remembering was demonstrated in both the control value and relational value conditions. Furthermore, facilitating equal item-specific processing by using a pleasantness rating task in the item value condition did not produce different levels of clustering between any of the conditions. These findings taken together make it clear that facilitating either type of processing does not inhibit the other type of processing.

The results obtained within this study suggest that both item-specific and relational processing play separate but important roles within value-directed remembering. More specifically, it appears that all items benefit from relational processing, whereas only high-value items benefit from item-specific processing. Although the current study furthers our understanding of the underlying mechanism(s) of value-directed remembering, it is limited in that it did not replicate the effects of value through the combination of item-specific and relational processing in the absence of value instructions themselves.

III. THE CURRENT STUDY

The current study built upon the second pilot study to further investigate the joint action of item-specific and relational processing within value-directed remembering. Each type of processing can be facilitated in a host of different ways. For instance, it has been argued that the nature of the study material may facilitate or influence relational processing (Hunt, 2012); more specifically, the value categories provide a structure for relational processing of the list items. The data from the second pilot study support this argument as directly facilitating relational processing produced no differences in clustering between the relational and control value conditions, and it had no impact on value-directed remembering. In contrast, directly facilitating equal item-specific processing did not produce differences in the number of items recalled per category and value-directed remembering. The results of the second pilot study supported the argument that all items benefit from relational processing, whereas only high-value items benefit from item-specific processing. Although the second pilot study directly manipulated relational and item-specific processing across all study list items in a given condition, the second study did not separately manipulate item-specific processing only for high-value items; thus, the second pilot study did not include a non-value condition that directly paralleled what is proposed to happen in the value conditions with respect to the selective combination of item-specific and relational processing for high-value items only.

The current study included conditions in which item-specific processing is encouraged selectively for high-value items. In these selective processing conditions, participants sorted all study list items into value categories; for items sorted as high-value, participants also performed a pleasantness rating task to engage item-specific processing for the high-value items only. This parallels what is proposed to occur for high-value items when given value-directed remembering instructions: the high-value items, but not the low-value items, engage both item-specific and relational processing while low-value items engage only relational processing. There were also two selective processing conditions: one with value-directed remembering instructions and one told to remember as many words as possible, but without value instructions.

In addition to the selective processing conditions, non-selective conditions asked participants to engage in the category sorting and pleasantness rating tasks for all study list items independent of assigned value. These conditions matched the orienting conditions in Pilot Study 2. One non-selective condition received value instructions while the other did not.

Two control conditions, both with and without value instructions, were also be included. Within these conditions participants were not be asked to complete any orienting tasks. The control conditions in the current study are exactly the same as the control conditions employed in Pilot Study 2. A summary of the different conditions can be found in Table 5. A summary of the proposed processing thought to be engaged in each condition for high and low-value items can be found in Table 6.

Predictions

Proportion of Items Recalled

Participants in the control value condition were predicted to demonstrate value-directed remembering (i.e., recall a greater proportion of high relative to low-value items); however, those in the control no value condition were not predicted to demonstrate value-directed remembering.

The selective processing conditions, both with and without value instructions were designed to facilitate the underlying processing thought to occur by default within the control value condition. More specifically, these conditions facilitated the joint action of relational and item-specific processing for high-value items, but only relational processing for low-value items. In line with this, participants in the selective processing conditions were predicted to recall a greater proportion of high relative to low-value items.

In contrast, the non-selective processing conditions did not accommodate selective processing of high-value items because they forced equal relational and item-specific processing for all items. Therefore, independent of instruction type, the proportion of items recalled was not predicted to differ as a function of value in the non-selective processing conditions.

Items Per Category

Participants in the control value condition were predicted to recall a greater number of high relative to low-value items; however, no difference was predicted to occur within the control no value condition.

The selective processing conditions directly facilitated differential item-specific processing only for high value-items. Thus, it was predicted that a greater number of items from the high-value category would be recalled relative to the low-value category within the selective processing conditions.

The non-selective processing conditions were designed to hold item-specific constant for all values, and therefore no difference in the number of items recalled per category was expected to occur as a function of value.

Category Clustering

Within the control value condition, the value instructions provided meaning to the assigned numbers, which was thought to induce relational processing for all items. This relational processing is absent within the control no value condition and therefore the items were not expected to benefit from relational processing in this manner. This lead to the prediction that clustering would be greater in the control value relative to the control no value condition. The relational processing thought to occur by default in the control value condition was directly facilitated in the selective and non-selective conditions, independent of value instructions, because participants engaged in sorting for all items. To this extent, clustering was not predicted to differ between these conditions and the control value condition.

Methods

Participants

One participant was excluded because over 75% of the items they recalled were intrusions (i.e., the words recalled were almost entirely non-presented items), 28 participants were excluded for writing the words down during encoding, 33 were excluded because they failed to complete the orienting tasks at least 70% of the time, and 32 were excluded because they failed to complete the study. Accounting for these exclusions, the final sample (n = 205) consisted of undergraduate students (M_{Ag}e = 19.49 (Min: 18; Max: 45), *SD* = 2.71; 78% female; 89.3% non-Hispanic; 79.5% Caucasian) enrolled in psychology courses at The University of Mississippi. A G*Power 3.1.9 software analysis (Faul et al., 2007) was conducted, which indicated that a sample size of 192 would provide a power of 0.95 for a medium effect size of 0.25. Participants received course credit for participation.

Design

This study implemented a 2 (Instruction Type: value instructions, no value instructions) x 3 (Orienting task: control, selective processing, non-selective processing) x 3 (Item type: high value, medium value, low value) x 5 (List: List 1, List 2, List 3, List 4, List 5) mixed factorial design. Conditions with value instructions were told that they would be presented with a list of words, each paired with a point value they could earn for correctly remembering the word, with the goal of remembering as many words as possible and maximizing their score on an upcoming recall test. Conditions without value instructions were told that they would be presented with a list of words, each paired with a number, with the goal of remembering as many words as possible on an upcoming recall test. Instruction type was manipulated between subjects, such that each orienting task was performed within two separate conditions, one with and one without value instructions.

Participants in either control condition (i.e., with or without value instructions) were only provided the basic instructions detailed above. Those in the selective processing conditions were given the same instructions as the control conditions but also provided additional instructions about the orienting tasks. They were informed that they should group all presented words into one of three categories by selecting the appropriate group option presented below the word. Items paired with a 30 were to be sorted into the “H” group, those paired with a 20 belonged to the “M” group, and those paired with a 10 belonged to the “L” group. Additionally, they were told that for some words, they would be asked to group them and rate the pleasantness of the word. This condition was designed to facilitate item-specific processing selectively for high-value items but equal relational processing across item types.

Participants in the non-selective processing conditions were told that they should group and rate the pleasantness of all words. This condition was designed to hold item-specific and relational processing constant across item types.

Point value was presented in a pre-randomized order. The primary dependent variables included overall recall performance, the proportion of items recalled (an index of value-directed remembering), number of items recalled per category (an index of item-specific processing), and clustering (an index of relational processing).

Materials

The current study used the same stimuli as the second pilot study. As in Pilot Study 2, six words were used as a practice trial and the remaining 120 words were used to create five study lists of 24 words. Given that words were randomly assigned to each study list and value in Pilot Study 2, we have no reason to suspect that the outcome of the second study reflects materials effects; nonetheless, the current study included four sets of study lists to eliminate any possible concerns that the particular combination of words and values contributed to the pattern of results in the second pilot study. The same 120 words were used in each set, with a different random assignment of specific words to each of the five study lists for each of the four sets. Within each set, any given word appeared on only one study list. Once the lists were created, each word within the list was randomly paired with either a high, medium, or low point value, with an equal number of words from each value category appearing on each list. Approximately eight participants studied each of the four sets of study lists[3].

Procedure

The general procedure of this study closely followed that of the second pilot study, excluding the needed changes in task instructions to reflect the different orienting tasks. This study was conducted online using Qualtrics software, which randomly assigned participants to one of the six between-subjects conditions previously described. At the onset of the study, a consent form appeared on the screen. Once participants provided consent, they were given instructions detailing the task to be performed in the practice trials. The participant was able to

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[3] The targeted number of 32 participants in each condition produced an even counterbalancing number, but some participants needed to be replaced so there were small variations from the eight participants per list.

move through the instruction screens at their own pace, but once all were read and acknowledged, the practice trials began. Upon completing the practice trials, participants were provided instructions for the main task, which were the same as the practice trial. Once participants acknowledged that they understood the instructions, the main task began. The selective and non-selective processing conditions required participants to make responses while studying each word. These were made by using the mouse to click the appropriate option listed below the study word. Participants in the selective and non-selective processing conditions engaged in the category sorting for all items by selecting the appropriate option with the cursor (i.e., selecting “H” for a word paired with a 30). Pleasantness ratings were made by selecting one of three options, pleasant, neutral, or unpleasant. Although participants in the selective processing conditions only completed the pleasantness rating task for high-value items, those in the non-selective conditions completed it for all items. The computer program automatically recorded participant responses to measure adherence to the assigned orienting task.

Beyond the orienting task instructions, all other aspects of this study were the same between conditions. The presentation of the words was held constant at 6s, regardless of when or if the participant responds. Following the presentation of all 24 words on each list, a screen was presented with the free recall test instructions. Participants were informed that they had 60s to type the words they could recall from the previously studied list. The participant was required to acknowledge that they understood the instructions before beginning the recall test. Upon acknowledgment, a free recall box appeared on the next screen for exactly 60s. After the time is up, participants were reminded of the task instructions again before the next list of words was presented. This cycle repeated until the fifth and final list was completed. Following the final recall test, participants were asked to complete a post-task questionnaire, which asked about their experience with the task. Additionally, they were asked to complete a health and demographics questionnaire, which collected basic demographic information, and a 20 question vocabulary task. Once all tasks were complete, the participant was debriefed.

Results

Individual participant data was examined and participants with unusually high intrusions, who reported writing down the words, or had incomplete data files were be excluded. All relevant statistical analyses were conducted using $\alpha = 0.05$.

