THE INFLUENCE OF RECOLLECTION, AND FAMILIARITY ON AGE-RELATED DIFFERENCES IN PRIMARY AND SECONDARY DISTINCTIVENESS

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THE INFLUENCE OF RECOLLECTION, AND FAMILIARITY ON AGE-RELATED DIFFERENCES IN PRIMARY AND SECONDARY DISTINCTIVENESS

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SUMMARY

The distinctiveness effect refers to the finding of unique information that stands out from the environment having a higher probability of remembering compared to common or more typical stimuli. In three studies, the distinctiveness effect was examined under intentional and incidental encoding conditions in samples of young and older adults. In addition, estimates of recollection and familiarity, two critical memory processes, were examined to ascertain the mechanisms underlying the distinctiveness effect. Recollection refers to having access to detailed information about a particular memory trace whereas familiarity refers to the feeling that something has been seen or experienced before, but without any retrieval of specific details. Finally, objective source memory questions were provided to participants in an attempt to understand what types of detailed information participants were remembering about distinct items. Under intentional learning instructions, young and older adults exhibited distinctiveness effects, that were accompanied by increases in recollection and familiarity. This result is somewhat surprising as older adults normatively show declines in recollection as a consequence of normal aging. Under incidental instructions, none of the groups demonstrated distinctiveness effects, and estimates of recollection and familiarity were identical for distinct and non-distinct items. In fact, the estimates of recollection for older adults in this experiment look similar to those reported at large in the episodic memory literature. There was very little evidence for heightened objective source memory across any of the three experiments.

Together, these add to a growing consensus in the literature that older adults can benefit from the presence of distinct information. However, this appears to be limited to

intentional learning and not incidental learning. These data also support that notion that neither recollection or familiarity can alone account for novelty-related effects in memory. Furthermore, the current experiments suggests that in this kind of remembering situation older adults are able to display estimates of recollection that are commensurate with young adults. This surprising finding may arise because this kind of paradigm supports relational processing, which in turn can improve item-specific processing and boost recollection judgments.

CHAPTER 1

INTRODUCTION

The distinctiveness effect refers to the empirical finding that distinct information is remembered better than more typical or common information (Hunt & Worthen, 2006). Historically, there have been two primary ways of understanding distinctiveness effects. At first, distinctiveness effects were thought to stem from perceptual processes that gave increased attention to the distinct item or isolate (Jenkins & Postman, 1948). This intuitive explanation suggested that increased memory was the byproduct of enhanced encoding spurred on by the attention-grabbing distinct item. In essence, this makes distinctiveness an independent variable and not the outcome of a psychological process (Hunt, 2006). Moreover, with this perspective circular definitions of distinctiveness cannot be avoided. Hunt writes, "if the term distinctiveness is used to label the processes of perception / comprehension, the distinctive representation is distinctive because it was processed distinctively, an unacceptably circular explanation"(p. 6).

To avoid this circularity, distinctiveness effects are now viewed as a set of theoretical processes that can account for high remembering of certain items. This account arose out of the levels of processing framework, where distinctive processing was defined as the specific processing of a particular item that enhanced the discriminability of that item, and ultimately lead to superior retrieval of that item (Jacoby & Craik, 1979; Lockhart, Craik, & Jacoby, 1976). At its core, this theoretical position suggests that distinctiveness is the processing of both similarities and differences (Hunt & McDaniel, 1993). Importantly, and in contrast to the previous approach, distinctiveness is not treated as an independent variable but rather a psychological construct of interest

(Hunt, 2006). In fact, the perceptual processes of salience that are central to the intuitive explanation are not required within this theoretical stance (Dunlosky, Hunt, & Clark, 2000).

Classifications of Distinctiveness

Schmidt (1991) suggested that a single operational definition does not suffice to explain distinctiveness. Instead, he argued that a more comprehensive understanding can be achieved by classifying the literature into different types of distinctiveness. This division can be accomplished by classifying distinctiveness effects based on experimental manipulations and their subsequent effects on memory. Of interest to the current proposal are primary and secondary distinctiveness.

Primary Distinctiveness. In primary distinctiveness, distinct items stand in contrast to an immediate background, held in short-term or working memory. The background is created by the experimental stimuli, which revolve around a specific semantic or perceptual feature. The prototypical example of primary distinctiveness is the von Restorff (1933) or isolation effect. In studies of perceptual distinctiveness, the majority of to-be-remembered items are presented in one color (e.g., black), except for one item that is presented in another color (e.g., red; Hunt, 1995). In semantic isolation, participants are presented with a categorized list of items, one of which is not a member of the category (e.g., Schmidt, 1985). These manipulations create an immediate context of similarity against which isolate is processed. The standard finding in these paradigms is that the probability of remembering for distinct items is greater than the probability for non-distinct items. This effect is routinely reported in recall, and cued-recall, and recognition tests (Schmidt, 1991). Traditionally, distinct items are most often presented in the middle of the list, when the context of similarity has been clearly established. However, the distinctiveness effect occurs even when distinct items are presented early in the list before a background of similarity has been fully established (Kelley & Nairne, 2001; Smith, 2011).

Secondary Distinctiveness. Secondary distinctiveness effects occur when distinct items stand out from general knowledge structures stored in long-term memory. One example of this effect is the *bizarreness effect* in which bizarre items are remembered better relative to more normal or common material (e.g., McDaniel et al., 1995). Another example is the *orthographic distinctiveness* effect, in which words that have unusual spelling or lettering (e.g., *subpoena*) are remembered with a higher probability than items with more usual or common orthography (Rajaram, 1998). Evidence for both types of distinctiveness can be found in recall and recognition, but it may vary on the specific effect of interest. For example, orthographic distinctiveness can be found in recall and recognition (Hunt & Eliot, 1980).

Importantly, these effects persist even when participants are presented with entire lists of bizarre words (McDaniel & Geraci, 2006). This is possible because distinct items stand out relative to general knowledge, and not the immediate context. It also follows that orthographically distinct or bizarre items are remembered well even when they are first in a list of items.

In all, primary and secondary distinctiveness fit the general definition of distinctiveness as involving differences in the context of similarity. A critical difference between primary and secondary distinctiveness is that the background of similarity is held in short-term memory for primary distinctiveness, and long-term memory for secondary distinctiveness. According to Schmidt (1991), there are other differences. For example, primary distinctiveness are only found with within-subjects designs, whereas secondary distinctiveness can be observed in within- and between- subject designs. For the purposes of the current studies, it is important to note that isolation effects and orthographic distinctiveness can be found in recognition tasks.

Explanations of Distinctiveness

While the distinctiveness effect is quite robust, the mechanisms that underlie this effect are not well understood. Over the years, many explanations have been offered to explain this finding. The following is a brief, but not exhaustive, overview of some of these frameworks. Because this proposal focuses on the role of recollection and familiarity in distinctiveness, a more thorough discussion of research in this area will be provided.

Encoding Explanations. Explanations of the memory advantage for distinct items have primarily been based on enhanced encoding of distinctive items. In this conceptualization, distinct items receive elaborative processing at encoding, which creates more easily retrievable memory traces. The nature of the extra processing has been theorized to be greater elaborative processing (Schmidt, 1991; Wadill & McDaniel, 1998), greater evaluative processing (Geraci & Rajaram, 2002), increased rehearsal (Schmidt, 1991), and enhanced processing of the context in which the item appears (Hirshman, Whelley, & Palij, 1989). While these explanations are straightforward, they cannot account for many findings in the distinctiveness literature. First, the von Restorff (1933) effect is found even when the distinct item is the first item in a list of words (Hunt, 1995). In this situation, the isolate does not become distinct until a certain number of the remaining words have established a local context in short-term memory. Thus, it is unlikely that the first item would receive elaborative processing, relative to a non-distinct item in the same list position. Although, some researchers have suggested that once the local context is established, the distinct item receives additional rehearsal after its initial presentation (Dunlosky et al., 2000). Second, according to encoding explanations, divided attention and speeded presentation rates should eliminate the distinctiveness advantage by limiting the amount of attention or time participants can devote to remembering the items. Some studies do find this pattern (Geraci & Rajaram, 2002; Hunt & Toth, 1990; Worthen & Loveland, 2001); however, other studies have not (Hunt & Lamb, 1999; McDaniel & Geraci, 2006; Wadill & McDaniel, 1998), casting doubt on this hypothesis.

Retrieval Explanations. Due to the incompleteness of encoding accounts, researchers developed distinctiveness theories based on better retrieval of distinct items. One idea is that the distinct features of certain items serve as highly diagnostic cues during retrieval (Hunt & McDaniel, 1993; Wadill & McDaniel, 1998). An alternative idea is that distinct items make up their own category (Bruce & Gaines, 1976), which has a higher probability of being recalled because there are fewer items in that category. This is referred to as the cue overload hypothesis (Watkins & Watkins, 1975). Finally, some have proposed that there are fewer interfering candidate responses for distinct items, creating a higher probability of recall in comparison to non-distinct items, which may have more interfering candidate responses (Hunt & Lamb, 2001; Schmidt, 1991). Like encoding explanations, retrieval-based explanations do not entirely account for the full array of distinctiveness findings. For example, it is unclear how longer study time for distinct items is associated with better recall under a purely retrieval-driven explanation (Worthen & Loveland, 2001). Further, a retrieval-based account cannot explain the anterograde amnesia experienced for items surrounding distinct items. In other words, it would be difficult to see how retrieval might create worse memory for previous items unless one invoked an output interference explanation (Smith, 1971; 1973). In all, neither an encoding- nor a retrieval-based explanation of distinctiveness is complete enough to account for all of the findings in the distinctiveness literature.

New Framework. In an effort to clarify the discrepant explanations of distinctiveness, McDaniel and Geraci (2006) proposed a new framework, tying primary and secondary distinctiveness effects to retrieval and encoding explanations, respectively. Primary distinctiveness is produced at retrieval. In support of this, if an isolate is presented early in the list distinctiveness effects are still evident (Hunt, 1995), but it is too early for enhanced encoding. Dunlosky et al. (2000) demonstrated that judgments of learning (JOLs), or participant provided predictions about how well particular items will be remembered at some point in the future, were not greater for distinct items relative to non-distinct items. If there were enhanced elaborative encoding, one would expect more confident JOLs for distinct items. Other evidence suggests that primary distinctiveness is retrieval-oriented. Bruce and Gaines (1976) demonstrated that perceptually isolated items are clustered together at recall. Regarding secondary distinctiveness, research shows that dividing attention during study hurts memory for orthographically distinct words (Geraci & Rajaram, 2002). Further, Kline and Groninger (1991) suggested that limiting the time at encoding eliminated the bizarreness effect. These results imply that secondary distinctiveness is an encoding-based phenomena. However, it should be noted that other research with limited study time finds no influence of study time (McDaniel & Geraci, 2006).

Distinctiveness and Aging

Despite the vast amount of research on distinctiveness, little of it has been dedicated to examining age-related changes. Given that distinctive processing has been conceptualized as a critical memory process for multiple memory frameworks (e.g., levels of processing), it is important to understand if this ability is preserved in older adults. If distinctive processing does decline with normal aging, it could be an important source of age-related differences in memory (Smith, 2011). In such a case, it would also be critical to understand the mechanisms underlying this age-related decline.

Initially, there are reasons to expect that older adults may not show distinctiveness effects. As discussed above, explanations of distinctiveness effects rely on enhanced encoding or retrieval. Research on age-related changes in memory suggests that older adults do not demonstrate equivalent encoding or retrieval abilities relative to younger adults (Zacks, Hasher, & Li, 2000). On the other hand, the distinctiveness effect is so robust that individuals of all ages may show this phenomenon.

Primary Distinctiveness. Several experiments have investigated age differences in the von Restorff effect. Cimbalo and Brink (1982) had young and older participants study lists of consonants, and in half of the lists distinct letters were presented in a larger font than the other items. Older adults did not demonstrate the isolation effect like young adults. However, this study had several confounds, such as inappropriate control lists and the requirement to recall items serially (McDaniel et al., 2008; Smith, 2006). Additionally, the font change might not have been drastic enough for older adults to perceive, especially given declines in sensory abilities that accompany normal aging (Schneider & Pichora-Fuller, 2000).

Subsequent studies arrived at the opposite conclusion that older adults demonstrated the isolation effect (Bireta, Suprenant, & Neath, 2008; Smith, 2011; Vitali et al., 2006). Vitali and colleagues (2006) presented subjects with lists of 10 words, each followed by a short delay, then a recall task. In most of the lists (20 out of 25), distinct words were presented (in positions four through seven) in a larger font. No differences between young and older adults were found in recall of items presented in positions four through seven, but young adults were better than older adults for overall recall. However, analyzing items four through seven in the aggregate (and not just the distinct items) is not the ideal way to examine age-related differences in distinctiveness. Despite this, the results suggest that young and older adults both showed a distinctiveness effect, despite the fact that young adults were better in recall of all items.

Geraci, McDaniel, Manzano, and Roediger (2009) examined age-related differences in semantic isolation. Subjects were presented with categorized lists of eight items. Half of the lists had a distinct item (i.e., item from a different category) that was presented in position five through seven. Participants were then given a cued recall test, in which they were told to write down as many members of a given category as possible. They found that older adults displayed a distinctiveness effect (Dist: $M = .28$; Non-Dist: $M = .21$), but not as large as the effect shown by young adults (Dist: $M = .35$; Non-Dist: $M = .22$). This effect seemed to be carried by young and older individuals who reported being aware that lists were categorized, and some items did not fit into those categories.

These previous studies just discussed presented the distinct items in the middle of a list, presumably allowing for the establishment of a background of similarity. R.E. Smith (2011) recently showed however that when the isolate is presented early in the list (i.e., 2nd item) so that a background of similarity had not been established, that older adults did not show distinctiveness effects in recall. However, a second study demonstrated that older adults could show an early isolation effect when the difference between the isolate and the background items was large. In particular, the isolate was a number presented among a group of words, whereas in the first experiment, the isolate was a word from a different category than other words.

Smith (2011) recently proposed the Contextual Support for Similarity and Difference (CSSD) framework to help explain the patterns of results in the distinctiveness and aging literature. This model postulates that cognitive resources are required to obtain distinctiveness effects and because older adults exhibit declines in cognitive resources (Craik, 1986) older adults may not be expected to show distinctiveness effects. However, according to the model, the benefits of the distinctiveness effect can be facilitated through contextual support. Contextual support can be provided by presenting ample related background items to establish a background of similarity. To this point, older adults show isolation effects when the isolate occurs in the middle or the end of the list (Geraci et al., 2009; Vitali et al., 2006) but not when the isolate occurs early in the list (Smith, 2011). Additionally, contextual support can be provided by exaggerating the difference between the isolate and the background items (Smith).

In sum, while the original study by Cimbalo and Brink (1982) demonstrated age-related declines in distinctive processing, subsequent work has found no age differences.

On the whole, these results suggest that older adults are capable of demonstrating primary distinctiveness effects. These results are adequately explained using the CSSD framework. It is important to note that distinctiveness has been assessed using only recall and cued recall and not recognition. Consequently, more work in this area, using new methods, is needed to obtain a clearer picture of the influence of age on distinctiveness. Specifically, experiments using new distinctiveness paradigms as well as studies identifying potential mechanisms of establishing distinctiveness effects would help clarify these mixed findings.

Secondary Distinctiveness. A review of literature suggests that secondary distinctiveness is intact in older adults. For example, older adults demonstrate advantages in memory for bizarre items over more typical items (Black et al., 2004; McDaniel et al., 2008). Mäntyla and Bäckman (1992) demonstrated that older adults show comparable memory for inconsistent or unexpected items in a room full of expected items (i.e., the consistency effect)[1]. However, the magnitude of this effect may not be as large for older adults (McDaniel et al., 2008; Smith, 2006). Nicolas and Worthen (2009) reported an intact bizarreness effect for older adults, although the strength of this effect varied depending on the composition of bizarre to common pictures. Bizarreness effects were observed for all participants (younger adults, young-old adults, old-old adults) when there were more normal items than bizarre items, but old-old adults did not exhibit the effect

[1] It's unclear whether the consistency effect is better described as a primary or secondary distinctiveness. Schmidt (1991) originally classified the consistency effect as a primary distinctiveness effect. Yet, understanding what is inconsistent in a given room would presumably depend on long-term memory structures that contain information about what is appropriate in an office versus a child's playroom, for example.

when there were an equal number of bizarre and normal items. In addition, even when all groups showed a distinctiveness effect, the effect was not as strong in the older adult groups as it was in the younger adult group. To my knowledge, no study has addressed the influence of age on orthographic distinctiveness.

In sum, the literature suggests that older adults demonstrate secondary distinctive effects items like young adults. Further, it is also possible that older adults may not show the effect to the same degree as young adults. However, this outcome is drawn from only a few studies and awaits future testing using different paradigms.

Distinctive Processing and False Recall

As a final point, it is worth noting several studies that examine how false recall in the Deese-Roediger-McDermott (DRM; 1995) paradigm can be reduced by using distinctive processing. Specifically, individuals study DRM lists but are asked to generate item-specific information for each item on the list. Or, individuals are shown certain items as pictures instead of words. Both of these manipulations should increase the discriminability of certain items, and in turn reduce false memories. In fact, young adults typically show reductions in false memories (McCabe, Presmanes, Robertson, & Smith, 2004; Smith & Hunt, 1996), but these manipulations have failed to elicit reductions in false memories for older adults (Butler McDaniel, McCabe, & Dornberg, 2010; Smith, Lozito, & Bayen, 2005). Thus, in more typical distinctiveness paradigms older adults seem to show the standard effect (although perhaps not to the same extent as young adults), in DRM paradigms, older adults seem to not benefit from these kind of manipulations.

Recollection and Familiarity in Distinctive Processing

Several recent studies have aimed to understand distinctiveness through the processes of recollection and familiarity. In recent years, recollection and familiarity have become important explanatory constructs in studies of old/new recognition memory (Yonelinas, 2002), but only recently have they been used to investigate other memory phenomena like distinctiveness. Recollection refers to the recall of specific contextual details about a memory episode (see Yonelinas, 2002 for a review of both recollection and familiarity). Recollection is conceptualized as slower than familiarity, because it is a controlled, effortful process that relies on limited cognitive resources (Jacoby, 1991). Familiarity refers to the feeling that something has been experienced before without recollection of any of the details about the original episode. In contrast to recollection, familiarity is a quick, automatic process that does not rely on limited cognitive resources. It should also be noted that recollection and familiarity are posited to be independent processes at retrieval.

Measuring Recollection and Familiarity

There are various ways to estimate recollection and familiarity. The current experiments used the Remember-Know (RK) procedure and so that will be focused on here. For excellent reviews of other estimation procedures see Yonelinas (2002).

Recollection and familiarity are commonly measured using RK judgments. Originally developed by Tulving (1985), this method was not intended to measure recollection and familiarity but rather to investigate whether subjects could remember themselves in the past (autonoetic consciousness). With this method, participants are asked to report whether they “remember” or “know” that an item was presented before. (Participants are often given the option of “new” to denote that an item was not presented before). Participants should report “remember” when they can recall some specific detail about the memory representation. On the other hand, participants are instructed to respond “know” when they remember being presented with the item but cannot recollect anything specific. Recollection is normally calculated as the proportion of “remember” responses. However, recent studies suggest that using the raw proportion of "remember" judgments may be inappropriate and d' may be a more appropriate statistic (McCabe & Geraci, 2009; McCabe, Roediger, McDaniel, & Balota, 2009). Familiarity is calculated as the probability of a “know” response given that it was not recollected, [Familiarity = “know”/(1 – recollection)] (Yonelinas & Jacoby, 1995). The major benefit of using this method is that recollection is inclusive, as opposed to Inclusion / Exclusion (IE) tasks which are exclusive. However, this method is also based on the assumption that individuals have some veridical access to their memory.

However, there are certain aspects of the standard RK procedure that elicit concern. For example, individuals have their own connotation for the ideas of “remembering and “knowing” that may be different from the instructions, which in turn may lead to inaccurate responses. Further, the original directions do not encourage participants to make sure they can recollect specific pieces of information about the memory trace. Since recollection is often measured as the raw proportion of “remember” judgments, accuracy may be improved by highlighting the importance of retrieving source information for “remember judgments”. In response to these concerns, McCabe and Geraci (2009) reformatted the RK procedure. Specifically, they instructed participants to use the term ‘Type A’ to denote a remember judgment and the term ‘Type B’ to denote a “know” judgment. In this way, the connotations of those two terms are removed. Additionally, the instructions provided to participants for 'Type A' responses emphasize the importance of being able to recall a specific piece of information. This set of instructions will be used in the current experiments.

In addition to asking participants about their subjective source retrieval (i.e., RK judgments), researchers have also begun asking participants to make objective source judgments following a "remember" or "know" judgment. For instance, Duarte, Henson, and Graham (2007) asked participants to recollect whether an "old" item was presented on the top or bottom portion of the computer screen, or whether it occurred on the first or second list of to-be-remembered objects. (Participants were also offered a "don't know" option if they have no idea about the source). This technique considerably narrows the operational definition of recollection. However, it does have the advantage of gaining actual information about what participants are recollecting about a particular memory trace. In terms of estimation, recollection is equal to the proportion of hits on the source question (sometimes corrected for response bias, by subtracting the probability of false alarms). Familiarity judgments are often associated with "don't know" source judgments, and so objective familiarity is not calculated.

Theoretical Accounts of Recollection and Familiarity in Distinctiveness

Within the framework of recollection and familiarity, two hypotheses have been proposed to explain distinctiveness effects. These hypotheses attempt to unitarily tie recollection or familiarity with distinctiveness effects. Perhaps the most straightforward account of distinctiveness is that distinctive items are simply recollected better (*recollection-distinctiveness hypothesis*; Kishiyama & Yonelinas, 2006). Rajaram (1998) found that distinct items were associated with more "remember" responses, indicating a greater subjective awareness of remembering. Moreover, this hypothesis suggests that individuals may be able to recall contextual information about these distinctive memory representations. The finding that distinctiveness effects are commonly found in recall (Hunt, 1995), also supports this hypothesis. Since recollection is thought to play a larger role in recall (Jacoby, 1991), this suggests that recollection is critical in memory for distinct items. Additionally, in an effort to tie recollection to encoding- and retrieval-based explanations, Kishiyama and Yonelinas (2006) have suggested that recollection might reflect enhanced encoding of novel items, which might include increased elaborative rehearsal.

A less obvious but equally plausible account is that familiarity plays a role in memory advantage for distinct items, the *familiarity-novelty hypothesis* (Kishiyama & Yonelinas, 2003, 2006). The rationale is that the same mechanism responsible for detecting distinctiveness may also be the same mechanism responsible for detecting familiar items (Kishiyama and Yonelinas, 2006). Parker, Wilding, and Ackerman (1998) demonstrated that isolation effects were eliminated with lesions to the parahippocampal gyrus and not with lesions to the hippocampus proper. Given that most research suggests that the hippocampus is linked to recollection, and the parahippocampal gyrus is linked with familiarity (e.g., Diana, Yonelinas, & Ranganath, 2007), it suggests that familiarity is the critical factor in distinctiveness. However, this study did not calculate estimates of recollection and familiarity, so the conclusions await further testing. It is further posited that familiarity may reflect reduced interference at retrieval or an automatic orienting response to novel items (Kishiyama and Yonelinas, 2006).

Primary Distinctiveness and Recollection and Familiarity

Recently, Kishiyama and colleagues (Kishiyama & Yonelinas, 2003, 2006; Kishiyama, Yonelinas, & Lazzara, 2004) investigated how novelty influenced estimates of recollection and familiarity. They presented subjects with a long series of objects, which were presented primarily in one color (e.g., red against a white background) but several items were presented in a distinct color (e.g., yellow against a black background). Half of the participants were given intentional memory instructions, and the other half were given incidental instructions (i.e., they were not told there would be a memory test). At test, subjects made RK judgments on items presented for recognition. Critically, there were 30 of each of the following items: old novel (items presented in yellow that were previously presented), new novel (items presented in yellow but were not actually presented), old non-novel (non-distinct items that were previously presented), and new non-novel (non-distinct items not actually presented). The distinct items (both new and old) were presented in their distinct color during recognition. There were three noteworthy results. First, under intentional encoding instructions, novel items were associated with increases in recollection and familiarity relative to non-novel items. Second, under incidental instructions, familiarity was reliably higher for novel compared to non-novel items, but no such increase was observed for recollection. Specifically, changing the instructions led to a reduction in recollection for distinct items. Third, across intentional and incidental conditions, the magnitude of the familiarity effect was numerically similar, although the actual numerical estimates declined from intentional to incidental conditions. Thus, primary distinctiveness stems from both recollection and familiarity, however certain manipulations (like differences in encoding instructions) can change the pattern of these estimates. Given that familiarity was the only consistent effect across conditions, this study may suggest that distinctiveness effects can be obtained with increases through familiarity alone.

Secondary Distinctiveness and Recollection and Familiarity

Several experiments have also addressed the role of recollection and familiarity in secondary distinctiveness. Rajaram (1998) had participants make RK judgments on orthographically distinct and non-distinct words. Later analyses (Kishiyama and Yonelinas, 2006) demonstrated that recollection and familiarity were higher for orthographically distinct words relative to common words. Considerably more research has been conducted using word-frequency effects. Notably, the pattern is identical to the one just described, as low-frequency words are recognized better than high-frequency words and are associated with larger recollection and familiarity. Studies have reported this pattern using RK judgments (Bowler, Gardiner, & Grice, 2000; Gardiner & Java, 1990), inclusion / exclusion (IE) tasks (Guttentag & Caroll, 1997; Komatsu, Graf, & Uttl, 1995), and response operator characteristic (ROC) curves (Arndt & Reder, 2000). Finally, Brandt, Macrae, Schloerscheidt, and Milne (2004) looked at differences in recollection and familiarity across typical and atypical faces (those rated highly on the dimension of being able to "stand out in a crowd"). Participants were presented with faces of both types under full or divided attention and then given a recognition test. With full attention, recollection and familiarity for distinct faces were elevated relative to normal faces. Under divided attention, both recollection and familiarity were higher with distinct faces, but the recollection advantage was reduced and the familiarity advantage was unaffected.

In summary, previous research suggests that recollection and familiarity are both critical processes in obtaining primary and secondary distinctiveness. The role of familiarity seems to be more consistent as it has been found across most conditions. Recollection on the other hand seems to vary with manipulations that influence encoding, such as instructions and divided attention. For example, with incidental encoding, individuals may not engage in elaborative encoding, which in turn lowers recollection estimates. Notably, research to date does not provide a clear answer to what each process is responsible for in establishing distinctiveness effects. Further, there are currently not enough studies to see if there are any meaningful differences between primary and secondary distinctiveness. Nevertheless, recollection and familiarity may be effective tools through which to understand distinctiveness.