Overall Recall

To calculate overall recall performance, the total number of words correctly recalled on each list was summed and used as the variable of interest in the following analysis. A 2 (Instruction Type) x 3 (Orienting Task) x 5 (List) three-way ANOVA, revealed that overall recall performance differed as a function of instruction type, $F(1, 199) = 7.283$, $p = 0.008$, $\eta_p^2 = 0.035$. Participants in the value conditions ($M = 8.99$, $SE = 0.33$) recalled a greater number of items across all lists compared to participants in the no value conditions ($M = 7.72$, $SE = 0.33$). Likewise, overall recall performance differed as a function of orienting task, $F(2, 199) = 11.592$, $p < 0.001$, $\eta_p^2 = 0.10$. Across all lists, participants in the control conditions ($M = 9.96$, $SE = 0.41$) recalled more words compared to the selective processing ($M = 7.66$, $SE = 0.41$), and non-selective processing conditions ($M = 7.45$, $SE = 0.41$). There was no main effect of list nor were any of the interactions significant (Fs < 0.418, ps > 0.199).

Proportion Recalled

Within the value-directed remembering paradigm, the proportion of items recalled is often used as an index to measure the impact of value on subsequent memory (e.g., Hennessee et al., 2019). Proportions were calculated for each value category per list by taking the number of correct items recalled on that list for each value and dividing it by the total number of items recalled on the same list. For example, to calculate the proportion of high-value items recalled on list one, the total number of high-value items correctly recalled on that list would be divided by the total number of words correctly recalled on that same list. To test the specific predictions laid out in the introduction, a 3 (Value: high, medium, low) x 5 (List: Lists 1 to 5) repeated measures ANOVA with proportion recalled as the dependent measure was conducted separately for each of the six conditions resulting from the orthogonal combination of value (value vs. no value) and orienting task (control, selective processing, non-selective processing). Although the statistics for all follow-up analyses are included in the text below, the results of the overall ANOVA conducted for each condition can be found in Table 7. When necessary, paired t-tests with Bonferroni adjustments were conducted to investigate the effects of value in a given list.

Control Conditions. When conducted for the control value condition, the analysis revealed a significant interaction between value and list. The data can be found in Figure 8. This interaction was explored through a one-way repeated measures ANOVA for each list. The analysis for the third list revealed a main effect of value, $F(1.62, 53.85) = 12.692$, $p < 0.001$, $\eta_p^2 = 0.278$, such that a greater proportion of high relative to medium ($p = 0.005$) and low-value items ($p < 0.001$) were recalled. The analysis for the fifth list revealed a main effect of value, $F(2, 66) = 17.415$, $p < 0.001$, $\eta_p^2 = 0.345$, such that a greater proportion of high relative to medium ($p = 0.002$) and low-value items ($p < 0.001$) were recalled. No other comparisons were significant (ps ≥ 0.105). As predicted, participants in the control value condition recalled a greater proportion of high relative to low-value items, with this difference emerging across lists.

As predicted for the analysis for the control no value condition, neither of the main effects nor the interaction were significant (all Fs < 0.916, ps > 0.478).

Selective Processing Conditions. The underlying processing is thought to be the same between the control value and selective processing conditions, both with and without value instructions. Because of this, we predicted that a greater proportion of high relative to low-value items would be recalled in both conditions. The analysis conducted for the selective value condition, revealed a significant main effect only for value. A greater proportion of high (M = 0.44, SE = 0.02) relative to medium-value items (M = 0.28, SE = 0.02) were recalled ($p < 0.001$). Likewise, a greater proportion of high relative to low-value items (M = 0.27, SE = 0.01) were recalled ($p < 0.001$). The difference in the proportion of medium relative to low-value items recalled was not significant ($p = 1.00$). Neither the main effect of list nor the interaction between list and value were significant. As predicted, participants reliably demonstrated value-directed remembering when relational processing was facilitated for all items, but item-specific processing was selectively facilitated for high-value items only.

The ANOVA for the selective no value condition revealed a significant main effect only for value. A greater proportion of high (M = 0.44, SE = 0.02) relative to medium-value items (M = 0.29, SE = 0.021) were recalled ($p < 0.001$). Additionally, a greater proportion of high relative to low-value items (M = 0.27, SE = 0.01) were recalled ($p < 0.001$). The difference in the proportion of medium relative to low value items recalled was not significant ($p = 1.00$). As predicted, participants in the selective no value condition demonstrated recall patterns consistent with value-directed remembering, despite not being given value instructions.

Non-Selective Value Conditions. In contrast, relational and item-specific processing were held constant across all items in the non-selective processing conditions, which was predicted to eliminate value-directed remembering independent of instruction type. The ANOVA for the non-selective value condition revealed a significant interaction between value and list. This interaction was explored through a one-way repeated measures ANOVA for each list. The analysis for the third list revealed a significant effect of value, $F(2, 66) = 4.220$, $p = 0.019$, $\eta_p^2 = 0.113$, such that a greater proportion of high ($M = 0.40$, $SE = 0.03$) relative to low ($M = 0.27$, $SE = 0.30$) items ($p = 0.045$), but no other comparisons were significant (ps > 0.115). Likewise, the analysis for the fifth list revealed a significant effect of value, $F(2, 66) = 3.554$, $p = 0.034$, $\eta_p^2 = 0.097$, such that a greater proportion of high ($M = 0.39$, $SE = 0.03$) relative to medium ($M = 0.26$, $SE = 0.23$) items ($p = 0.022$), but no other comparisons were significant (ps > 0.220). The main effect of value was not significant ($p = 0.066$).

As predicted, the ANOVA conducted for the non-selective no value condition revealed that neither the main effect of value nor the interaction were significant (Fs < 0.644, ps > 0.0700).

Items Per Category

As in the second pilot study, the number of items per value category was recorded for each list and then analyzed using a repeated measure ANOVA. Separate 2 (Value) x 5 (List) repeated measures ANOVAs were conducted for each of the six conditions to test the predictions outlined in the introduction. Although the statistics for any follow-up analyses are included in the text below, the results of the overall ANOVA conducted for each condition can be found in Table 8. When necessary, paired t-tests with Bonferroni adjustments were conducted to investigate the effects of value in a given list.

Control Conditions. The control value condition in the current study did not differ from that of the second pilot study. Therefore, we expected to replicate the finding that more items would be recalled from the high-value category relative to the low-value category in the control value condition. ANOVA revealed a significant value by list interaction. This interaction was explored through a series of ANOVAs conducted for each list. The data for this interaction can be found in Figure 9. The analysis for the third list revealed a significant effect of value, $F(2, 66) = 13.930$, $p < 0.001$, $\eta_p^2 = 0.297$. A greater number of items from the high-value category to medium ($p = 0.004$) and low-value items ($p < 0.001$) were recalled on the third list. The analysis for the fifth list revealed a significant effect of value, $F(2, 66) = 17.067$, $p < 0.001$, $\eta_p^2 = 0.341$: a greater number of items from the high-value category relative to medium ($p = 0.001$) and low-value items ($p < 0.001$) were recalled. No other comparisons were significant (Fs > 1.037, ps ≥ 0.134). As predicted participants in the control value condition recalled a greater number of items from the high relative to low-value category, with this emerging across lists.

Due to the lack of value instructions, the number of items recalled per category was not expected to differ as a function of value in the control no value condition. Neither of the main effects nor the interaction were significant (Fs > 0.547, ps ≥ 0.492). As predicted, in the absence of value instructions participants recalled roughly equal numbers of items from the high, medium, and low-value categories across all lists.

Selective Processing Conditions. In contrast, the selective processing conditions both with and without value instructions directly facilitated the underlying processing thought to occur by default in the control value condition. We predicted that participants in the selective processing conditions, independent of the presence or absence of value instructions, would recall a greater number of items from the high-value category relative to the low-value category.

The ANOVA for the selective value condition revealed a significant value by list interaction (see Figure 10). This interaction was explored through a series of ANOVAs conducted for each list. The analysis for the first list revealed a significant effect of value, F(2,

66) = 11.584, $p < 0.001$, $\eta_p^2 = 0.254$. On the first list, a greater number of high relative to medium ($p = 0.026$) and low-value category items ($p < 0.001$) were recalled. A greater number of items from the high relative to low-value category were recalled on the second list ($p = 0.010$). The analysis for the fourth list revealed a significant effect of value, $F(1.63, 55.53) = 10.169$, $p < 0.001$, $\eta_p^2 = 0.230$. On the fourth list, a greater number of high relative to low-value category items ($p = 0.001$) and medium relative to low-value category items were recalled ($p = 0.027$). The analysis for the final list revealed a significant effect of value, $F(1.63, 55.39) = 11.720$, $p < 0.001$, $\eta_p^2 = 0.256$. A greater number of high relative to medium ($p = 0.001$) and low-value category items ($p = 0.002$) were recalled on the fifth list.

The ANOVA for the selective no value condition revealed a significant main effect of value. Participants recalled a greater number of high ($M = 3.13$, $SE = 0.24$) relative to medium-value ($M = 2.28$, $SE = 0.23$) items ($p <0.001$), and low-value ($M = 2.09$, $SE = 0.21$) category items ($p < 0.001$). No other comparisons were significant (ps ≥ 0.276).

As predicted, independent of value instructions, participants recalled a greater number of high relative to low-value category items when relational processing was facilitated for all items, but item-specific processing was selectively facilitated for only high-value items.

Non-Selective Value Conditions. The non-selective processing conditions, both with and without value instructions, directly facilitate equal distinctive processing for all items. Therefore, the number of items recalled per category was not expected to differ as a function of value for either of the non-selective processing conditions.

The ANOVA for the non-selective value condition revealed a main effect of value. Participants recalled a greater number of high ($M = 3.09$, $SE = 0.25$) relative to medium-value ($M = 2.57$, $SE = 0.22$) category items ($p = 0.040$). No other comparisons were significant (ps $\geq$

0.509). Although this finding was not predicted, it remains possible that the value instructions may have overridden the orienting task instructions and contributed to a greater number of items being recalled from the high relative to medium-value category. However, in line with our predictions, no significant difference emerged between high and low-value items.

The ANOVA for the non-selective no value condition revealed that neither of the main effects nor the interaction were significant (*F*s > 0.273, *p*s ≥ 0.587). As predicted, when both item-specific and relational processing were held constant across value categories, participants recalled roughly an equal number of items from the high, medium, and low categories.

Clustering

Calculating LBC was discussed in detail within the clustering results of the second pilot study. Please refer to that section for more information. An LBC score was calculated for each list and used in a 2 (Condition) x 5 (List) repeated-measures ANOVA to compare the control value condition to all others. Although the statistics for any follow-up analyses are included in the text below, the results of the overall ANOVA conducted to compare the control value and all other conditions can be found in Table 9. When necessary, paired t-tests with Bonferroni adjustments were conducted to investigate the differences that arose between lists.