Recollection and Familiarity and Aging

In memory and aging research, recollection and familiarity have become important explanatory constructs. The most commonly observed pattern is that aging is associated with declines in recollection but leaves familiarity intact (Hoyer & Verhaeghen, 2006). This has been found using IE tasks (Jacoby, 1999; Jennings & Jacoby, 1997), RK judgments (Norman & Schacter, 1997; Parkin & Walker, 1992) and ROC curves (Daselaar et al., 2006). This pattern is entirely consistent with the notion that older adults show declines in controlled processing tasks like source memory (Spencer & Raz, 1995), and do not show declines in automatic processes (Hasher & Zacks, 1979). Recently, Prull et al. (2006) had the same group of elderly subjects complete three separate memory tests used to derive estimates of recollection and familiarity. With all three methods, they found that recollection declined in the older adults relative to the younger adults. Interestingly, they reported that familiarity declined in older adults when measured using RK judgments and ROC curves. This finding is consistent with other reviews (Healy, Light, & Chung, 2005; Light, Prull, LaVoie, & Healy, 2000).The only time familiarity remained invariant was when it was measured using IE tasks.

Additionally, researchers have begun to investigate differences within groups of older adults. In general, older adults are split into high- and low-performing groups based on a neuropsychological test battery (e.g., Glisky, Polster, & Routhieaux, 1995) or by performing a median-split on participants' memory data (Duarte, Ranganath, Trujillo, & Knight, 2006). Duarte and colleagues (2006, 2007) reported that high-functioning older adults demonstrated estimates of recollection (as measured by RK judgments) equivalent to young adults. This agrees with research showing that high-frontal functioning older adults demonstrate source memory performance similar to young adults (Glisky, Rubin, & Davison, 2001). Conversely, low-functioning older adults had significantly lower estimates of subjective recollection relative to high-functioning older adults and young adults. However, both high- and low-functioning older adults exhibited deficits in recollection when measured by objective source judgments. Lower objective recollection estimates are inconsistent with previous work demonstrating equal and numerically larger estimates of objective recollection as compared to subjective recollection (Jacoby, Debner, & Hay, 2001), although there are differences between these studies that may account for this inconsistency. Nonetheless, this research suggests there are meaningful differences between high- and low-functioning older adults that alter the picture of cognitive aging. High-functioning older adults may not demonstrate declines; rather they may be restricted to low-functioning older adults.

Distinctiveness, Recollection, Familiarity, and Aging

The previous discussion on distinctiveness, aging, and the role of recollection and familiarity leads to a perplexing situation. The majority of studies (although few in number) find intact distinctiveness effects (both primary and secondary) in older adults. Additionally, Kishiyama and Yonelinas (2003) suggest that memory for distinct items is associated with increases in recollection and familiarity. Thus, if older adults demonstrate a memory advantage for distinct items over non-distinct items, one might predict that this would also be accompanied by increases in recollection and familiarity. However, this result would be inconsistent with literature suggesting declines in recollection and familiarity (when measured by RK judgments) in older adults.

In this circumstance, several possibilities arise. First, older adults may demonstrate distinctiveness effects comparable to young adults. According to the work of Jacoby and colleagues (Jacoby, 1999; Jennings & Jacoby, 1997), older adults should exhibit declines in recollection, and thus the distinctiveness effect should be carried by increased familiarity for distinct items. This outcome is entirely possible, as Kishiyama and Yonelinas (2003) reported greater familiarity judgments for distinct items under both incidental and intentional encoding conditions. Similarly, divided attention lowered recollection estimates to memory for distinct faces (Brandt et al., 2003) and divided attention is often times used in the cognitive aging literature to mimic the effects of normal aging (e.g., Craik, 1982; Craik, Govoni, Naveh-Benjamin, & Anderson, 1996 but also see Naveh-Benjamin, 2001for a different result). Another possibility is that older adults will show distinctiveness effects, but not as large as those exhibited by young adults (e.g., Geraci et al., 2009). This finding might be accurately explained by age-related decreases in recollection (and not familiarity). This would suggest that distinctiveness effects can be obtained through familiarity alone, but recollection contributes to the strength or magnitude of the effect. Alternatively, it might be explained by small and simultaneous decreases in recollection and familiarity. In other words, estimates of recollection and familiarity for distinct items may be statistically different than estimates for non-distinct items, but the magnitude of this difference for older adults will not be as large as the difference displayed by young adults. This pattern of findings would be consistent with recent work reporting that both recollection and familiarity decline with age, especially when measured with RK judgments (Prull et al., 2006). A final possibility is that older adults show distinctiveness effects, similar in magnitude to young adults. If this were associated with similar estimates of recollection and familiarity, it would provocatively suggest that recollection does not unequivocally decline with age, and rather, in certain situations, older adults show preserved recollection abilities to support their memory performance.

An opposite finding would be that older adults do not demonstrate distinctiveness effects. Again, this possibility could be associated with various patterns of recollection and familiarity. Based on Kishiyama and Yonelinas (2003), the complete absence of a distinctiveness effect would be associated with declines in recollection and familiarity (e.g.,Jacoby, 1999). This finding would disagree with the conclusions of Jacoby and colleagues. However, it would support research suggesting the simultaneous decline of recollection and familiarity (Prull et al., 2006).

Finally, the previous discussion of possibilities neglects to acknowledge any potential interactions arising from differences between primary and secondary distinctiveness. Even within primary distinctiveness, one could observe differences between semantic and perceptual primary distinctiveness (Craik, 2006). There might also be interesting interactions occurring across high- and low-functioning older adults. For example, it may be the case that age-related differences could be due to low-functioning older adults (Butler et al., 2004; McDaniel et al., 2008).

In the three studies reported next, distinctiveness effects were examined across young and older adults. In the first two studies, participants were instructed to remember words for a future memory test (i.e., intentional) and in the third study, participants were not informed of a upcoming memory test (i.e., incidental). In addition, the mechanisms of recollection and familiarity were examined, and the above-stated hypotheses were tested. Although there are many possibilities, it was predicted that older adults would demonstrate distinctiveness effects and that these would be accompanied by increases in familiarity but not recollection.

CHAPTER 2

PRIMARY DISTINCTIVENESS AND AGING UNDER INTENTIONAL LEARNING INSTRUCTIONS

The primary goal of this experiment was to investigate whether distinctiveness effects would be evident in recognition for young and older adults under intentional encoding conditions with an isolation paradigm. Previous research is clear that young adults demonstrate this effect, and more recent research has suggests that older adults also demonstrate this effect (e.g., Bireta et al., 2008; Geraci et al., 2009; Vitali et al., 2006). However, previous research has also failed to find distinctiveness effects in older adults (e.g., Cimbalo & Brink, 1982), and a more recent study suggested that older adults can show isolation effects when the isolate occurs late, but not when the isolate appears early (Smith, 2011). Further, in studies where distinctiveness processing can be helpful for avoiding false recall, older adults have also shown deficits (Butler, et al., 2010; Smith, et al., 2005) Thus, the current study should add to this literature and also extend it by examining estimates of recollection and familiarity using RK judgments.

Kishiyama and Yonelinas (2003) found that under intentional instructions both recollection and familiarity estimates were larger for distinct items relative to non-distinct items, albeit with pictures instead of words. They also only examined the performance of young adults. Also, in the current experiment, the influence of medial temporal lobe (MTL) and frontal lobe (FL) functioning was examined. This was done because intra-group differences in functioning may be an important factor. Specifically, the results may suggest that only low-functioning older adults do not show the distinctiveness effect. In turn this might suggest that previous research which failed to find distinctiveness effects in older adults, might have been driven by low-functioning individuals. Finally, objective source performance was examined to attempt to understand what about the distinct items individuals are remembering.

Method

Participants

Thirty-seven younger adults and 35 older adults participated in the study. Five younger adults and 3 older adults were removed from the analysis for committing an excessive amount of false alarms (≥.6). Hence, the final analysis was conducted on a sample of 32 younger and 32 older adults. The characteristics of the sample, separated by MTL function (see below for more details) are presented in Table 2.1.

Table 2.1 Participant characteristics by MTL group

Group	N	Age	Range	Education	Health	MTL Score
Low-MTL YA	16	19.6 (1.2)	18 - 22	13.4 (1.0)	4.3 (.70)	-.14 (.18)
High-MTL YA	16	20.0 (1.5)	18 - 24	13.6 (1.2)	4.3 (.60)	.14 (.06)
Low-MTL OA	15	68.5 (3.8)	63 - 76	16.5 (2.2)	4.1 (.83)	-.20 (.15)
High-MTL OA	17	70.8 (5.3)	62 - 78	15.8 (2.0)	3.9 (.83)	.18 (.07)

*Standard deviations are presented in parentheses. YA = Young adults. OA = Older adults.

Older adults reported more years of education (M = 16.2; SD = 2.1) than younger adults (M = 13.5; SD = 1.1), t (62) = 6.3, p < .001. There were no differences in education between the high- and low-MTL young adults, t(30) = 0.47, p = .64, nor between the high- and low-MTL older adults, t (30) = 0.79, p = .43.There were no differences in self-reported health between older (*M* = 4.0; *SD* = .82) and young (*M* = 4.3; *SD* = .64) adults, *t* (62) = -1.52, *p* = .133. To get more information about the sample, young and older adults were compared on cognitive performance. Specifically, performance on the neuropsychological test battery (see below for task descriptions) is presented in Table 2.2.

Table 2.2 Performance on the Neuropsychological Test Battery for Older and Younger Adults

	Older Adults		Younger Adults		Statistics	
Measure and Max Score	Mean	SD	Mean	SD	*t* value	*p* value
mWCST (8)	3.4	2.1	5.1	1.6	3.61	.001
Mental Control (6)	5.6	0.8	5.5	0.7	0.68	.50
COWAT	47.3	16.7	48.2	12.1	0.27	.79
Backward Digit Span (12)	6.6	2.0	7.7	1.9	2.23	.023
Mental Arithmetic (19)	12.8	3.1	12.4	2.7	0.47	.64
Logical Memory I (50)	20.8	6.5	25.0	7.4	2.38	.02
Verbal Paired Associates I (18)	18.4	3.7	22.9	1.6	6.24	< .001
Visual Paired Associates I (24)	13.1	4.0	16.8	2.0	4.73	< .001
CVLT - Delayed (16)	10.2	3.6	13.7	1.9	4.95	< .001

*mWCST = modified Wisconsin Card Sorting Test. COWAT = California Oral Word Association Test. CVLT = California Verbal Learning Test.

Young adults, on average, performed superior to older adults on all episodic memory measures (see Table 2.2 for specific results). Young adults also scored better on the mWCST and Backward Digit Span. There were no age-related differences however on the measures on Mental Control, COWAT, and Mental Arithmetic.

Design

This experiment was a 2 (Distinctiveness: Distinct, Non-Distinct) x 4(Group: High-MTL YA, High-MTL, OA, Low-MTL YA, Low-MTL OA) mixed factorial design with Distinctiveness serving as a within-subjects variable and Group serving as a between-subjects variable.

Materials

Words for the current study were gathered from the English Lexicon Project (Balota et al., 2007). The word lists contained three types of words: distinct, control, and filler. Distinct words appeared in red. Control words appeared in yellow and were tested during the recognition. Filler words appeared in yellow, appeared at the beginning and end of lists as well as interspersed in the middle, but were not tested during recognition. To facilitate the source memory question, during the encoding phase words appeared on either the top or bottom of the screen.

Words were randomly assigned to one of 5 lists. Each list contained 2 distinct words, 2 control words, and 8 filler words. Over the 5 lists, participants saw a total of 10 distinct words and 10 control words. An additional 10 distinct and control words served as lures during the recognition test. To ensure that all words appeared as studied and non-studied items across the experiment, two versions of the task were created. In other words, the studied distinct and common words in the first version, served as lures in the second version. Within each version, there were two orders (that were randomly determined) to ensure that presentation order of the lists did not affect results.

In addition to the distinctiveness test, participants completed a neuropsychological test battery (Glisky et al., 1995). The test consists of 5 tests of FL function and 4 tests of MTL function. Each of these tests will be described briefly.

Modified Wisconsin Card Sorting Task (mWCST; Hart, Kwentus, Wade, & Taylor, 1988). In this task, participants are given a deck of 48 cards and are asked to sort those cards by one of three classifying rules: color, number, or shape. When the participant places a card down, they are told whether they have correctly or incorrectly classified that card. Participants use this information to figure out the rule. The rule changes once the participant correctly sorts the cards six times in a row. When participants have sorted the entire deck the task is over. The participant’s score on the test is the number of rules learned over the course sorting the deck.

Mental Control. In this task from the WAIS (Weschler, 1997), participants are asked to (1) count backwards from 20 as fast as they can, (2) say the alphabet as fast as they can, and (3) count forwards by 3's as fast as they can (up to the number 40). Participants need to accomplish the first two tasks in under 30 seconds each and must accomplish the third task in under 45 seconds. An error occurs when participants exceed the allotted time for each task or make an error in their responses. For each trial two points can be earned. One point for completing the task in under the allotted time and another for making no errors. A perfect score on this measure is a 6.

California Oral Word Association Test (COWAT). In this task (Benton & Hamsher, 1976), participants are given a letter and are instructed to name as many words that start with that letter that they can think of in 60 seconds. Participants are given the letters *F*, *A*, and *S* in that order. The score is the number of words generated across those three letters.

Backward Digit Span. In this task from the WMS-R (Weschler, 1987), participants are read strings of numbers and asked to recall them to the experimenter in the reverse order from which they were read. Participants receive two trials of each set size (2 - 7). Participants are stopped when they incorrectly repeat items for both trials within the same set size. The score on this measure is the total number of correct trials.