Comparing the Two Control Conditions. The ANOVA comparing clustering in the control value and control no value condition revealed a significant main effect of list. Participants demonstrated significantly (*p* = 0.002) higher levels of clustering on the third list (*M* = 0.55, *SE* = 0.18) relative to the fourth list (*M* = -0.30, *SE* = 0.14), and significantly (*p* = 0.014) lower levels of clustering on the fourth list relative to the fifth list (*M* = 0.35, *SE* = 0.16). No other comparisons were significant (*p*s ≥ 0.233). More importantly, a significant main effect of condition was found. As predicted, participants in the control value condition demonstrated significantly (p = 0.022) higher levels of clustering (M = 0.33, SE = 0.11) relative to the control no value condition (M = -0.05, SE = 0.11). The interaction between list and condition was not significant, $F(4, 264) = 0.67$, $p = 0.612$, $\eta_p^2 = 0.01$.

Comparing Control Value with Each of the Selective and Non-Selective Processing Conditions. Selective value: Analysis produced a significant main effect of list, but follow-up analyses failed to identify any significant differences between the lists (ps ≥ 0.098). Neither the main effect of condition nor the interaction between condition and list were significant, Fs <1.265, ps > 0.284.

Selective no-value: Neither the main effect of condition nor the interaction between condition and list were significant, Fs <0.951, ps > 0.435. Although, a significant main effect of list was revealed - with significantly (p = 0.007) higher levels of clustering on the third list (M = 0.78, SE = 0.20) relative to the fourth list (M = -0.09, SE = 0.14) and no other significant comparisons between the lists (ps ≥ 0.111) – the lack of a main effect of condition and no interaction are consistent with the predicted effects.

Non-selective value: Neither the main effects nor the interaction were significant (Fs < 0.95, ps > 0.435).

Non-selective value: Neither the main effect of condition nor the interaction between condition and list were significant (Fs < 1.27, ps > 0.284). However, a significant main effect of list was revealed, indicating that participants demonstrated significantly (p = 0.030) lower levels of clustering on the second list (M = -0.76, SE = 0.15) relative to the third (M = 0.63, SE = 0.19) and fifth lists (M = 0.43, SE = 0.13; p = 0.046). Clustering levels were significantly (p = 0.001) lower on the fourth (M = -0.31, SE = 0.13) list relative to the third list. A significant difference (p = 0.001) also arose between the fourth and fifth lists. No other comparisons between lists were significant (ps ≥ 0.655).

Summary: As predicted, when relational processing was facilitated for all items either through the use of value instructions or through the engagement of relational processing in through the category sorting orienting task, there was no difference in overall clustering between the control value and any of the selective or non-selective processing conditions.

Discussion

The current study aimed to examine the joint role of item-specific and relational processing in explaining value-directed remembering by directly facilitating item-specific processing only for high-value items. Given that only high-value items are thought to benefit from item-specific processing in the standard value directed paradigm - represented by the control value condition in this study - directly facilitating item-specific processing selectively for the high value items afforded a more nuanced examination of its influence beyond that offered by the second pilot study, in which item-specific processing was engaged for all items. Furthermore, the current study included a condition without value instructions that directly facilitated the underlying processing thought to occur by default within value-directed remembering. The selective no value condition was central in examining the joint action of item-specific and relational processing within value-directed remembering.

Of critical importance was the finding that in the absence of value instructions, participants in the selective processing no value condition demonstrated the same pattern in the proportion of items recalled and items per category as was seen in the control value-directed condition. In contrast, when both relational and item-specific processing were engaged for all items in the non-selective no value condition, participants did not reliably recall a greater proportion of high relative to low-value items and also showed no difference in items per category as a function of value. These patterns of results in the selective no value and non-selective no value conditions nicely demonstrate that value-directed remembering is contingent upon the selective engagement of item-specific processing for high-value items only.

As noted throughout this document, item-specific processing is only one part of the equation. In line with the results of the second pilot study, the findings of the current study suggest that all items benefit from relational processing by default within value-directed remembering. As noted in the introduction, the value instructions are thought to induce relational processing for all items independent of the assigned value. Within the current study, participants in the control value condition demonstrated significantly greater clustering relative to those in the control no value condition. The value instructions were the only difference between these two conditions, which further suggests that the value instructions induce relational processing. Furthermore, no difference in overall clustering emerged between the control value condition and all other conditions in which relational processing was directly facilitated for all items. These results are in line with the data from the second pilot study, demonstrating that facilitating relational processing for all items has no impact on value-directed remembering as all items benefit from relational processing by default. In addition, these findings help explain the neuroimaging data collected by Cohen and colleagues (2014; 2016), which indicated a lack of differential activation of the dorsolateral prefrontal cortex as a function of value, which has been linked to relational processing.

Differences Between Control and Selective Value Conditions

While the primary findings support the proposal that distinctive processing can explain the effects of the value instructions in the value directed remembering paradigm, the results for the selective value conditions did not entirely map onto the results for the control value condition. In the control value condition, the interaction of value and list was significant with the advantage for high value items relative to low value items emerging on later lists for analyses of both proportion of items recalled and items per category. In line with prior literature, value-directed remembering was not fully potentiated within the control value condition until after the third study list (Castel, Benjamin, Craik, Watkins, 2002; Castel et al., 2007), indicating that some task experience is needed adopt an effective strategy.

The interaction of value and list was not significant for either the selective value or selective no value conditions in the analyses of proportion of items recalled. The interaction was not significant in the analysis of items per category for the selective no value condition. Within these conditions, distinctive processing was directly facilitated for high-value items through the orienting task instructions, thereby removing the need to gain task experience to adopt an effective strategy. This point is well illustrated by the finding that higher recall for high value items relative to low value items emerged sooner and remained consistent across more lists in the selective processing conditions relative to the control value condition.

However, an interaction of value and list was found for the selective value condition in the analysis of items per category. The interaction may have resulted from variability across lists in the exact pattern of value effects. Importantly, the advantage for high value items relative to low value items emerged on the first list and was present on four out of five lists; in other words, the pattern of results for the selective value condition in the analysis of items per category is consistent with the argument that the memorial advantage for high value items can be explained by distinctive processing.

Summary

Taken together the results for proportion of items recalled, the number of items recalled per category, and clustering all replicate and extend the findings of the second pilot study. The current study provides support for the joint action of item-specific and relational processing within value-directed remembering (i.e., distinctive processing). More specifically, the results obtained support the argument that all items benefit from relational processing, whereas only high-value items benefit from item-specific processing.

IV. GENERAL DISCUSSION

Value-directed remembering has generated numerous publications over three decades of research; however, the underlying mechanism of the effect is not well understood. Although several explanations have been proposed, all but the most recent has been subsequently dismissed. The current explanation provided in the literature argues that high-value items disproportionally benefit from semantic processing (Cohen et al., 2014; 2016). As discussed in the introduction of this paper, Hennessee and colleagues (2019) sought to test this explanation in their second and third experiments; however, their design incorporated several limitations, which were subsequently addressed by the first pilot study reported in this paper. In general, the results of the first pilot study largely replicated the findings of Hennessee and colleagues' (2019) third experiment. More specifically, when semantic processing was held constant, there was no evidence of value-directed remembering across lists. Furthermore, value-directed remembering persisted when non-semantic processing was held constant, suggesting that forcing equal semantic, but not non-semantic processing, would eliminate the effect. Although the work of Hennessee and associates (2019) and the first pilot study found support for the role of differential semantic processing, these studies were not designed to address how semantic processing influences memory performance.

The second pilot study built on earlier work by exploring a potential mechanism by which semantic processing may influence memory. Specifically, that semantic processing influences memory by increasing the processing of unique aspects of meaning, making the items more discernable at retrieval (Jacoby & Craik, 1979; Lockhart et al., 1976). The second pilot investigated the role of item-specific processing while also addressing previous literature suggesting the role of relational processing in value-directed remembering (Bui et al., 2013, Middlebrooks & Castel, 2018). The results of the second pilot study supported the new theoretical proposal that all items benefit from relational processing, whereas only high-value items benefit from item-specific processing. Most notably, when item-specific processing was held constant, value-directed remembering was eliminated; however, when equal relational processing was facilitated, it had no impact on value-directed remembering. Furthermore, when item-specific processing was held constant, more items were recalled from lower value categories relative to when it was allowed to be engaged differentially. The clustering data indicated that the value instructions induced equal relational processing for all items, as a difference emerged between the control value and control no value conditions. However, when equal relational processing was directly facilitated for all items, no difference emerged concerning value-directed remembering or clustering. This pattern demonstrates that item-specific and relational processing both play a role in value-directed remembering. More specifically, it appears that item-specific processing is engaged differentially as a function of value, whereas relational processing is engaged for all items. To this extent, it appears that value-directed remembering is not solely the byproduct of differential item-specific processing but more so that of distinctive processing (i.e., joint item-specific and relational processing).

The aim of the current study was to examine the joint action of item-specific and relational processing (i.e., distinctive processing) in value-directed remembering in a more nuanced way than possible in the second pilot study. Specifically, the inclusion of conditions without value instructions, that directly facilitated the underlying processing thought to occur by default within value-directed remembering is a critical distinction from the second pilot study.

This was achieved through the selective processing conditions both with and without instructions. Of critical importance was the finding that independent of value instructions, participants in the selective processing conditions produced similar patterns in the proportion of items recalled as those in the control value condition. This finding suggests that the selective processing and control value conditions are functionally equivalent. In contrast, when both item-specific and relational processing were held constant for all items, as they were in the non-selective processing conditions, participants did not demonstrate value-directed remembering. The facilitation of item-specific processing through the use of orienting tasks is the only difference between these conditions, which given the patterns found, suggests that value-directed remembering is partially contingent upon selective engagement of item-specific processing.

The patterns found when examining the number of items recalled per category further suggest that selective engagement in item-specific processing is critical for value-directed remembering. More specially, the number of items recalled per category differed as a function of value in the control value and selective processing conditions, but not in the non-selective conditions. This lack of an effect of value in the non-selective processing conditions was driven by an increase in the number of medium and low-value items recalled relative to high-value items. Subsequently, this increase in item-specific processing for low and medium value items in the non-selective processing conditions would also help explain the lack of value-directed remembering in those conditions. Although the findings of the current study clearly suggest the role of selective engagement of item-specific processing, it alone does not provide a mechanistic explanation of value-directed remembering.

In line with the second pilot study, the current study found support for the robust role of relational processing within value-directed remembering. More specifically, a significant difference in overall clustering was found within the control value and control no value condition; however, no difference was found between the control value condition and all others that directly facilitated equal relational processing. Furthermore, we found no difference in the patterns of the proportion of items recalled or the number of items recalled per category when equal relational processing was directly facilitated. Taken together, these findings suggest that the value instructions induce relational processing for all items by default in value-directed remembering.