Mental Arithmetic. In this task from the WAIS-R, participants are read aloud math problems and are instructed to solve them without the use of paper and pencil in a limited amount of time. Participants are allowed to trace numbers and math equations with their finger on a table. There are a total of 14 questions of progressing difficulty. The task ends when all questions have been attempted or the participant answers incorrectly to four consecutive questions. The score is the number of questions answered correctly plus any bonus points for answering certain questions quickly.

Logical Memory I. In this task from the WMS - R (Weschler, 1987), participants are read two short stories and asked to recall the story using the exact words if possible. The score on this test is the number of idea units correctly recalled by the participant across the two stories.

Verbal Paired Associates I. In this task from the WMS-R, participants are read a list of eight paired associates (e.g., *school - grocery*), half of which are related. At test, participants are provided with a cue word (*school*) and are asked to respond with the appropriate paired associate (*grocery*). During recall, wrong answers are corrected by the experimenter. This study-test cycle occurs three times and the participant's score is the number of correctly recalled words across the three study-test cycles.

Visual Paired Associates I. In this task from the WMS-R, participants are shown figures that are paired with colors. After being shown these 6 paired associates, participants are given just the figure and are asked to point to the color (on a slip of paper) that goes with that figure. During test, incorrect answers are corrected by the experimenter. Again, there are three study-test cycles and the participant's score is the total number of correctly recalled words across all study-test cycles.

California Verbal Learning Test (CVLT) - Delayed. In this task (Delis, Kramer, Kaplan, & Ober, 2000), participants are read aloud a list of 16 items they are to get on a shopping list. The list contains four items for from four different categories (e.g., tools, fruits, spices, and articles of clothing). After each time the list is read, participants write down as many of the items as they can remember from the list. This is repeated 5 times at the beginning of the neuropsychological test battery. Then at the end of the test battery, participants were again asked to recall as many items as they could from the list, without having the list read to them again. Participants score on this measure is the number of items they correctly recalled during the final list retrieval.

Procedure

Participants first completed the informed consent and demographic questionnaire. Then participants were seated in front of a computer and told their task in the current study was try to remember words for an upcoming memory test. Words were broken up into 5 lists of 12 words each. For young adults, each word appeared for 2000msec and for older adults each word appeared for 3500msec. This was done to account for age-related slowing (Salthouse, 1991). Participants were allowed to take a break between lists.

After finishing the study phase, participants were given instructions for the test phase. Participants were told they were going to be presented with a word on the screen and they were to respond with one of three responses to indicate their memory for the item: Type A, Type B, or New (McCabe & Geraci, 2009). The full instructions are provided in Appendix A. Participants were instructed to press the button labeled 'A' to indicate a Type A response, if they could recall or recollect a specific detail about the original study episode. For example, participants should make a ‘Type A’ response if they can remember what the word looked like on the screen, or they remember they associated that particular word with another word on the list. Participants were instructed to press the button labeled 'B' to indicate a Type B response, if they think the item was previously presented but cannot recollect any specific details about the original encoding episode. Finally, participants were instructed to press the key labeled 'N' to indicate that a given word was new to the experiment and had not been seen previously. After the initial explanation, participants told the experimenter what each type of response indicated. If it was not clear the participant understood the distinctions between the response options, the instructions were repeated until this understanding was reached.

Next, participants were informed that if they made a ‘Type A’ or’ Type B’ response they would be asked an additional question: Where on the screen did the word appear? If participants remembered the word was presented on the top part of the screen, they were instructed to press the '1' key. If they remember it was presented on the bottom half of the screen they were to press '2'. Finally, if the participant could not recall where the word was presented they were instructed to press the '3' key. These cues were available to participants during the task in case they forgot. If there were no further questions, participants proceeded through the test phase at their own pace. Before beginning the task, participants were also informed that half of the items presented during the recognition phase would be new to the experiment, and half of the items they would have been presented with.

Data Analysis

Neuropsychological Test Battery

A principle axis factor analysis was performed on the tests from the neuropsychological test battery above. The factor solution was constrained to two factors based on previous research (e.g., Glisky et al., 1995). A Promax rotation was also applied to the original factor solution to aid in the clarity of interpretation.

Groups were formed on the basis of a median-split on the dependent variable of the factor score (either MTL or FL). Each individual's factor score was calculated as follows. First, all relevant measures for a given factor (e.g., MTL: Logical Memory, I, Visual Paired Associates I, Verbal Paired Associates I, CVLT-Delayed) were standardized. These standardized scores were then weighted by the appropriate weight in the factor score coefficient matrix. Finally, to compute a factor score, an average was taken of all the weighted standardized measures. A median was computed, and individuals within each group were split into groups on the basis of that median. In the event an individual scored at the median, they were placed in the high- group.

Distinctiveness Analysis

To examine distinctiveness effects, recognition memory performance for distinct items is contrasted with that for non-distinct items. This basic procedure was conducted for all of the components of recognition memory performance. Hits are defined as old judgments (i.e., Type A or Type B) to items that were viewed during the study phase of the experiment. False alarms are defined as old judgments to items that were not viewed during the study phase. Corrected recognition is calculated as Hits - False alarms. Finally, *d'* is calculated: *z*(hits) - *z*(false alarms). Since *d'* cannot be calculated when using zeros and ones, a standard correction was applied to all these instances (Wixted & Lee, 2011). Specifically, for scores of zero, the correction 1/(2N) was applied, where N is the maximum number of false alarms possible. In experiments1 and 3, $N = 10$. In experiment 2, $N = 15$. For scores of one, the correction 1 - 1/(2N) was applied.

When a main effect of Group is reported, these are followed by all planned pairwise comparisons using Tukey's Honestly Significant Difference Test. These tests identify differences that drive the omnibus effect, while controlling for Type I error amongst contrasts.

Estimates of Recollection and Familiarity

In addition to basic recognition memory performance, estimates of recollection and familiarity were derived from the variant of the RK procedure. Recollection was calculated as the raw proportion of 'Type A' (i.e., "Remember") responses. For comprehensiveness, *d'* was also calculated for ‘Type A’ judgments (i.e., z ['Type A' hits] - z ['Type' A false alarms]). In line with independence remember-know procedure described by Yonelinas and Jacoby (1995), familiarity is calculated as the probability of a 'Type B' (i.e., "Know") response given that it was not recollected: Familiarity = 'Type B' / (1 - Type A).

Source Memory Data Analysis

For the objective source memory test, participants' responses can be classified into 3 categories: hits, miss, and don't know. As an index for examining performance on this measure, a corrected source memory score was created using the formula: Hits-Misses / # of responses. A score of zero or lower indicates chance performance on the task (i.e., guessing). Positive scores indicate above chance objective source memory.

Results

We conducted a factor analysis on the younger and older adult data to examine if we could extract a MTL and FL factor. The factor loadings after a Promax rotation are shown in Table 2.3.

Table 2.3 Factor Loadings for the Neuropsychological Battery of Tasks After Promax Rotation

Measure	Factor 1	Factor 2
mWCST		.27
Mental Control		.62
COWAT		.08
Backward Digit Span		.12
Mental Arithmetic		.65
Logical Memory I	.51	
Verbal Paired Associates I	.87	
Visual Paired Associates II	.67	
CVLT - Delayed	.82	
Eigenvalue	2.81	1.56

* mWCST = modified Wisconsin Card Sorting Test.
COWAT = California Oral Word Association Test.
CVLT = California Verbal Learning Test.

The first factor appears to represent MTL function as evidenced by the high loadings of the tests purported to measure episodic memory ability. The executive function tasks load predominantly on the second factor suggesting that this factor measures FL function[2]. The FL groups are discussed after MTL groups.

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[2] The factor analysis perhaps suggested the extraction of 3 factors as there were three factors with an eigenvalue over 1. However, for the sake of consistency, only two factors were extracted based on prior research.

A factor score was calculated for each person and then within each age group, high- and low-MTL groups were determined by a median split. The group differences across the different tasks can be seen in Table 2.4.

Table 2.4. Performance on the MTL Tasks Across Groups

	High-MTL YA		Low-MTL YA		High-MTL OA		Low-MTL OA	
Measure	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Logical Memory I	28.9	7.2	21.1	5.6	22.8	6.0	18.6	6.5
Verbal Paired Associates I	23.6	0.5	22.3	2.1	21.1	2.2	15.4	2.6
Visual Paired Associates I	17.1	1.9	16.6	2.0	14.9	3.7	10.1	3.5
CVLT - Delayed	15.3	0.9	12.3	1.3	12.5	2.2	7.7	3.1

* CVLT = California Verbal Learning Test. YA = Young adults. OA = Older adults.

There were reliable differences across the MTL scores, F (3,60) = 35.68, $p < .001$. Planned comparisons revealed there were significant differences between the low-MTL young adults and the high-MTL young adults and older adults (both *p*’s < .001). Similarly, low-MTL older adults had significantly lower scores compared to high-MTL young and older adults (both *p*’s < .001). However, there were no differences between either low-MTL group ($p = .55$) or either high-MTL group ($p = .834$).

To examine actual performance differences on these tests between groups, one-way ANOVAs were conducted. All omnibus tests were reliable ($p < .001$) and so, only planned comparisons for each test will be mentioned. For Logical Memory I, high-MTL young adults performed better than all groups (high-MTL older adults, $p = .038$; low-MTL young adults, $p = .005$; low-MTL older adults, $p < .001$). There were no differences among any of the other groups. For Verbal Paired Associates, high-MTL young adults performed better than high-(p = .004) and low-MTL (p < .001) older adults. Additionally, low-MTL older adults performed worse relative to both high-MTL older adults (p < .001) and low-MTL young adults (p < .001). For Visual Paired Associates, high-MTL young and older adults and low-MTL younger adults were reliably better than low-MTL older adults (all p's < .001). No other comparisons were significant. For CVLT-Delayed, high-MTL young adults performed better than all groups (high-MTL older adults, p = .001; low-MTL young adults, p = .001; low-MTL older adults, p < .001). The high-MTL older adults also performed better than the low-MTL young (p < .001) and older (p = .001) adults. Finally, the low-MTL young adults out-performed the low-MTL older adults (p < .001).

In all, on the basis of this analysis there seems to be a clear separation of high-MTL young adults and low-MTL older adults from the other groups. The difference between high-MTL older adults and low-MTL young adults was not always clear. However, within each age group there is reason to believe that median split created two qualitatively different groups.

To preview the analysis, the data are first examined in reference to the relative importance of the MTL. Then, the same analyses were conducted in regards to the importance of FL function.

Distinctiveness Effects

Evidence for distinctiveness effects was gathered by comparing recognition performance for distinct items to performance for non-distinct items. The data were submitted to a 2 x 4 mixed factorial ANOVA. The data are presented in Table 2.5.

Table 2.5 Recognition Memory Measures by MTL group and Distinctiveness Type

Group	Recognition Memory Measures			
	Hits	False Alarms	Corrected Recognition	d'
	Distinctive Items			
High-MTL OA	.91 (.04)	.09 (.03)	.82 (.05)	2.60 (.16)
High-MTL YA	.84 (.04)	.15 (.03)	.69 (.05)	2.16 (.17)
Low-MTL OA	.78 (.04)	.21 (.03)	.56 (.05)	1.72 (.17)
Low-MTL YA	.71 (.04)	.18 (.03)	.53 (.05)	1.62 (.17)
	Non-Distinctive Items			
High-MTL OA	.74 (.05)	.07 (.04)	.70 (.05)	2.10 (.18)
High-MTL YA	.69 (.05)	.17 (.04)	.53 (.06)	1.62 (.18)
Low-MTL OA	.66 (.05)	.19 (.04)	.47 (.06)	1.43 (.19)
Low-MTL YA	.73 (.05)	.24 (.04)	.49 (.06)	1.47 (.18)

* Standard errors are presented in parentheses. YA = Young adults. OA = Older adults.

For hits, there was a main effect of distinctiveness, with distinct items (M = .81 ; SD = .17) having a higher probability of recognition than common items (M = .70; SD = .20), F (1,60) = 19.13, $p < .001$. There was no differences across groups, F (3,60) = 1.64, p = .19, however there was a Group x Distinctiveness interaction, F (3,60) = 3.20, p = .03. This effect derives from the low-MTL young adults, who showed no performance differences across distinct and common items, although the other groups did.

For false alarms, there were no reliable differences between distinct and common items, $F < 1$, however there was an effect of Group, F (3,60) = 3.67, p = .02. Planned comparisons suggested that this difference was driven by high false alarm rates for the low-MTL young adults and low false alarm rates for high-MTL older adults (*p* = .02). No other pairwise comparisons were significant. The Distinctiveness x Group interaction was not reliable, *F* (3,60) = 1.38, *p* = .26.

Using the corrected recognition metric (hits - false alarms), there was evidence of a distinctiveness effect, *F* (1,60) = 17.68, *p* < .001 with distinct items (*M* = .65; *SD* = .21) demonstrating higher recognition than common items (*M* = .54; *SD* = .23). There was a main effect of Group, *F* (3,60) = 5.89, *p* = .001. Planned comparisons demonstrated that high-MTL older adults recognized more items on average than did low-MTL older (*p* = .005) and young (*p* = .003) adults. No other pairwise comparisons were significant. The interaction failed to reach significance, *F* (3,60) = 1.10, *p* = .36.

Additionally, *d'* was calculated as a measure of recognition memory performance. The results were nearly identical. Distinct items (*M* = 2.04; *SD* = .76) were remembered better than non-distinct items (*M* = 1.66; *SD* = .76), *F* (1,60) = 16.50, *p* < .001. There was a main effect of Group, *F* (3,60) = 6.45, *p* = .001, which was again driven by differences between the high-MTL older adults and low-MTL young (*p* = .002) and older (*p* = .003) adults. The interaction was not reliable, *F* (3,60) = 1.04, *p* = .38.

Estimates of Recollection and Familiarity

In the next set of analyses, the relative importance of recollection and familiarity was examined. The results for recollection estimates can be seen in Figure 2.1.

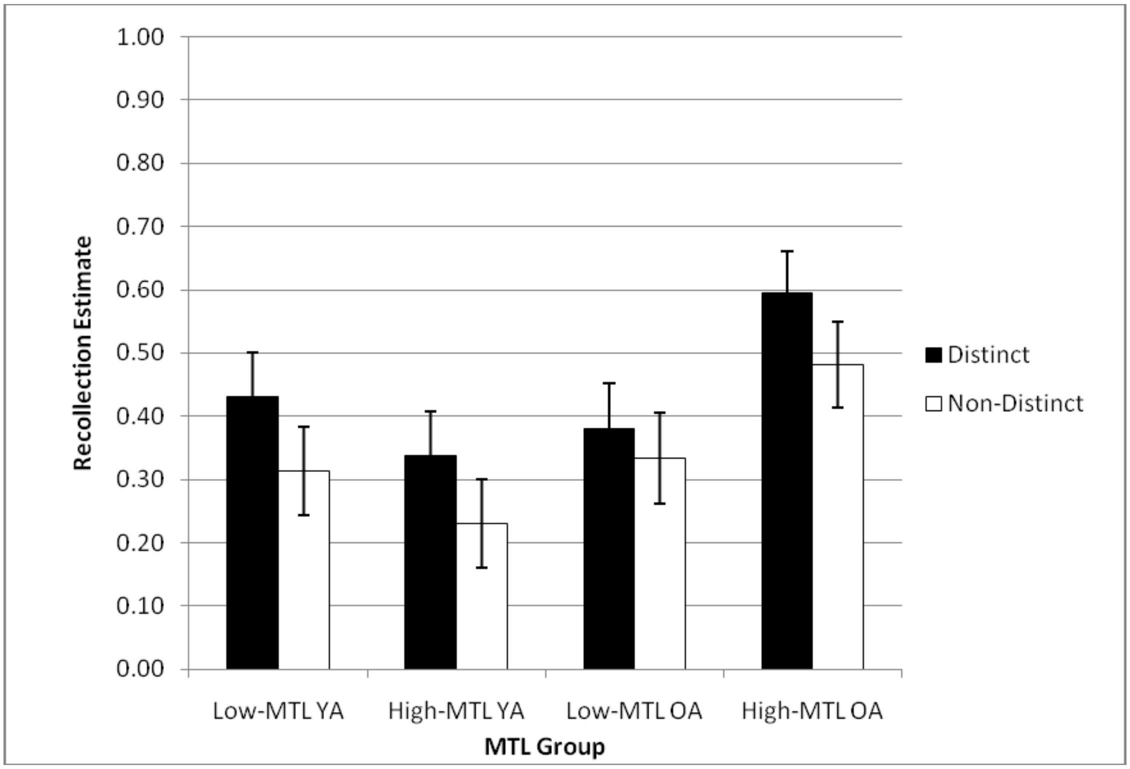

Figure 2.1. Recollection Estimates by MTL Group

Distinct items were associated with higher levels of recollection (*M* =.44; *SD* = .29) compared to non-distinct items (*M* =.34, *SD* = .29) , F (1,60) = 11.11, p = .001. There was also differences across groups, F (3,60) = 2.98, p = .04, which planned comparisons suggest is driven by higher levels of recollection for the high-MTL older adults, especially relative to the high-MTL young adults (p = .028). The interaction was not reliable, $F < 1$.

We also calculated recollection using the metric of *d'*. The results of this analysis mirrored the previous results and can be seen in Table 2.6.

Table 2.6 Recollection Estimates for Distinct and Non-Distinct Items Using d'

Group	Distinct	Non-Distinct
High-MTL OA	1.87 (.20)	1.51 (.21)
High-MTL YA	1.18 (.20)	.74 (.21)
Low-MTL OA	.97 (.21)	1.02 (.22)
Low-MTL YA	1.31 (.20)	1.00 (.21)

* Standard errors are presented in parentheses. MTL = Medial Temporal Lobe. YA = Young adults. OA = Older adults

On average, recollection estimates were higher for distinct items (*M* = 1.35; *SD* = .86) than for non-distinct items (*M* = 1.07; *SD* = .87), *F* (1,60) = 8.34, *p* = .005. There were also group differences, *F* (3,60) = 3.56, *p* = .022. High-MTL older adults exhibited higher recollection estimates on average than did high-MTL young adults (*p* = .03) and low-MTL older adults (*p* = .049). The interaction was not reliable, *F* (3,60) = 1.34, *p* = .269.

Regarding familiarity, distinct items were associated with higher estimates of familiarity (*M* =.61; *SD* = .31) compared to non-distinct items (*M* =.49; *SD* = .30), *F* (1,60) = 11.09, *p* = .001. There was no effect of Group, *F* (3,60) = 2.17, *p* = .10, but there was a reliable Distinctiveness x Group interaction, *F* (3,60) = 3.39, *p* = .02. Inspection of Figure 2.2 reveals that the interaction stems from low-MTL young adults exhibiting numerically higher familiarity estimates for non-distinct items, whereas all other groups showed a higher familiarity estimates for distinct items.

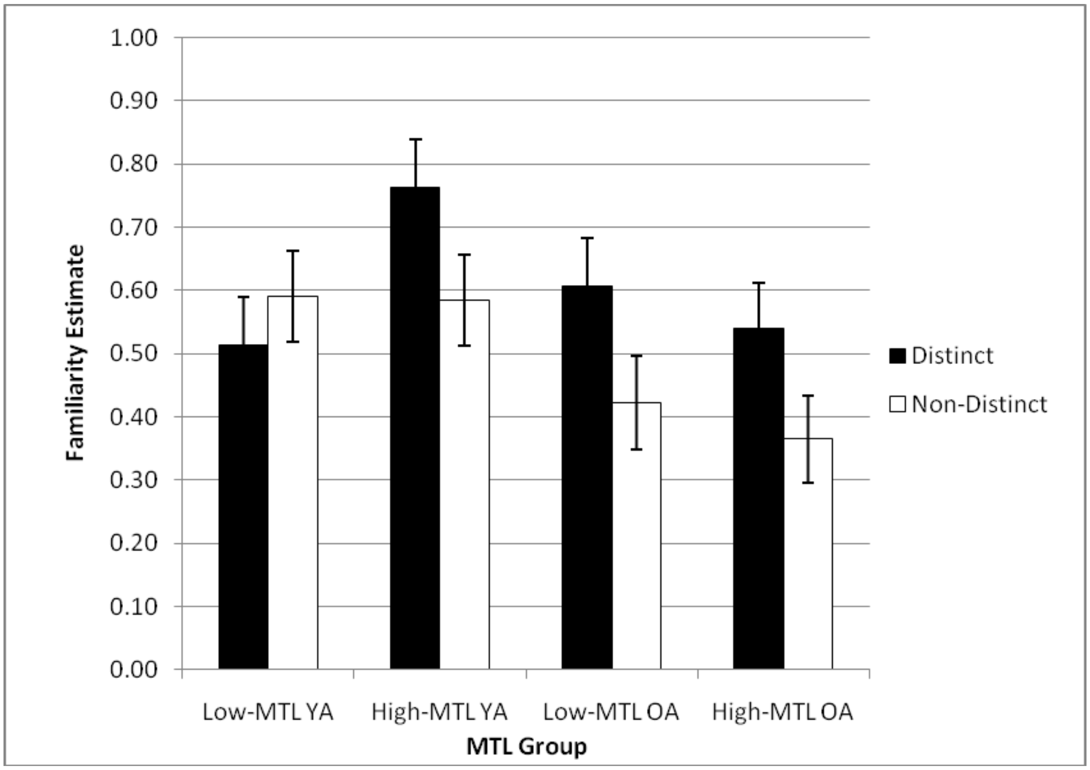

Figure 2.2. Familiarity Estimates by MTL Group

In a final examination, we included recollection and familiarity in the same analysis in a effort to ascertain if recollection or familiarity is a more important contributor to the distinctiveness effect. The results from that analysis suggest that both are important, as the Recollection x Familiarity interaction, $F < 1$ was not significant. However, the Recollection x Familiarity x Group interaction was reliable, F (3, 60) = 2.84, $p = .046$. An inspection of the figures above suggests that the reliable 3-way interaction stems from the performance of low-MTL young adults who showed an advantage for distinct items in recollection estimates, but the opposite with familiarity estimates.

Objective Source Memory Performance

Next, we examined source memory performance to ascertain what types of source information individuals could remember about distinct items, if any. Table 2.7 displays the corrected source memory scores across the four types of responses, as well as the statistical outcomes associated with whether these means were statistically different than zero.

Table 2.7. Source Memory Accuracy and Results from Statisitical Analysis Organized by Response Type

Measure	Performance and Statistical Outcomes			
	Mean	SD	*t* - value	*p*- value
Distinct Recollection	.14	.49	2.31	.024
Distinct Familiarity	.05	.34	1.16	.251
Non-Distinct Recollection	.05	.56	0.66	.512
Non-Distinct Familiarity	.03	.29	0.86	.395

As can be seen in the table, source memory performance was poor, with the glaring exception of recollection responses to distinct items. These judgments were reliably above chance although all other judgments were not. To further analyze these scores, especially the recollection judgments to distinct items, source memory was also analyzed by group. These results are displayed in Table 2.8

Table 2.8. Source Memory Accuracy Separated by MTL-Group, Distinctiveness, and Response Type

Group	Source Memory Accuracy			
	Distinct		Non-Distinct	
	Mean	SD	Mean	SD
	Recollection			
High-MTL OA	.05	.44	-.01	.52
High-MTL YA	.42	.52	.06	.62
Low-MTL OA	-.05	.43	-.20	.39
Low-MTL YA	.12	.48	.30	.61
	Familiarity			
High-MTL OA	.08	.31	-.03	.29
High-MTL YA	.01	.28	.11	.36
Low-MTL OA	-.03	.28	.07	.15
Low-MTL YA	.12	.45	-.01	.31

* SD = Standard deviation. MTL = Medial Temporal Lobe. YA = Young adults. OA = Older adults.

Regarding the recollection judgments to distinct items, the results suggest that the reliable omnibus effect is driven by the high-MTL young adults, t (15) = 3.22, p = .006. All other groups for this judgment were not reliable (low-MTL young adults: p = .349; low-MTL older adults: p = .682; high-MTL older adults: p = .597). None of the other comparisons for any of the other judgments were reliable.

For completeness, we also analyzed group differences based on FL functioning. Within each age group a median split determined membership in the high- or low-FL group. Examining the FL factor changed the number of individuals in each group (low-

MTL young adults: $N = 15$; high-MTL young adults: $N = 17$; low-MTL older adults: $N = 16$; high-MTL older adults: $N = 16$). The performance on the neuropsychological battery across tasks is shown in Table 2.9.

Table 2.9. Performance on the FL Tasks Across Groups

	High-FL YA		Low-FL YA		High-FL OA		Low-FL OA	
Measure	Mean	SD	Mean	SD	Mean	SD	Mean	SD
mWCST	5.6	1.2	4.5	1.7	3.7	2.0	3.2	2.2
Mental Control	5.9	.24	4.9	.70	6.0	0.0	5.2	.90
COWAT	49.8	10.4	46.5	13.9	50.7	17.9	44.2	15.4
Backward Digit Span	8.1	1.6	7.3	2.1	7.4	2.3	5.9	1.5
Mental Arithmetic	14.0	1.9	10.6	2.2	15.0	1.4	10.8	2.9

*mWCST = modified Wisconsin Card Sorting Test. COWAT = California Oral Word Association Test. YA = Young adults. OA = Older adults.

There were differences in the factor scores across the groups, $F(3,60) = 30.6$, $p < .001$. Planned comparisons suggested that both low-FL groups differed from both high-FL groups (p's < .001). However, there were no factor score differences across age groups, within each FL group (Low-FL: $p = .821$; High-FL: $p = 1.0$). Thus, the group differences appear to reflect reliable differences in FL functioning.

All omnibus tests across groups were significant at the $p \leq .01$ level except for the COWAT, which was not significant, $F < 1$. For the mWCST, high-FL young adults out-performed high- ($p = .021$) and low-FL ($p = .002$) older adults. No other comparisons were significant. For Mental Control, high-FL young adults performed better than low-FL older ($p = .005$) and young ($p < .001$) adults. High-FL older adults also performed better than low-FL older ($p = .003$) and young ($p < .001$) adults on this measure. On the measure of Backward Digit Span, high-FL young adults performed reliably better than low-FL older adults. No other comparisons were significant. Finally for Mental

Arithmetic, high-FL young adults performed better than low-FL older ($p < .001$) and young ($p < .001$) adults. High-FL older adults also performed better than low-FL older ($p < .001$) and younger ($p < .001$) adults on this measure.

Distinctiveness Effects

Distinctiveness effects were examined as before. The data were submitted to a 2 x 4 mixed factorial ANOVA. The data are presented in Table 2.10.