The findings of the current study clearly highlight the important role of selective item-specific processing but also provide strong evidence to suggest that all items benefit from relational processing. To this extent, the findings of the current study make a strong case for the role of distinctive processing (i.e., the joint action of relational and item-specific processing) within value-directed remembering. More specifically, the results obtained support the argument that all items benefit from relational processing whereas only high-value items benefit from distinctive processing.

As previously noted, memory performance is often optimized when distinctive processing is engaged (Epstein et al., 1975; Begg, 1978, but see Hunt, 2012, for further explanation). The non-selective processing conditions directly facilitated equal distinctive processing of all items, and therefore it is reasonable to expect overall recall to be greatest in this condition relative to the control and selective conditions in which all items are not thought to benefit from distinctive processing. However, the data from the current study indicate that overall recall was substantially greater in the control conditions relative to the selective and non-selective conditions. There is no clear explanation for this finding, but despite this exception, the findings of the current study provide strong support for distinctive processing as a mechanistic explanation of value-directed remembering.

Unlike the semantic engagement explanation, distinctive processing affords a mechanistic explanation for the effect, through the combination of relational processing, which restricts the search to a smaller subset of targets, and item-specific processing that makes the targets within that subset more discernable (Hunt, 2012). It is worth noting that the distinctive processing explanation of value-directed remembering is not at odds with either the semantic engagement explanation (Cohen et al., 2014; 2016) or the work suggesting the role of relational processing (Bui et al., 2013; Middlebrooks & Castel, 2018). Instead, distinctive processing accounts for both, thereby providing a more complete explanation for value-directed remembering than either of the earlier proposals.

Summary

The current study was a needed step to help bridge the gap in the literature to better understand the underlying mechanism of value-directed remembering. Prior literature has suggested the role of both item-specific and relational processing, but the current study is the only work done to examine how both might interact to play separate but important roles within value-directed remembering. The current study built upon prior literature and empirically sound pilot studies to explore distinctive processing as a potential mechanistic explanation of value-directed remembering. The findings of the second pilot study paired with those of the current study suggest that neither item-specific or relational processing alone can explain value-directed remembering, but instead their joint action (i.e., distinctive processing) can. Future studies should aim to replicate these findings using varied methods and apply the principles of distinctive processing to address other areas of the value-directed remembering literature, such as false memories and age-related differences.

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LIST OF APPENDICES

Table 1

Experiment 2: Summary of Analyses- 3 (Value) by 5 (List) Repeated Measures ANOVA for the proportion of items recalled in the conditions with value instructions.

Control Condition					
	$Df_{hypothesis}$	df_{error}	F	p	η_p^2
Value	2	40	6.87	0.003	0.26
List	2	40	1.00	0.377	0.05
Value by List	8	34	3.93	0.002	0.48
Category Sorting Condition					
	$Df_{hypothesis}$	df_{error}	F	p	η_p^2
Value	2	40	6.26	0.004	0.24
List	1	41	1.00	0.323	0.02
Value by List*	5.72	234.45	1.04	0.396	0.03
Pleasantness Rating Condition					
	$Df_{hypothesis}$	df_{error}	F	p	η_p^2
Value	2	47	1.46	0.242	0.06
List	2	47	1.10	0.336	0.02
Value by List	8	41	2.45	0.029	0.32

Note: Analyses denoted by an asterisk (*) violated the assumption of Sphericity. To correct for this, the degrees of freedom were adjusted using a Greenhouse Geisser correction.

Table 2

Experiment 2: Summary of Analyses – 3 (Value) by 5 (List) Repeated Measures ANOVA for the proportion of items recalled in the conditions without value instructions.

Control Condition	$\mathrm{Df}_{\mathrm{hypothesis}}$	$\mathrm{df}_{\mathrm{error}}$	*F*	*p*	η_p^2
Value	2	43	2.57	0.088	0.11
List	1	44	1.00	0.323	0.02
Value by List*	5.95	261.61	2.77	0.013	0.06

Category Sorting Condition	$\mathrm{Df}_{\mathrm{hypothesis}}$	$\mathrm{df}_{\mathrm{error}}$	*F*	*p*	η_p^2
Value	2	41	0.06	0.946	0.00
List	3	40	1.75	0.171	0.12
Value by List	8	35	3.51	0.004	0.45

Pleasantness Rating Condition	$\mathrm{Df}_{\mathrm{hypothesis}}$	$\mathrm{df}_{\mathrm{error}}$	*F*	*p*	η_p^2
Value	2	43	1.50	0.235	0.07
List	2	43	1.00	0.376	0.04
Value by List*	5.26	231.55	2.18	0.054	0.05

Note: Analyses denoted by an asterisk (*) violated the assumption of Sphericity. To correct for this, the degrees of freedom were adjusted using a Greenhouse Geisser correction.

Table 3

Experiment 2: Summary of Analyses – 3 (Value) by 5 (List) Repeated Measures ANOVA for the items recalled per category in the conditions with value instructions.

Control Condition					
	$\mathrm{Df}_{\mathrm{hypothesis}}$	$\mathrm{df}_{\mathrm{error}}$	F	p	η_p^2
Value	4	38	1.83	0.144	0.16
List*	3.19	130.91	2.17	0.091	0.05
Value by List	8	34	3.01	0.012	0.41
Category Sorting Condition					
	$\mathrm{Df}_{\mathrm{hypothesis}}$	$\mathrm{df}_{\mathrm{error}}$	F	p	η_p^2
Value*	1.67	71.83	8.43	0.001	0.16
List*	3.30	141.92	0.10	0.970	0.00
Value by List	8	36	0.69	0.697	0.13
Pleasantness Rating Condition					
	$\mathrm{Df}_{\mathrm{hypothesis}}$	$\mathrm{df}_{\mathrm{error}}$	F	p	η_p^2
Value	2	47	1.53	0.210	0.12
List*	4	153.60	1.21	0.310	0.02
Value by List	8	41	3.02	0.009	0.37

Note: Analyses denoted by an asterisk (*) violated the assumption of Sphericity. To correct for this, the degrees of freedom were adjusted using a Greenhouse Geisser correction.

Table 4

Experiment 2: Summary of Analyses- 3 (Orienting Task) by 5 (List) Repeated Measures ANOVA for items recalled per category in the no value conditions.

	$Df_{hypothesis}$	df_{error}	F	p	η_p^2
List*	3.41	446.27	2.58	0.046	0.02
Orienting Task	2	131	0.36	0.696	0.01
Orienting by List	8	524	0.87	0.540	0.01

Note: Analyses denoted by an asterisk (*) violated the assumption of Sphericity. To correct for this, the degrees of freedom were adjusted using a Greenhouse Geisser correction.

Table 5

Summary of the design of the current study.

	Within-Subject Item Types	
Six Between-Subject Conditions	High-value	Low-value
Control - Value Instructions	No orienting task.	No orienting task.
Control - No Value Instructions	No orienting task.	No orienting task.
Selective Processing – Value Instructions	CS and PR	CS Only
Selective Process – No Value Instructions	CS and PR	CS Only
Non-Selective – Value Instructions	CS and PR	CS and PR
Non-Selective – No Value Instructions	CS and PR	CS and PR

Note: CS = Category sorting for these items. PR = Pleasantness Rating for these items.

Table 6

Summary of the type of processing proposed to be engaged in each condition for each item type.

	Within-Subject Item Types	
Six Between-Subject Conditions	High-value	Low-value
Control - Value Instructions*	Distinctive	Relational Only
Control - No Value Instructions	Relational Only	Relational Only
Selective Processing – Value Instructions*	Distinctive	Relational Only
Selective Processing – No Value Instructions*	Distinctive	Relational Only
Non-Selective – Value Instructions	Distinctive	Distinctive
Non-Selective – No Value Instructions	Distinctive	Distinctive

Note: Distinctive = Distinctive processing (the combination of item-specific and relational process) proposed to occur for a given item type. In the control no value condition participants may spontaneously engage in item-specific processing, but the likelihood of this is smaller relative to conditions that directly encourage item-specific processing through orienting task or value instructions, and the no-value control condition would not encourage relational processing of value categories. *Conditions expected to show recall memory performance advantage for high-value relative to low-value items.

Table 7

Experiment 3: Summary of Analyses – 3 (Value) by 5 (List) Repeated Measures ANOVA for the proportion of items recalled.

Condition	**Measure**	**$Df_{hypothesis}$**	**Df_{error}**	***F***	***p***	**η_p^2**
Control Value	*Value**	1.49	47.75	11.22	0.001	0.26
	*Value by List**	4.76	152.34	2.76	0.022	0.08
Control No Value	*Value*	2	66	0.10	0.902	0.003
	*Value by List**	5.47	180.34	0.92	0.478	0.03
Selective Value	*Value**	3.18	42.24	19.61	0.001	0.39
	*Value by List**	5.52	171.21	1.85	0.098	0.06
Selective No Value	*Value**	1.66	53.20	31.38	0.001	0.50
	*Value by List**	4.99	159.65	1.50	0.190	0.05
Non-Selective Value	*Value**	1.54	50.95	3.10	0.066	0.09
	*Value by List**	5.82	192.11	2.19	0.047	0.06
Non-Selective No Value	*Value*	2	68	0.36	0.700	0.01
	Value by List	8	272	0.64	0.740	0.02

Note: Analyses denoted by an asterisk (*) violated the assumption of Sphericity. To correct for this, the degrees of freedom were adjusted using a Greenhouse Geisser correction. Given that the sum of all proportions for each list will always equal one, the mean for each list will always be the same across all conditions (i.e., 1/3 = 0.333). To this end, the inclusion of the list variable in the analyses below is only meaningful when exploring the interaction of value and list. No statistical data for the main effect of list (i.e., *F*, *p*, or η_p^2) is generated during the analyses to report.

Table 8

Experiment 3: Summary of Analyses – 3 (Value) by 5 (List) Repeated Measures ANOVA for the number of items recalled per category.

Condition	Measure	$Df_{hypothesis}$	Df_{error}	F	p	η_p^2
Control Value	*Value*	2	66	14.65	0.001	0.31
	List	4	132	1.29	0.278	0.04
	Value by List	8	264	2.58	0.010	0.07
Control No Value	*Value*	2	66	0.55	0.581	0.02
	*List**	3.18	104.99	0.82	0.492	0.02
	Value by List	8	264	0.60	0.777	0.02
Selective Value	*Value**	1.64	55.72	20.94	0.001	0.38
	*List**	2.37	80.42	1.03	0.372	0.03
	Value by List	8	272	2.09	0.037	0.06
Selective No Value	*Value**	1.67	53.55	27.97	0.001	0.47
	*List**	3.13	100.18	0.41	0.758	0.01
	Value by List	8	256	1.770	0.083	0.05
Non-Selective Value	*Value**	1.49	49.28	3.53	0.050	0.09
	*List**	2.54	83.67	0.48	0.666	0.01
	Value by List	8	264	1.67	0.105	0.05
Non-Selective No Value	*Value*	2	68	0.27	0.762	0.01
	List	4	136	0.60	0.663	0.02
	Value by List	8	272	0.82	0.587	0.02

Note: Analyses denoted by an asterisk (*) violated the assumption of Sphericity. To correct for this, the degrees of freedom were adjusted using a Greenhouse Geisser correction.

Table 9

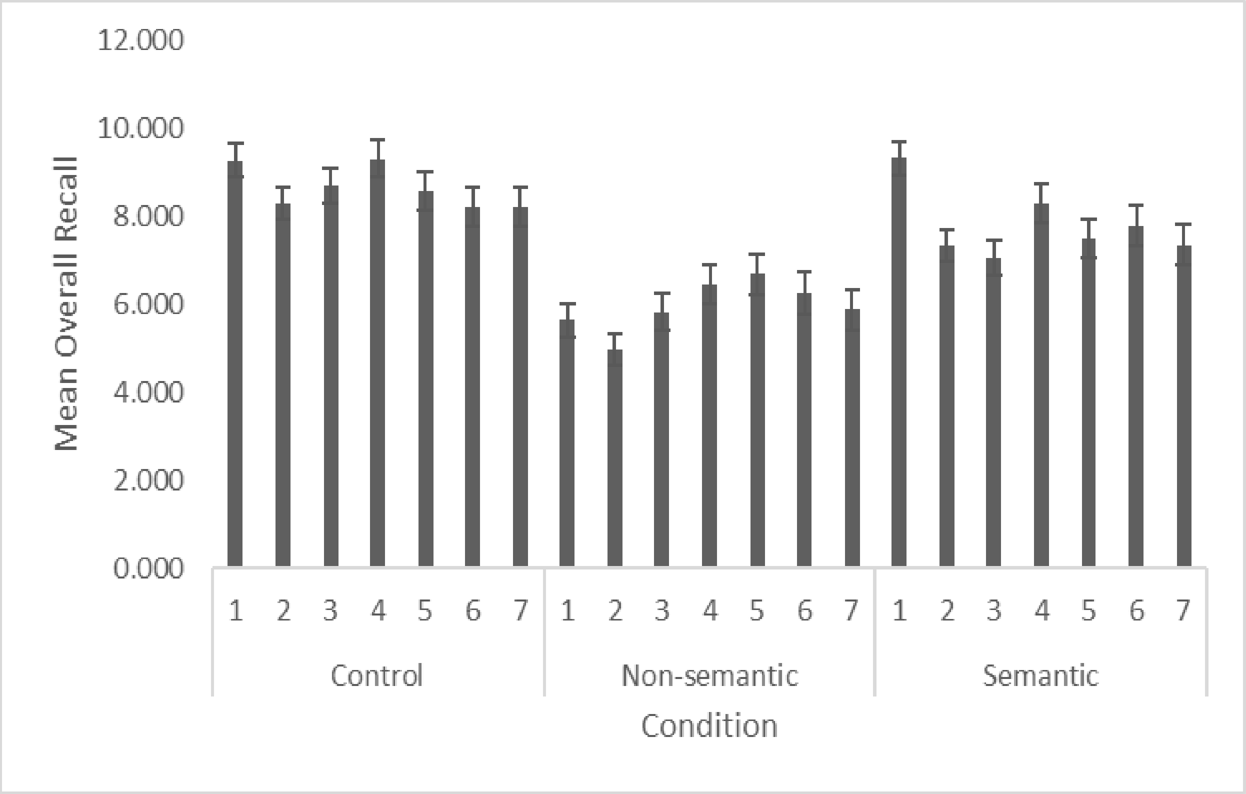
Experiment 3: Summary of Analyses – 2 (Condition) by 5 (List) Repeated Measures ANOVA for Overall Clustering

Condition	**Measure**	**Df$_{hypothesis}$**	**Df$_{error}$**	***F***	***p***	η_p^2
Control No Value	*Condition*	1	66	5.48	0.022	0.08
	List	4	264	5.21	0.001	0.07
	Condition by List	4	264	0.67	0.612	0.01
Selective Value	*Condition*	1	67	0.89	0.348	0.01
	List	4	268	3.39	0.010	0.05
	Condition by List	4	268	1.27	0.284	0.02
Selective No Value	*Condition*	1	64	0.00	0.993	0.00
	List	4	256	4.15	0.003	0.06
	Condition by List	4	256	0.95	0.435	0.02
Non-Selective Value	*Condition*	1	66	0.50	0.481	0.01
	List	4	264	2.53	0.041	0.04
	Condition by List	4	264	1.83	0.123	0.03
Non-Selective No Value	*Condition*	1	67	3.86	0.054	0.05
	List	4	268	7.20	0.001	0.09
	Condition by List	4	268	0.38	0.825	0.01

Note: The analyses listed above compared overall clustering between the control value condition and all others (i.e., The control value condition was used as part of each analysis).

Figure 1

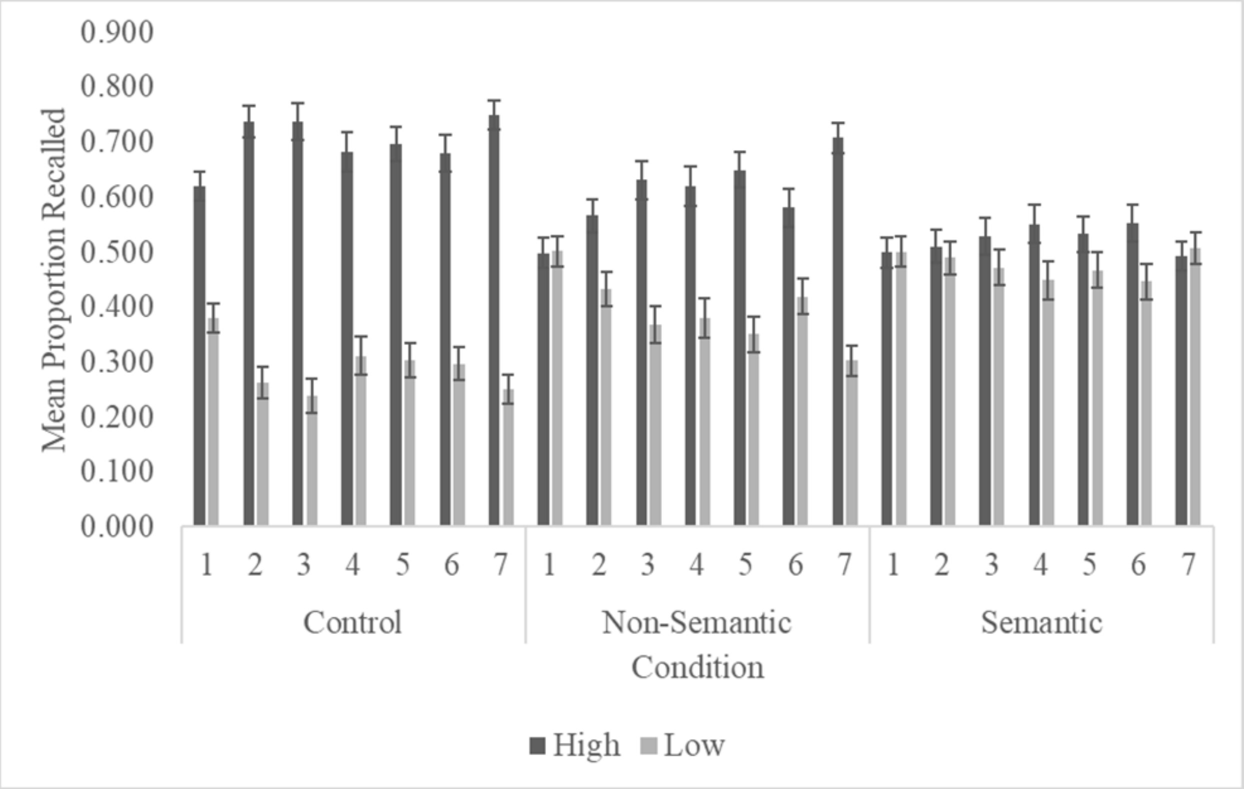
Mean overall recall as a function of condition and list for Experiment 1



Note: The error bars represent standard error.

Figure 2

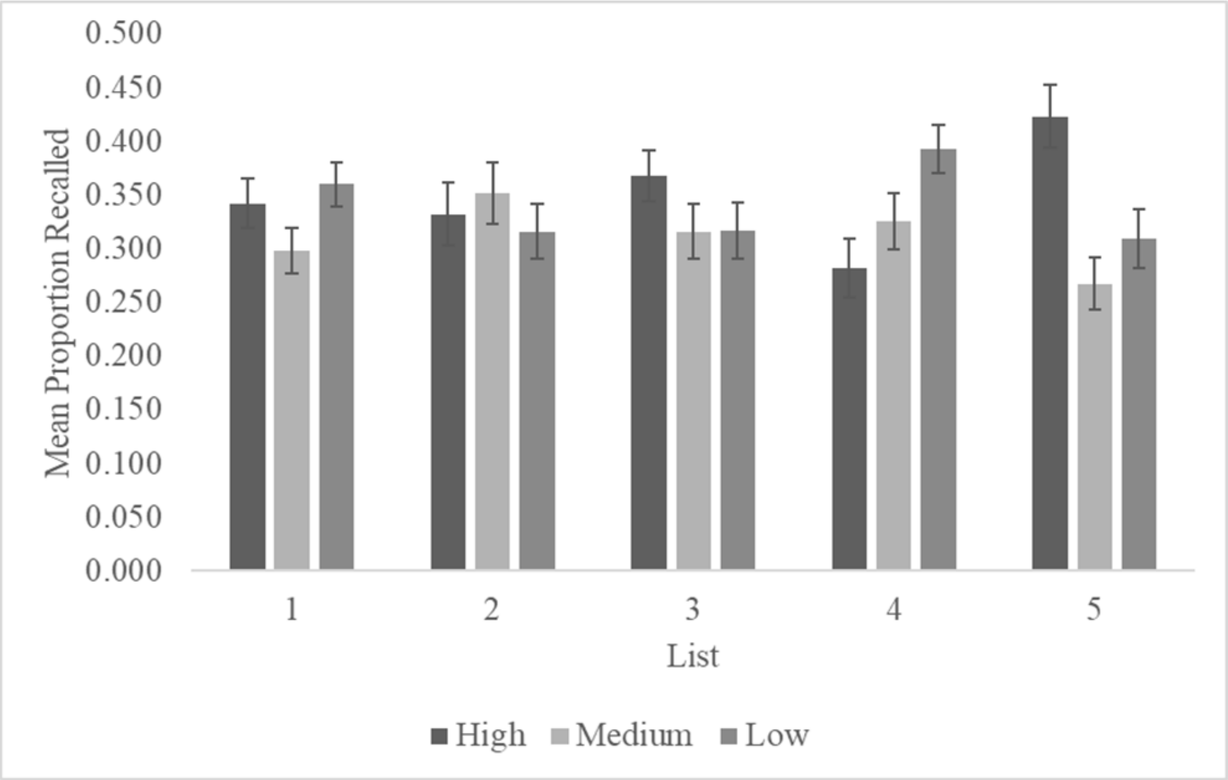
Mean proportion recalled as a function of condition, list and value for Experiment 1



Note: The error bars represent standard error.