Table 2.10 Recognition Memory Measures by FL group and Distinctiveness Type

	Recognition Memory Measures			
Group	Hits	False Alarms	Corrected Recognition	d'
	Distinctive Items			
High-FL OA	.83 (.05)	.11 (.02)	.73 (.06)	2.29 (.20)
High-FL YA	.78 (.04)	.14 (.04)	.64 (.05)	1.98 (.17)
Low-FL OA	.86 (.03)	.19 (.04)	.68 (.06)	2.10 (.21)
Low-FL YA	.77 (.05)	.19 (.03)	.58 (.05)	1.78 (.16)
	Non-Distinctive Items			
High-FL OA	.68 (.06)	.09 (.03)	.59 (.06)	1.87 (.21)
High-FL YA	.71 (.05)	.16 (.03)	.55 (.05)	1.71 (.17)
Low-FL OA	.72 (.05)	.16 (.04)	.55 (.06)	1.71 (.20)
Low-FL YA	.71 (.04)	.25 (.04)	.45 (.05)	1.36 (.18)

* Standard errors are presented in parentheses. YA = Young Adults. OA = Older Adults.

For hits, distinct items ($M = .81$; $SD = .17$) were remembered with a higher probability than non-distinct items($M = .70$; $SD = .20$), $F(1,60) = 17.6$, $p < .001$. There was no effect of Group, nor Distinctiveness x Group interaction (both F's < 1). For false alarms, there were no differences across distinct and non-distinct items, $F < 1$. There was a trend for an effect of Group, $F(3,60) = 2.60$, $p = .06$. This marginally significant effect seems to be driven by the higher rates of false alarms committed by the low-FL young adults. The interaction was not reliable, $F(3,60) = 1.42$, $p = .25$

Using corrected recognition, distinct items ($M = .65$; $SD = .22$) were remembered with a higher probability than non-distinct items ($M = .54$; $SD = .23$), $F(1,60) = 17.4$, $p < .001$. On average, there were no differences across groups, $F(3,60) = 1.42$, $p = .25$. The interaction failed to reach significance, $F < 1$. As another measure, we also analyzed *d'*. The results closely mirrored the findings with corrected recognition. Distinct items ($M = 2.04$; $SD = .76$) were better remembered than non-distinct items ($M = 1.66$; $SD = .76$), $F(1,60) = 16.31$, $p < .001$. On average, there were no differences across groups, $F(3,60) = 1.55$, $p = .21$. Finally, the Distinctiveness x Group interaction failed to reach significance, $F < 1$.

Estimates of Recollection and Familiarity

The recollection and familiarity data were analyzed in the same way as before. The results for recollection can be seen in Figure 2.3.

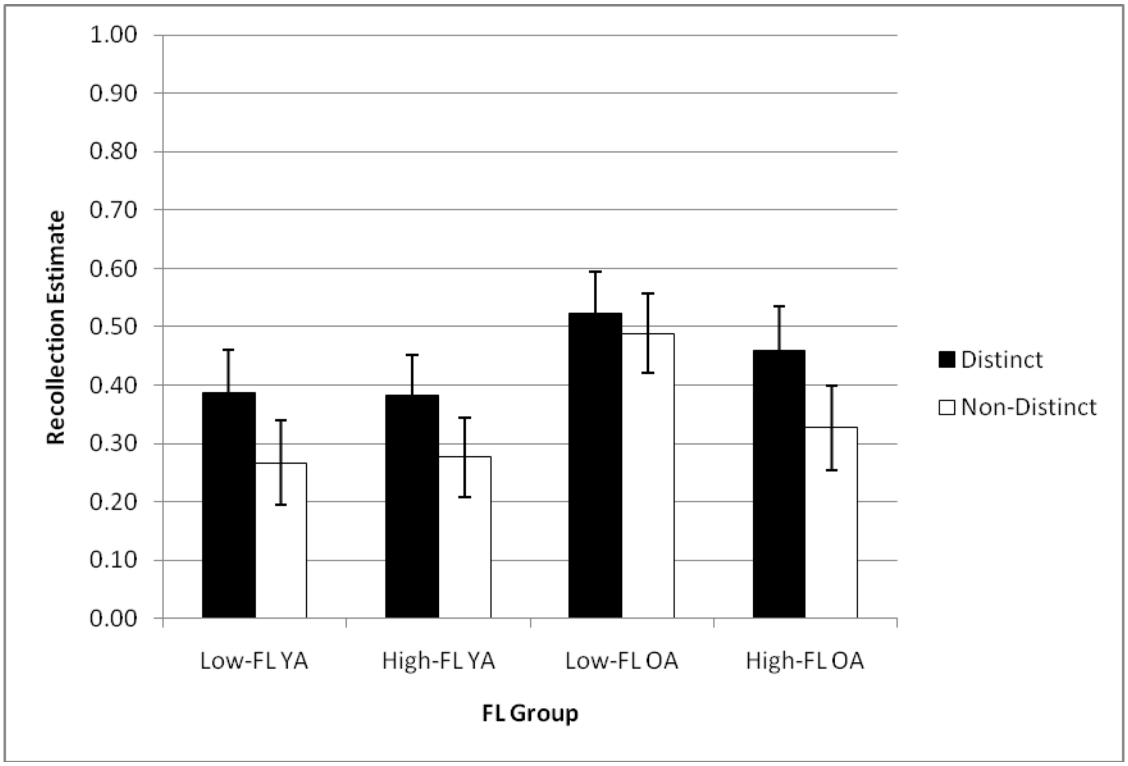

Figure 2.3. Recollection Estimates by FL Group

On average, recollection estimates were higher for distinct items (M =.44 ; SD =.29) when compared to non-distinct items (M = .34 ; SD = .29), F (1,60) = 11.90, p < .001. Statistically, there were no differences across groups, F (3,60) = 1.71, p = .17. The Distinctiveness x Group interaction was also not reliable, F < 1.

We again calculated recollection using *d'* and the results of this analysis can be seen in Table 2.11

Table 2.11 Recollection Estimates for Distinct and Non-Distinct Items Using d'

Group	Distinct	Non-Distinct
High-FL OA	1.44 (.23)	1.07 (.22)
High-FL YA	1.26 (.21)	0.94 (.21)
Low-FL OA	1.46 (.21)	1.46 (.21)
Low-FL YA	1.23 (.23)	0.78 (.22)

* Standard errors are presented in parentheses. FL = Frontal Lobe. YA = Young adults. OA = Older adults.

As was the case with the raw proportion of 'Type A' judgments, recollection estimates were higher for distinct items (M = 1.35; SD = .86) relative to non-distinct items (M = 1.07; SD = .87), F (1,60) = 9.18, p = .004. On average, there was no differences between groups, F (3,60) = 1.04, p = .38. The Group x Distinctiveness interaction was not reliable, F (3, 60) = 1.19, p = .32.

Data for the familiarity estimates are presented in Figure 2.4.

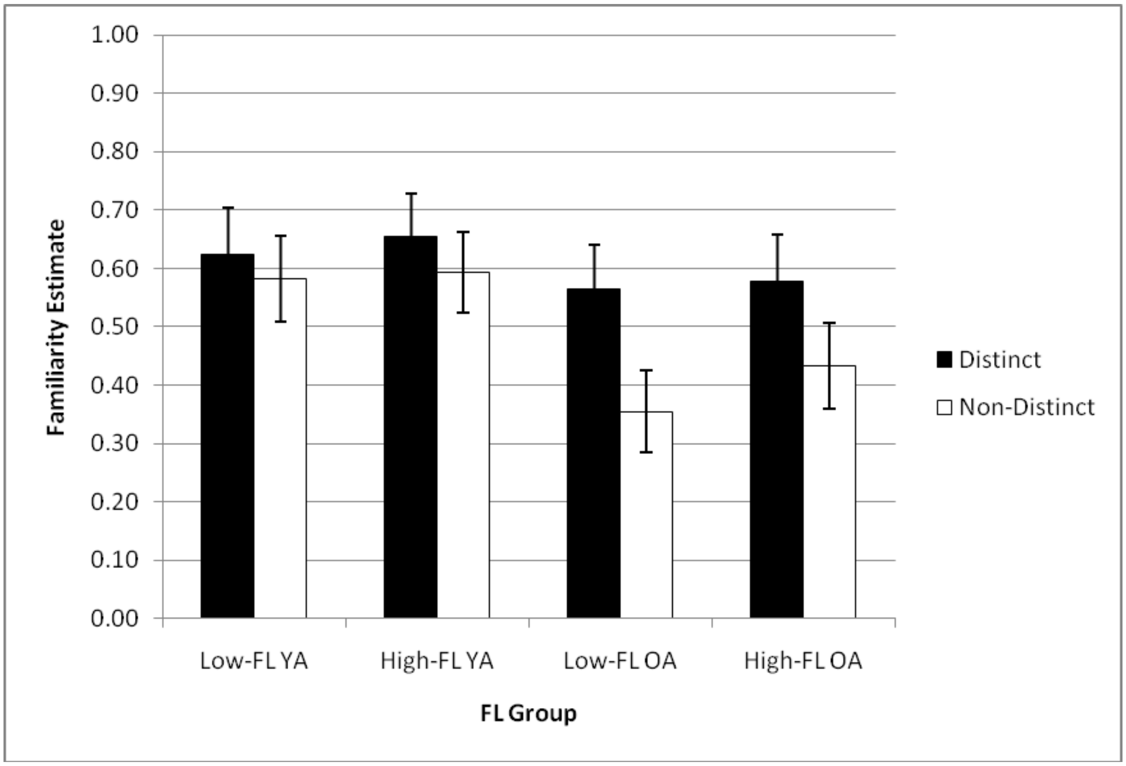

Figure 2.4. Familiarity Estimates by FL Group

Familiarity estimates for distinct items (*M* = .61; *SD* = .31) were higher than those of non-distinct items (*M* = .49; *SD* = .30), *F* (1,60) = 9.76, *p* = .003. There were no statistical differences across groups, *F* (3,60) = 1.47, *p* = .23, and the interaction was not significant, *F* (3,60) = 1.17, *p* = .33.

In a final examination, we included recollection and familiarity in the same analysis. The Recollection x Familiarity interaction, *F* < 1 was not significant. The 3-way interaction was also not reliable, *F* (3,60) = 1.64, *p* = .19.

Objective Source Memory Performance

The averaged data for each source memory decision can be viewed in Table 2.12.

Table 2.12. Source Memory Accuracy Separated by FL-Group, Distinctiveness, and Response Type

Group	Source Memory Accuracy			
	Distinct		Non-Distinct	
	Mean	SD	Mean	SD
	Recollection Responses			
High-FL OA	.04	.20	-.05	.50
High-FL YA	.24	.47	.16	.74
Low-FL OA	-.01	.59	-.13	.45
Low-FL YA	.30	.58	.21	.47
	Familiarity Responses			
High-FL OA	-.03	.30	.06	.17
High-FL YA	.08	.38	-.01	.35
Low-FL OA	.09	.29	-.03	.30
Low-FL YA	.06	.39	.17	.31

* SD = Standard deviation. FL = Frontal Lobe. YA = Young adults. OA = Older adults.

Analysis by group revealed no responses reliably above chance. There were several instances in which there were trends for reliability. Specifically, high-FL young adults, t (16) = 2.11, p = .051, were close to being above chance for recollection judgments given to distinct items. Given that many of the high-FL young adults were also high-MTL young adults, this finding is not too surprising. Low-FL young adults were also close to, being above chance for these judgments as well, t (14) = 2.00, p = .065.

Discussion

Several interesting findings emerged from this experiment. First, young and older adults both showed evidence of the distinctiveness effect suggesting that aging spares the ability to remember distinct information quite well. This is in line with recent research using various distinctiveness paradigms (Bireta, et al., 2008; Geraci et al., 2009; Smith, 2011; Vitali et al., 2006). In those previous studies, older adults showed the distinctiveness effect, but the magnitude of that effect was not as large as it was for young adults. In the current experiment however, the young and older adults showed distinctiveness effects of similar magnitude. Moreover, this did not seem to vary by MTL-group. The reasons for this could be attributed to differences in the sample. Perhaps it was the case that the current sample was rather high-functioning relative to the other studies. However, the fact that there were no magnitude differences across the high- and low- groups sheds doubt on this reasoning. Another potential difference is the nature of the task. For example, Geraci et al. (2009) used a semantic task, and Smith (2011) also used a semantic task but reported that older adults reported a late isolation effect but not an early one. Perhaps a perceptual- based manipulation as in the current study produces similar magnitude. In the second experiment of Smith (2011), the manipulation was a combination of perceptual and semantic (a number in a series of words), thus it is difficult to determine how this fits in with the current study. It would be useful for future research to address the issue of how the nature of the manipulation affects distinctiveness, and age differences in distinctiveness. Another important caveat is that allowing older adults to encode the stimuli for longer might have allowed them a chance to engage in more processing, resulting in performance that appears similar to young adults. Finally, it could also be the case that using a recognition task, instead of recall or cued-recall helped eliminate this magnitude difference.

A second major finding was that estimates for recollection and familiarity were larger for distinct items than non-distinct items. Kishiyama and Yonelinas (2003) demonstrated increased levels of recollection and familiarity in a sample of young adults with pictoral stimuli and the current study extends this finding by showing the same pattern with older adults. However, because estimates of both processes were elevated it could not be determined what role each is playing in the distinctiveness effect, as was the case in previous studies. The role that the recollection and familiarity are playing in the distinctiveness effect will be expounded on later in the General Discussion.

Perhaps, the most surprising finding from the current study was that young and older adults exhibited similar levels of recollection. Research suggests that older adults experience normative decline in accurate recollection abilities, however this prediction was not borne out in the current experiment. Other research suggests that high-functioning older adults can demonstrate equal levels of recollection to younger adults (e.g., Davidson & Glisky, 2002; Duarte et al., 2007). However, the current results demonstrated equivalent levels of recollection regardless of MTL-level. Again, this results may be a function of increased encoding time for older adults. However, it is also tenable there is something about the distinctiveness effect, namely the power of item-specific processing in the context of similarity-based processing that allows older adults to have access to specific pieces of context information. However, before saying too much about this effect, it is important to demonstrate this finding in a new sample and perhaps with different materials. This was a partial goal of the next experiment.

A final noteworthy conclusion pertains to the objective source memory judgments. While recollection estimates were higher for distinct items, this did not translate into superior objective source memory. A noteworthy exception to this pattern was high-MTL young adults who exhibited above chance performance to distinct items given recollection judgments. Given that these items were generally speaking the ones that would be predicted to have the highest recognition memory, this is a somewhat positive finding. It is interesting that only the young adults show this effect and not the older adults. This matches well with the well reported finding that older adults suffer deficits in source memory retrieval as a function of age (c.f., Mitchell, Hunt, & Schmitt, 1986; Spencer & Raz, 1995). However, on the whole source memory was particularly poor in the current experiment. Even in this instances when performance was above chance, it was not greatly over chance. Thus, more research is needed before drawing stronger conclusions.

The reason for generally poor performance could be that in this type of situation, location on the screen is simply not something that individuals remember, and as such, are not basing their recollection decisions on that piece of information. In the next study, the objective source memory question will pertain to temporal information, so perhaps this is something that people would have better memory for. A more plausible piece of information that individuals may be using may be the color of the distinct word. One way to tease this out would be to manipulate the color of the distinct word during encoding, and during test, query participants if they could recall the actual color of the various distinct words.

CHAPTER 3

SEONDARY DISTINCTIVENESS AND AGING UNDER INTENTIONAL LEARNING INSTRUCTIONS

The previous experiment investigated primary distinctiveness through an examination of the von Restorff (1933) or isolation effect. However, much less is known about secondary distinctiveness, especially concerning the influence of age on secondary distinctiveness. To date, only a few studies have been conducted within the domain of secondary distinctiveness, and those have examined the bizarreness effect. Black and colleagues (2004) reported bizarreness effects for older and younger adults across incidental and intentional learning conditions. Nicolas and Worthen (2009) reported an intact bizarreness effect for older adults, although the strength of this effect varied depending on the composition of bizarre to common pictures and the age of the participants. Thus, there currently is not a clear consensus on whether or not older adults can show preserved secondary distinctiveness effects.

In the current experiment, secondary distinctiveness was examined with an orthographic distinctiveness manipulation. The orthographic distinctiveness effect is the empirical finding that words with unusual orthographies or spellings (e.g., *subpoena*) are remembered better than orthographically common words (Hunt & Elliot, 1980). This effect has been found with various memory tests including free recall (Hunt & Mitchell, 1982), cued recall (Geraci & Rajaram, 2002), and recognition (Hunt & Elliot). However, it is typically not observed on implicit tests like word-fragment completion (Geraci & Rajaram) or perceptual identification (Hunt & Toth, 1990).

Once again, the relative contributions of recollection and familiarity were measured using a RK judgment during recognition. Rajaram (1998) used this method to examine orthographic distinctiveness in a sample of young adults and discovered that estimates of both recollection and familiarity were elevated for orthographically distinct items relative to orthographically common items (Kishiyama & Yonelinas, 2006). Thus, it is predicted that young adults would show the same pattern in the current experiment. Additionally, based on the finding of age invariance in the previous experiment, it is also predicted that older adults will show elevated levels of recollection and familiarity for orthographically distinct items relative to common items.

Method

Participants

Forty-two young adults and 42 older adults participated in the study. Two young adults and two older adults were removed and replaced in the study for excessive false alarm rates. Hence the final analysis was based on a sample of 40 younger adults and 40 older adults. The characteristics of the final sample classified by MTL function can be seen in Table 3.1

Table 3.1. Participant characteristics by MTL functioning

Group	N	Age	Range	Education	Health	MTL Score
Low-MTL YA	20	20.8 (1.3)	19 - 23	13.9 (1.3)	4.1 (.79)	-.15 (.21)
High-MTL YA	20	21.4 (1.7)	19 - 26	13.7 (1.6)	4.3 (.79)	.15 (.05)
Low-MTL OA	20	69.8 (5.3)	62 - 80	15.7 (2.3)	3.6 (1.1)	-.17 (.13)
High-MTL OA	20	68.9 (3.7)	63 - 78	16.0 (2.1)	3.8 (.85)	.17 (.11)

* Standard deviations are presented in parentheses. YA = Young adults. OA = Older adults.

Older adults, on average, reported more years of education (M = 15.8; SD = 2.2) than young adults (M = 13.8; SD = 1.4), F (1,78) = 22.69, p < .001. Importantly, there were no differences in education between the high- and low-MTL young adults, t(38) = 0.34, p = .74, nor the high- and low-MTL older adults, t(38) = 0.42, p = .68. The performance data for young and older adults from the neuropsychological test battery can be seen in Table 3.2.

Table 3.2 Performance on the Neuropsychological Test Battery for Older and Younger Adults

Measure and Max Score	Older Adults		Younger Adults		Statistics	
	Mean	SD	Mean	SD	t value	p value
mWCST (8)	2.8	2.1	5.0	1.4	5.56	< .001
Mental Control (6)	5.5	.88	5.5	.78	0.27	.79
COWAT	47.3	14.2	46.2	10.3	-0.41	.69
Backward Digit Span (12)	7.1	2.2	8.0	2.0	1.79	.08
Mental Arithmetic (19)	12.3	3.8	12.2	2.7	-0.14	.89
Logical Memory I (50)	20.4	7.9	23.3	9.7	1.47	.145
Verbal Paired Associates I (18)	18.4	3.6	22.6	1.9	6.62	< .001
Visual Paired Associates I (24)	12.0	14.2	16.7	1.6	6.67	< .001
CVLT - Delayed (16)	11.3	3.5	13.3	2.7	3.00	.004

* mWCST = modified Wisconsin Card Sorting Test. COWAT = Controlled Oral Word Association Test. CVLT = California Verbal Learning Test. SD = Standard Deviation

On average, young adults outperformed older adults on most MTL tasks (Visual Paired Associations, Verbal Paired Associates, and CVLT-Delayed). The only exception was with Logical Memory. Young adults also outperformed older adults on one of the FL tests: mWCST. There were no reliable age differences on any of the other measures (Mental Control, COWAT, Mental Arithmetic, and Backward Digit Span).

Materials, Design, Procedure

The design for this experiment was a 2 (Distinctiveness: distinct, common)x 4 (Group: High-MTL older adults, High-MTL young adults, Low-MTL older adults, Low-MTL young adults) mixed-factorial design, with Distinctiveness serving as a within-subjects variable and Group serving as the between-subjects variable.

Thirty orthographically distinct words were gathered from previous studies (i.e., Geraci & Rajaram, 2002; Hunt & Eliot; 1980). Thirty orthographically common words were collected from the English Lexicon project (Balota et al., 2007) and were closely matched to the orthographically distinct words on word length and frequency (based on the Hyperspace Analogue to Language). See Appendix B for the full list of orthographically distinct and common words used in this experiment. An additional 20 words were used to serve as primacy and recency buffers placed at the beginning and end of each list.

As before, to ensure that all words appeared as studied and non-studied items across the experiment, two versions of the task were created. Within each version, distinct and common words were randomly assigned to either List 1 or List 2 with the stipulation that an equal number of distinct and common words appeared in each list. There were 24 items (10 filler, 7 distinct, 7 common) in List 1 and 26 items (10 filler, 8 distinct, 8 common) in List 2. Also within each version, we created two orders (List 1 followed by List 2, and List 2 followed by List 1). Once again, older adults were given more encoding time relative to young adults. The procedure was the same as Experiment 1.

Results

A factor analysis was conducted on the young and older adult data to examine if a MTL and FL factor could be extracted. The factor loadings after a Promax rotation are shown in Table 3.3.

Table 3.3 Factor Loadings for the Neuropsychological Battery of Tasks After Promax Rotation

	Factor	
Measure	1	2
mWCST		.22
Mental Control		.47
COWAT		.48
Backward Digit Span		.78
Mental Arithmetic		.44
Logical Memory I	.61	
Verbal Paired Associates I	.84	
Visual Paired Associates I	.70	
CVLT - Delayed	.80	
Eigenvalue	3.34	1.53

* mWCST = modified Wisconsin Card Sorting Test.
COWAT = California Oral Word Association Test.
CVLT = California Verbal Learning Test.

The high loading of Logical Memory I, Verbal Paired Associates I, Visual Paired Associates I, and CVLT-Delayed suggest that the first factor represented MTL function. The moderately high loadings for Mental Control, COWAT, Backward Digit Span, and

Mental Arithmetic on the second factor suggest this factor represents FL function[3]. Peculiarly, the mWCST did not load highly on the second factor, even though this task is thought to rely heavily on FL function. In fact, this task loaded more highly on the MTL factor (.44). Despite this unexpected finding, mWCST was still grouped with the FL-functioning factor to be consistent with previous research.

Individuals in each age group were classified on the basis of a median split on MTL factor scores. Performance for each MTL measure by group is shown in Table 3.4

Table 3.4. Performance on the MTL Tasks Across Groups

	High-MTL YA		Low-MTL YA		High-MTL OA		Low-MTL OA	
Measure	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Logical Memory I	29.4	6.6	17.2	8.5	24.3	7.4	16.4	6.4
Verbal Paired Associates I	23.7	4.9	21.6	2.2	21.0	2.2	15.8	2.8
Visual Paired Associates I	17.4	.82	16.0	1.8	14.2	3.1	9.8	4.0
CVLT - Delayed	15.0	1.1	11.7	2.8	13.9	2.1	8.7	2.4

* CVLT = California Verbal Learning Test. MTL = Medial Temporal Lobe. SD = Standard deviation. YA = Young adults. OA = Old adults.

[3] The factor analysis perhaps suggested the extraction of 3 factors as there were three factors with an eigenvalue over 1. However, for the sake of consistency, only two factors were extracted based on prior research.

There were reliable differences across MTL scores, F (3,76) = 37.49, $p < .001$. Planned comparisons suggested there were statistical differences between the high- and low-MTL groups within each age group (both p's < .001). Further, low-MTL young and older adults did not differ from each other ($p = .91$), nor did high-MTL young or older adults ($p = .91$).

Because differences in the aggregated MTL scores can be misleading, performance differences between groups were analyzed using a one-way ANOVA. All omnibus tests were reliable (all p's < .001), and so only the significant paired comparisons are reported for each task. For Logical Memory I, there were differences between high-MTL young adults and low-MTL young and older adults (both p's < .001). There were difference between the high-MTL older adults and the low-MTL young (p = .014) and older adults ($p < .001$). There were no differences between the high-MTL groups ($p = .128$) nor between the low-MTL groups ($p = .988$). For Visual Paired Associates, high-MTL young adults scored better than high-MTL ($p = .002$) and low-MTL ($p < .001$) older adults. This group was no different than the low-MTL young adults ($p = .369$). Finally, the high-MTL older adults were not different from the low-MTL young adults ($p = .164$). For Verbal Paired Associates, all comparisons were significant at the $p \leq .015$ level except for: high-MTL older adults vs. low-MTL young adults (p = .768). Finally, for CVLT-delayed all comparisons were significant at the $p \leq .011$ level except for the difference between the high-MTL groups ($p = .348$).

In sum, there appeared to be no difference between the high-MTL groups on verbal tasks that required straightforward recall of information. There were differences among these groups on the two paired-associate tasks. It was also on these tasks that the low-MTL young adults were similar to the high-MTL older adults. The patterns of data on these tasks seem to support an associative deficit hypothesis (Naveh-Benjamin, 2000). It also appears from these results that the median split would appear to have some basis.

Distinctiveness Effects

The data for the distinctiveness analysis are presented in Table 3.5.

Table 3.5 Recognition Memory Measures by MTL group and Distinctiveness Type

Group	Recognition Memory Measures			
	Hits	False Alarms	Corrected Recognition	d'
	Distinctive Items			
High-MTL OA	.89 (.03)	.16 (.04)	.73 (.04)	2.45 (.16)
High-MTL YA	.92 (.03)	.20 (.04)	.73 (.04)	2.47 (.16)
Low-MTL OA	.82 (.03)	.31 (.04)	.51 (.04)	1.67 (.16)
Low-MTL YA	.88 (.03)	.29 (.04)	.59 (.04)	1.91 (.16)
	Non-Distinctive Items			
High-MTL OA	.74 (.04)	.09 (.03)	.65 (.05)	1.84 (.18)
High-MTL YA	.76 (.04)	.14 (.03)	.62 (.05)	1.83 (.18)
Low-MTL OA	.74 (.04)	.17 (.03)	.57 (.05)	1.33 (.18)
Low-MTL YA	.74 (.04)	.20 (.03)	.55 (.05)	1.40 (.18)

* Standard errors are presented in parentheses. MTL = Medial Temporal Lobe. YA = Young adults. OA = Older adults.

For hits, there was evidence of a distinctiveness effect, F (1,76) = 55.9, $p < .001$, with distinct items (M = .88; SD = .13) being recognized with a higher probability than orthographically common items (M = .75; SD = .17). There were no differences between groups, *F* < 1, and the Distinctiveness x Group interaction failed to reach significance, *F* < 1.