Figure 3

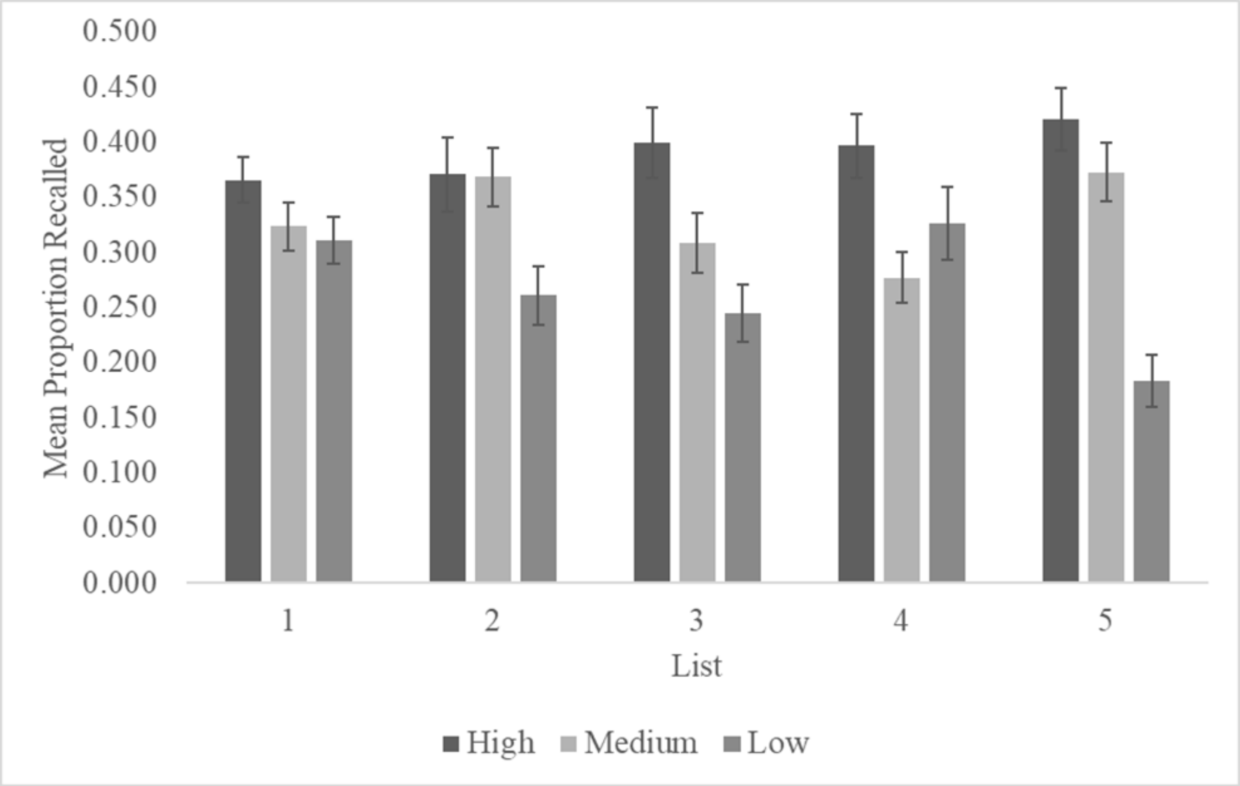
Mean proportion recalled as a function of value and list for the pleasantness rating condition with value instructions in Experiment 2



Note: The error bars represent standard error.

Figure 4

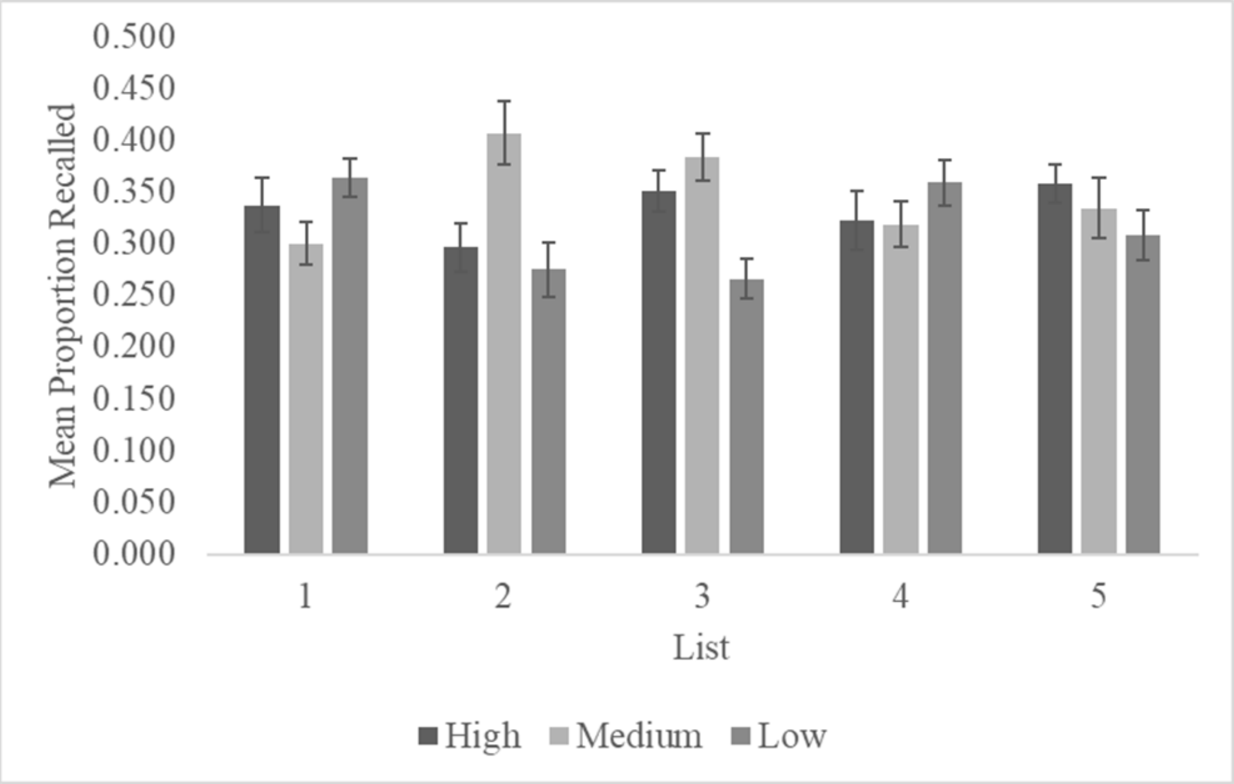
Mean proportion recalled as a function of value and list for the control condition with value instructions in Experiment 2



Note: The error bars represent standard error.

Figure 5

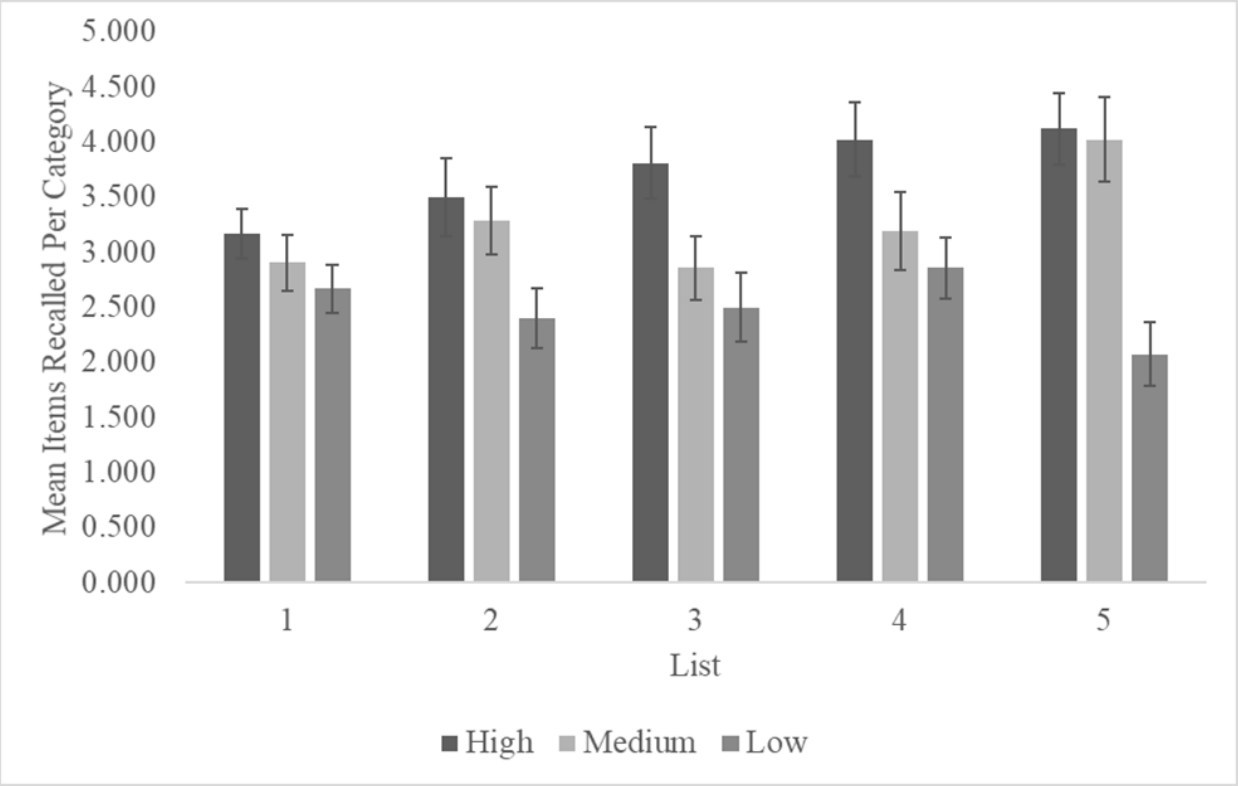
Mean proportion recalled as a function of value and list for the control condition without value instructions in Experiment 2



Note: The error bars represent standard error.

Figure 6

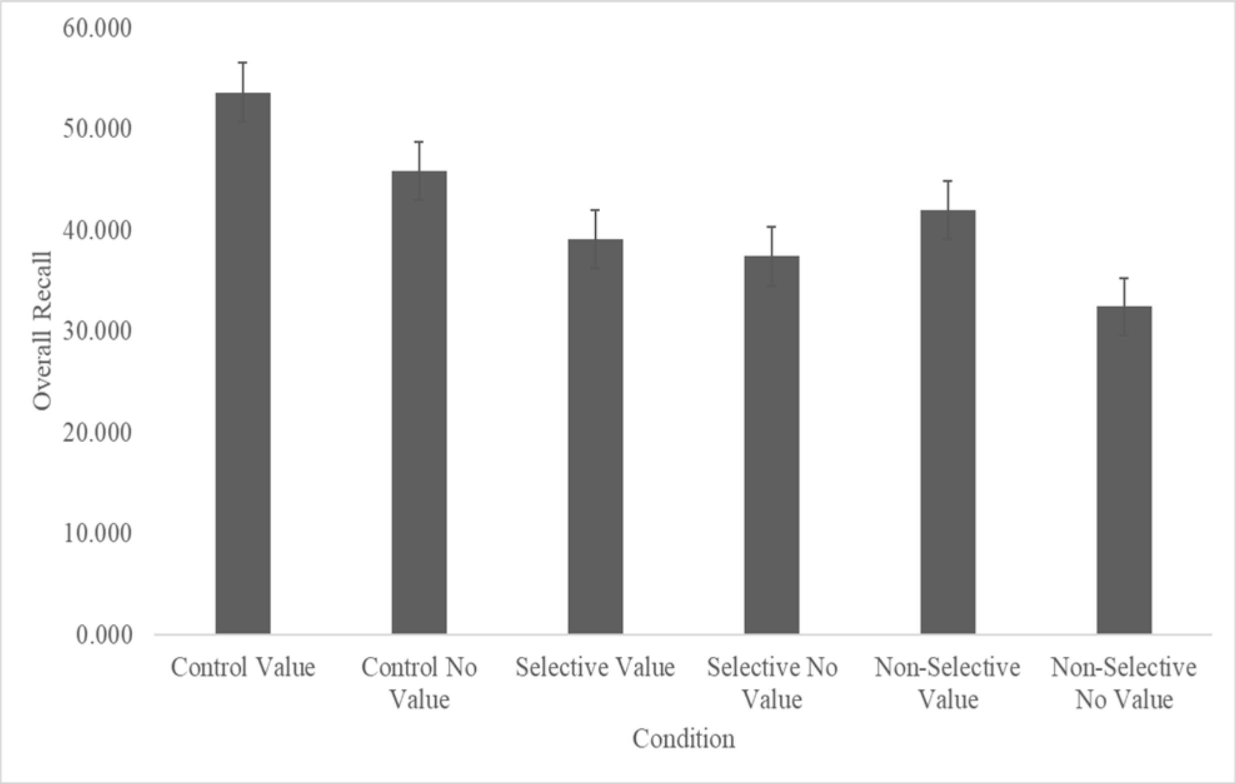
Mean items recalled per category as a function of value and list for the control condition with value instructions in Experiment 2



Note: The error bars represent standard error.

Figure 7

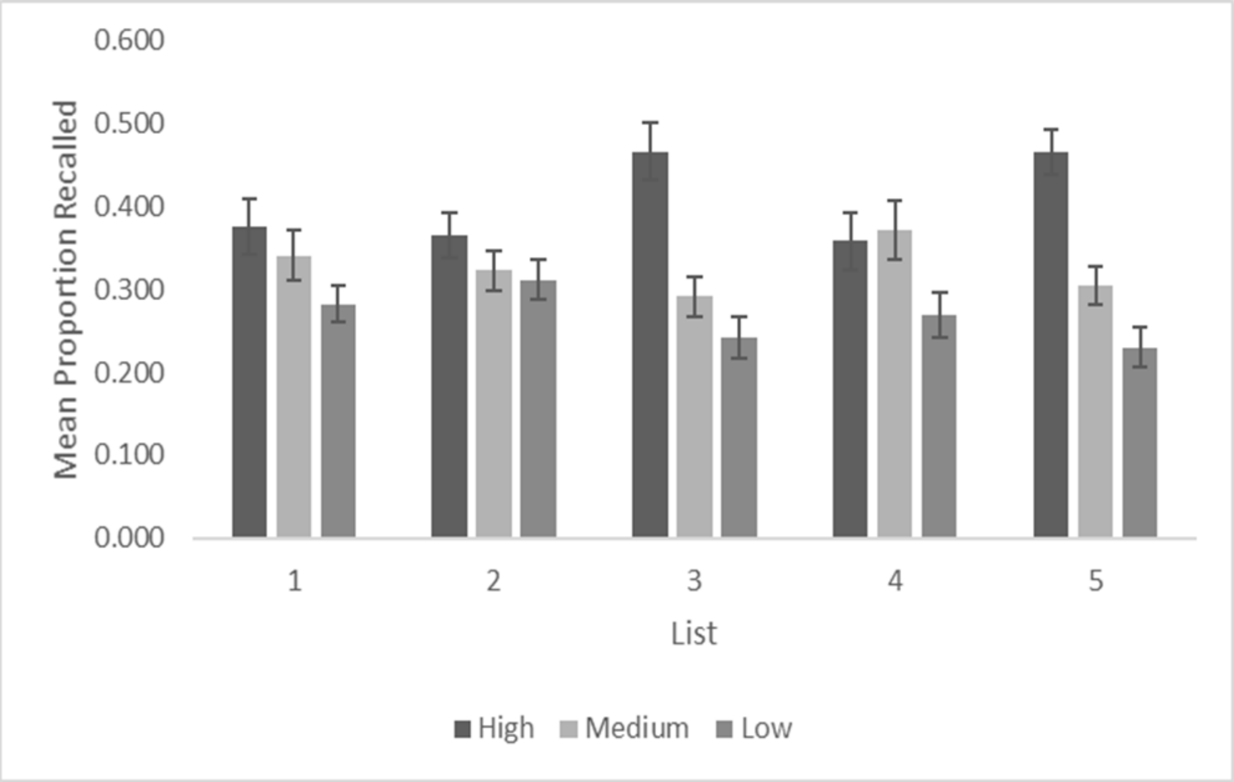
Overall recall performance as a function of condition for Experiment 3



Note: The error bars represent standard error.

Figure 8

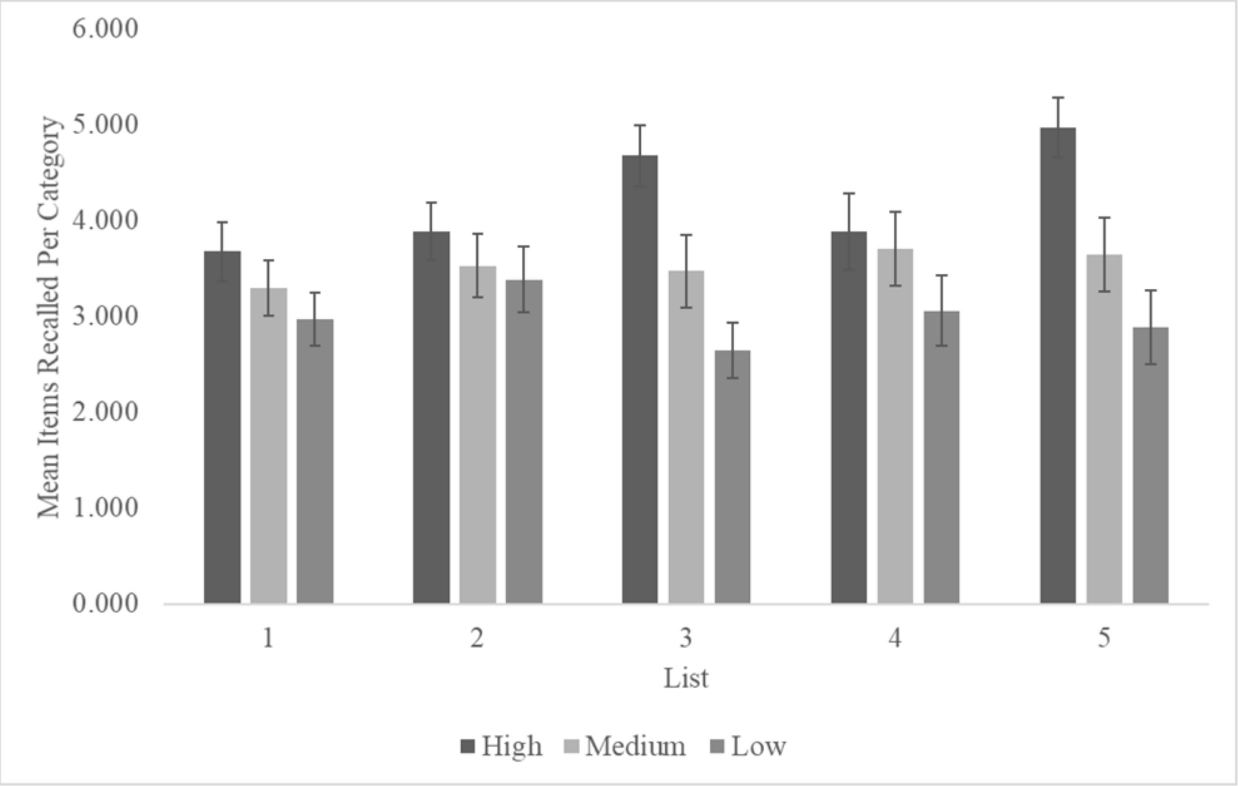
Mean proportion recalled as a function of value and list for the control value condition in Experiment 3



Note: The error bars represent standard error.

Figure 9

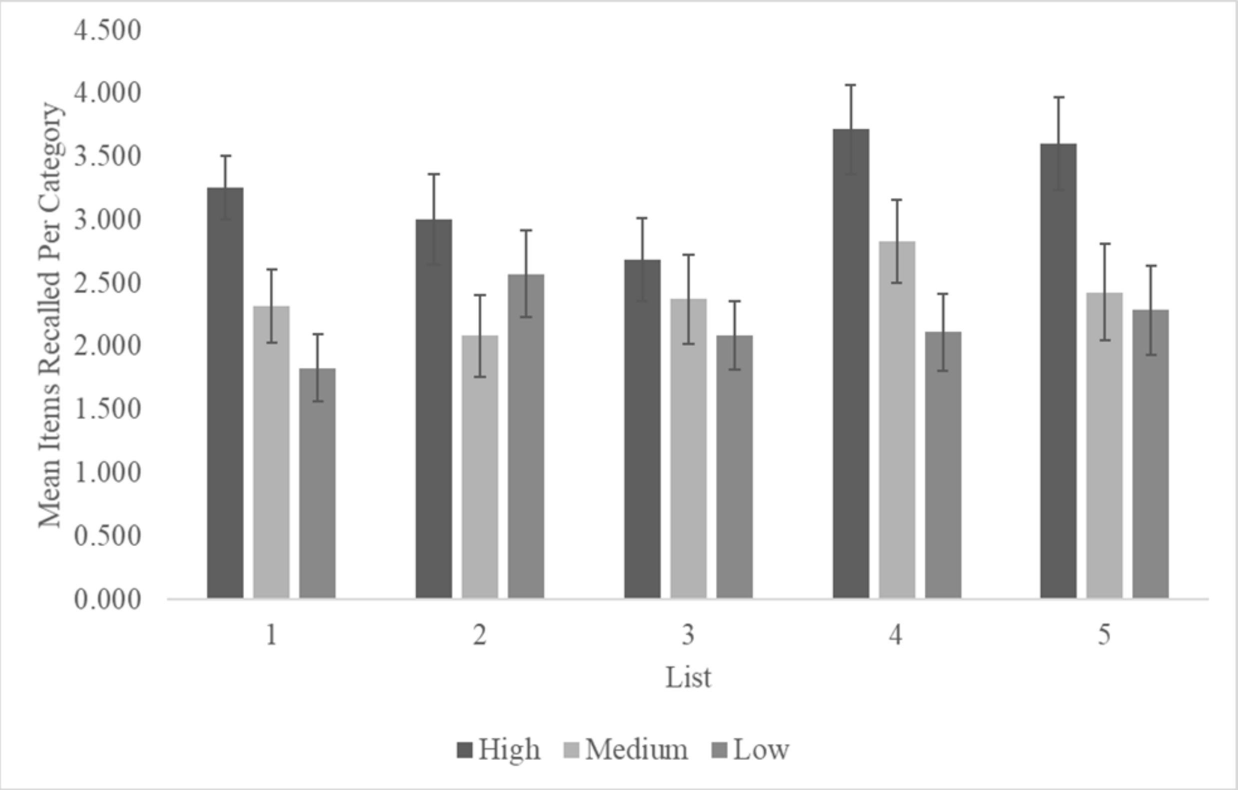
Mean items recalled per category as a function of value and list for the control value condition in Experiment 3



Note: The error bars represent standard error.

Figure 10

Mean items recalled per category as a function of value and list for the selective value condition in Experiment 3



Note: The error bars represent standard error.

VITA

Education

May, 2017	**M.A.**	**Experimental Psychology, The University of Alabama in Huntsville** Thesis: The Roles of Schematic Support and Fluency in Value Directed Remembering Advisor: Dr. Jodi Price
May, 2015	**B.A.**	**Psychology, North Carolina State University**

Teaching Experience

Instructor of Record	***University of Mississippi***
Spring, 2022	Developmental Psychology (Web), 162 students *Evaluation Score: Pending*
Spring Session II, 2022	Developmental Psychology (Web), 53 students *Evaluation Score: Pending*
Fall, 2021	Developmental Psychology (Web), 160 students *Evaluation Score: 4.07/5*
Fall Session II 2021	Developmental Psychology (Web), 62 students *Evaluation Score: 4.27/5*
Summer Session II, 2021	Introductory Psychology, 23 students *Evaluation Score: 4.0/5*
Spring, 2021	Developmental Psychology (Web), 133 students *Evaluation Score: 4.05/5*
Fall, 2020	Introductory Psychology (Web), 93 students *Evaluation Score: 4.27/5*

Spring, 2020	Special Topics - Psychology and Aging, 7 students
	Evaluation Score: 4.6/5
Fall, 2019	Research Methods in Psychology – Lab Instructor, 20 students
	Research Methods in Psychology – Lab Instructor, 20 students
	Research Methods in Psychology – Lab Instructor, 20 students
Teaching Assistant	***University of Mississippi***
Spring, 2022	Introductory Psychology
Summer Session I, 2021	Introductory Psychology
Spring, 2019	Brain and Behavior
	Cognitive Psychology
Fall 2017 – Fall 2018	Introductory Psychology
Tutoring	***University of Mississippi***
Spring 2018 & 2019	Undergraduate Statistics

Instructional Training & Endorsements

eLearning Endorsement, The University of Mississippi

Essentials of Online Teaching and Content Delivery, The University of Mississippi

Academic Outreach Training Series on Online Teaching and Learning, The University of Mississippi

Part 1: Student-centered learning, the theory of online teaching, and standard practices.

Part 2: Accessibility, University Policies, Available Technology, and Compliance.

Part 3: Designing activities and assessments that align with the learning objectives.

Part 4: Applying the theory of online teaching and design into practice.

Seminar on College Teaching, The University of Mississippi

Peer-Reviewed Publications

Skinner, D. J., & Price, J. (2019). The roles of meaningfulness and prior knowledge in younger and older adults' memory performance. *Applied Cognitive Psychology*, 1-10. doi:10.1002/acp.3552

Invited Chapters

Smith, R. E., & ***Skinner, D. J.*** (2019). Prospective Memory in Context: Methods, Findings, and Future Directions. In J. Rummel and M. McDaniel (Eds.), *Current Issues in Memory: Prospective Memory* (pp. 1-18). London: Taylor Francis.

Conference Presentations

Skinner, D. J., Smith, R. E., & Hunt, R. R. (2021) *The roles of item-specific and relational processing in value-directed remembering.* Poster to be presented at the Psychonomic Society Conference (New Orleans, November).

Skinner, D. J., Smith, R. E., & Hunt, R. R. (2020) *Another Glance at the Role of Semantic Processing in Value-Directed Remembering.* Poster presented at the Psychonomic Society Conference (Virtual, November).

Thibault, J., ***Skinner, D. J.***, Smith, R. E., & Hunt, R. R. (2019). *The Effects of Picture-Word Mismatch in the DRM Paradigm.* Poster presented at the Psychonomic Society Conference (Montréal, Canada, November).

Skinner, D., Erwin, H., Bonnell, S., & Price, J. (2018). *Value-directed Remembering in the Absence of Point Value: The Role of Fluency in Younger and Older Adults' Metamemory and Memory.* Poster presented at the Cognitive Aging Conference (Atlanta, GA, May).

Harrison, A., Huber, E., Crane, B., Waldon, M., ***Skinner, D.***, Myers, L., Erwin, H., & Price, J. (2017). *The role of relatedness and font size in JOLs.* Paper presented at the Southeastern Psychological Association Conference (Atlanta, GA, March).

Lester, W., Erwin, H., Harrison, A., Dyer, M., Hammett, K., Groves-Scott, B., ***Skinner, D.***, Waldon, M., & Price, J. (2017). *The impact of sequencing math problems on anxiety and performance.* Paper presented at the Southeastern Psychological Association Conference (Atlanta, GA, March).

Lester, W., Harrison, A., Hammett, K., Erwin, H., ***Skinner, D.***, Waldon, M., & Price, J. (2017). *Volume, implied volume, and gender's impact on judgments and performance.* Poster presented at the Southeastern Psychological Association Conference (Atlanta, GA, March).

Skinner, D., Erwin, H., Lester, W., Hammett, K., Dyer, M., & Price, J. (2016). *Examining the roles of familiarity and fluency in value-directed remembering.* Poster presented at the Psychonomic Society Conference (Boston, MA, November).

Harrison, A., Erwin, H., Waldon, M. A., ***Skinner, D.***, Crane, B., & Price, J. (2016). *Examining the roles of fluency and memory beliefs in participants' encoding strategies, judgments of* *learning, and memory performance.* Poster presented at the Psychonomic Society Conference (Boston, MA, November).

Lester, W., Harrison, A., Erwin, H., ***Skinner, D.***, Blakely, V., Hammett, K., Crane, B., Gazzola, C., Waldon, M. A., Blunt, M., & Price, J. (2016). *The role of problem fluency and difficulty in math problem solving.* Poster presented at the Southeastern Psychological Association Conference (New Orleans, LA, March).

Research Experience

June 2017-Present	Lab Manager and Graduate Research Assistant
	MIND Lab, The University of Mississippi
Fall 2015 – Spring 2017	Graduate Research Assistant
	Lifelong Learning Lab, The University of Alabama in Huntsville
Spring 2015 – Summer 2017	Graduate Research Assistant
	Institutional Review Board, The University of Alabama in Huntsville
Spring 2014 – Spring 2015	Undergraduate Research Assistant
	Adult Development Lab, North Carolina State University

Pertinent Research Skills & Certifications

Advanced knowledge of Qualtrics

Advanced knowledge of SPSS for statistical analysis

Collaborative Institutional Training Initiative (CITI) certified

Basic knowledge of R for statistical analysis

Basic knowledge of Tobii eye-trackers

Basic programming knowledge with E-prime and Python

Professional Service

Ad hoc Reviewer – *Memory & Cognition*

Ad hoc Reviewer – *Experimental Psychology*

Departmental Service

Fall, 2020 – Present	Diversifying Psychology Committee, The University of Mississippi Committee Member
Spring, 2019 – Present	Conference on Psychological Science, The University of Mississippi Committee Member
Fall, 2019	Faculty Search Committee, The University of Mississippi Committee Member
Spring 2017 – Fall 2018	Graduate Student Council, The University of Mississippi Senator – Psychology Department