False alarms were greater to distinct items (*M* = .24; *SD* = .19) compared to common items (*M* = .15; *SD* = .16), *F* (1,76) = 49.78, *p* < .001. There was also a main effect of Group, *F* (3,76) = 2.83, *p* = .044. Although no comparisons reached significance, planned comparisons suggest this difference derives from lower false alarms for the high-MTL older adults when compared to low-MTL young (*p* = .08) and older (*p* = .09) adults. There was also a trend for a Distinctiveness x Group interaction, *F* (3,76) = 2.23, *p* = .091. Visual inspection of the means suggests this effect stems from both low-MTL groups showing noticeably greater false alarms for distinct items relative to common items, whereas this disparity is diminished in the high-MTL groups.

Using the metric of corrected recognition, distinct items had a higher probability of recognition (*M* = .64; *SD* = .21) when compared to common items (*M* = .60; *SD* = .20), although this effect just failed to reach conventional levels of significance, *F* (1,76) = 3.75, *p* = .057. There were also differences across groups, *F* (3,76) = 3.53, *p* = .019. Planned comparisons suggested that this stems from both high-MTL groups showing better recognition on average, than the low-MTL groups. However, these effects were overshadowed by a Distinctiveness x Group interaction, *F* (3,76) = 2.84, *p* = .043. To follow up on this interaction, separate ANOVAs were conducted for the young and older adult groups. For young adults, there was a marginally significant distinctiveness effect, *F* (1,38) = 3.87, *p* = .057, but there was no Distinctiveness x Group interaction, *F* < 1. This suggests that both younger adults groups showed evidence of a distinctiveness effect with a corrected recognition measure. For the older adults, there was no evidence of a distinctiveness effect, *F* < 1, but there was a reliable Distinctiveness x Group interaction, *F* (1,38) = 10.84, *p* = .002. This stems from the high-MTL group showing a substantial distinctiveness effect, while the low-MTL group actually shows the reverse pattern.

Together, these findings suggest the interaction stems from this difference among the older adult groups.

Lastly using *d'*, distinct words ($M = 2.12$; $SD = .79$) were recognized with a higher probability than common words ($M = 1.60$; $SD = .81$), $F\ (1,76) = 71.3$, $p < .001$. On average, there were also differences between groups, $F\ (3,76) = 4.57$, $p = .005$. Planned comparisons suggested this effect derived from both high-MTL older and young adults exhibiting more accurate recognition in comparison to low-MTL older adults (*p*'s = .024 and .023, respectively). The Distinctiveness x Group interaction was not reliable, $F\ (3,76) = 1.17$, $p = .33$.

Estimates of Recollection and Familiarity

Estimates of recollection were higher for distinct items ($M = .52$; $SD = .24$) when compared to non-distinct items ($M = .38$; $SD = .24$), $F\ (1,76) = 63.37$, $p < .001$. On average, estimates of recollection did not differ across groups, $F < 1$. There was no evidence of a Distinctiveness x Group interaction, $F < 1$. The estimates of recollection can be seen in Figure 3.1.

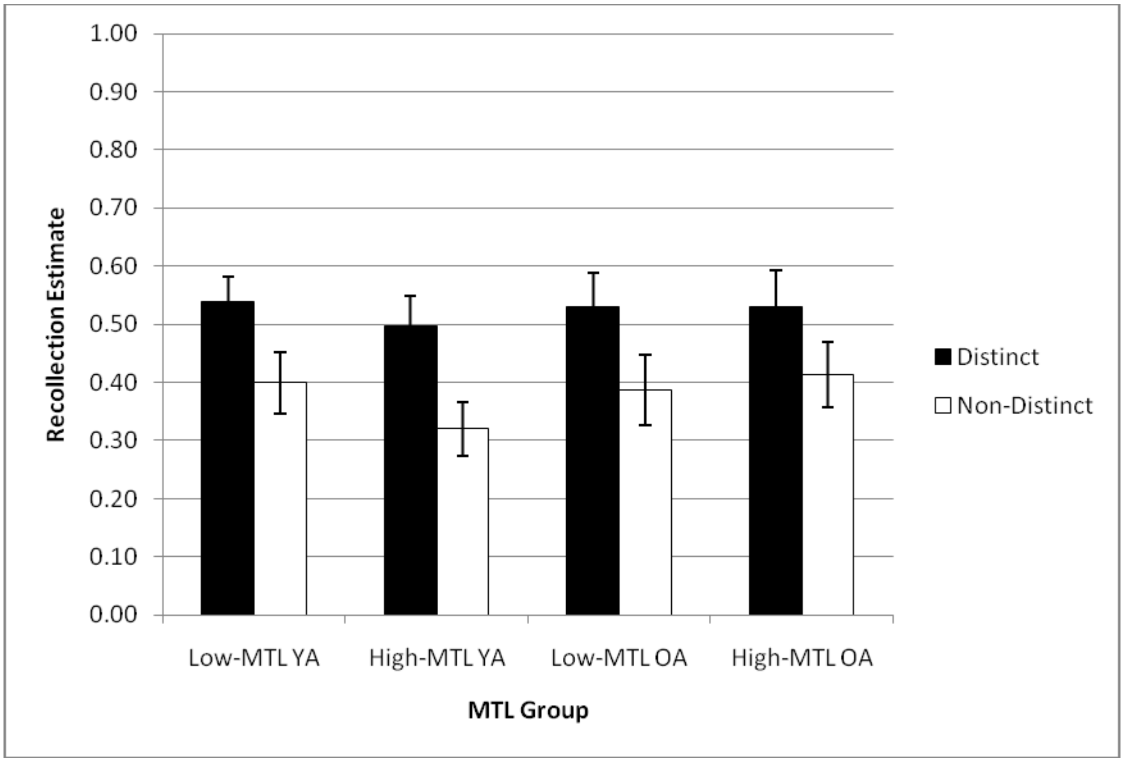

Figure 3.1. Recollection Estimates by MTL Group. The error bars represent the standard error.

For completeness, recollection was also calculated using the metric of *d'*. The recollection estimates can be seen in Table 3.6. Estimates of recollection were higher for distinct items (M = 1.64, SD = .76) than for non-distinct items (M = .73; SD = 1.1), F (1,76) = 70.14, $p < .001$. On average, there were no differences across groups, F (3, 76) = 1.29, p = .285. The interaction was also not reliable, $F < 1$. These results mirror the results using the standard metric of the raw proportion of 'Type A' judgments.

Table 3.6 Recollection Estimates for Distinct and Non-Distinct Items Using d'

Group	Distinct	Non-Distinct
High-MTL OA	1.90 (.20)	1.01 (.24)
High-MTL YA	1.65 (.14)	0.59 (.21)
Low-MTL OA	1.36 (.17)	0.68 (.27)
Low-MTL YA	1.67(.15)	0.59 (.24)

* Standard errors are presented in parentheses. MTL = Medial Temporal Lobe. YA = Younger adults. OA = Older adults.

Regarding familiarity, estimates were higher for distinct items (*M* = .71; *SD* = .31), in comparison to common items (*M* = .58; *SD* = .24), *F* (1,76) = 22.99, *p* < .001. There was no main effect of Group, *F* (3,76) = 2.11, *p* = .11. The Distinctiveness x Group interaction fell short of statistical significance, *F* (3,76) = 2.32, *p* = .082. This trend towards an interaction stems from all groups demonstrating higher familiarity estimates for distinctive items except for the low-MTL older adults who show no difference. These data can be seen in Figure 3.2.

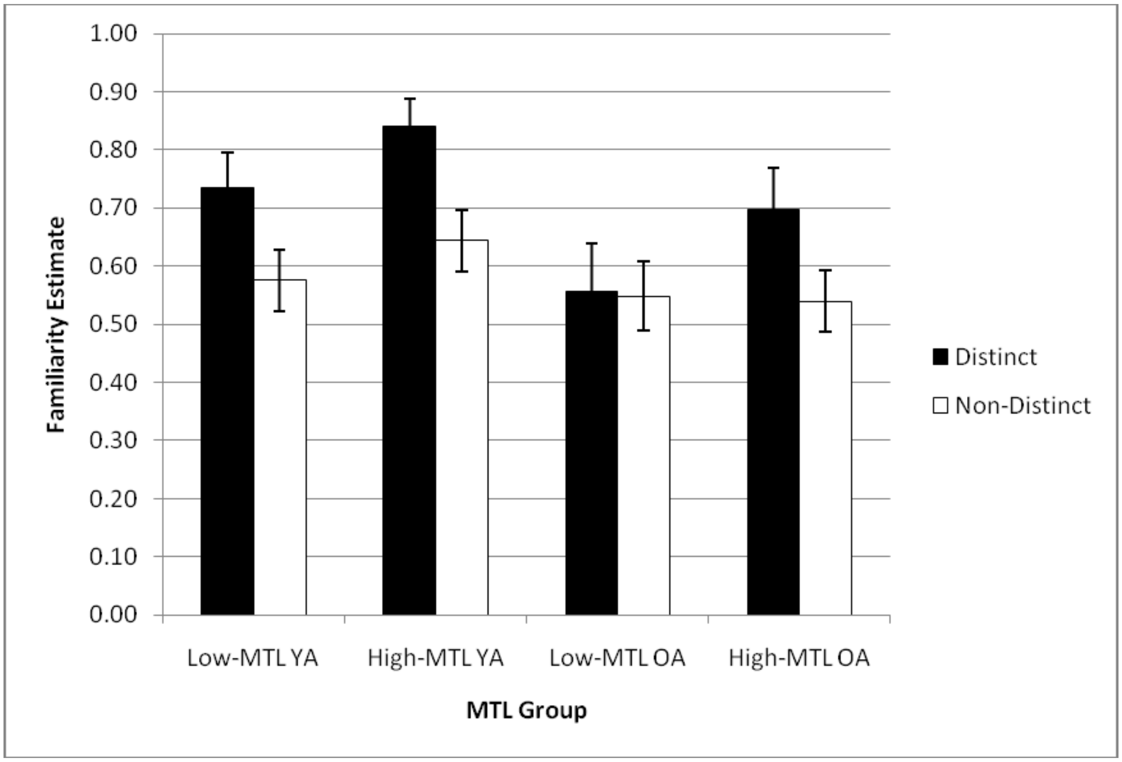

Figure 3.2. Familiarity Estimates by MTL Group. The error bars represent the standard error.

In a final examination, we included recollection and familiarity in the same analysis in a effort to ascertain if recollection or familiarity is a more important contributor to the distinctiveness effect. The results from that analysis suggest that both are important, as the Recollection x Familiarity interaction, $F < 1$ was not significant, nor was the Recollection x Familiarity x Group interaction, F (3, 76) = 1.57, p = .20.

Objective Source Memory Performance

Source judgments were measured as in the previous experiments. The results for this analysis are presented in Table 3.7.

Table 3.7. Source Memory Accuracy and Results from Statisitical Analysis Organized by Type of Response

Measure	Performance and Statistical Outcomes			
	Mean	SD	*t* - value	*p*- value
Distinct Recollection	-.004	.54	-.06	.95
Distinct Familiarity	.043	.55	.68	.50
Non-Distinct Recollection	-.029	.62	-.41	.69
Non-Distinct Familiarity	-.037	.43	-.75	.45

* SD = Standard deviation.

A visual inspection of the means clearly demonstrates that the accuracy of the source judgments were no different than chance (i.e., 0). This was confirmed by, a one-sample t-test on each score type. The results from these tests all indicated that the mean accuracy for each type of response did not notably differ from zero.

However, since these scores were aggregated across groups, it is important to examine any potential differences between groups as well as any potential interactions. The objective source judgment accuracy broken down by MTL-function group is presented in Table 3.8.

Table 3.8. Source Memory Accuracy Performance Separated by MTL-Group, Distinctiveness, and Type of Response

Group	Source Memory Accuracy			
	Distinct		Non-Distinct	
	Mean	SD	Mean	SD
	Recollection Responses			
High-MTL OA	.07	.58	.09	.53
High-MTL YA	-.16	.54	-.25	.66
Low-MTL OA	-.19	.51	.03	.63
Low-MTL YA	.21	.51	.03	.70
	Familiarity Responses			
High-MTL OA	.03	.55	-.06	.43
High-MTL YA	-.15	.53	-.07	.46
Low-MTL OA	.20	.58	.01	.35
Low-MTL YA	.07	.51	.05	.46

* SD = Standard deviation. MTL = Medial Temporal Lobe. YA = Younger adults. OA = Older adults.

The results of a 4 (group) x 2 (Recollection) x 2 (Familiarity) mixed-factors ANOVA showed no main effects for Recollection, nor Familiarity, and no interactions between them, all *F*s < 1. Additionally, there were no differences across groups, F (3, 66) = 1.61, $p = .20$, and no interactions with the variables of Recollection and Familiarity, both *F*s < 1). The three-way interaction was also not reliable, F (3, 66) = 1.64, $p = .19$

As in the previous experiment, we also wanted to explore differences that could be attributed to differences in frontal functioning, even though statistically, this factor accounted for less of the variance than MTL functioning. Within each age group a median split determined membership in the high- or low-FL group. The performance on the neuropsychological battery across tasks is shown in Table 3.9.

Table 3.9. Performance on the FL Tasks Across Groups

	High-FL YA		Low-FL YA		High-FL OA		Low-FL OA	
Measure	Mean	SD	Mean	SD	Mean	SD	Mean	SD
mWCST	5.3	1.2	4.7	1.6	3.4	2.3	2.2	1.8
Mental Control	5.8	.51	5.2	.9	5.8	.44	5.2	1.1
COWAT	50.6	9.8	41.3	8.5	55.5	12.4	39.1	10.1
Backward Digit Span	9.4	1.4	6.4	1.3	8.9	1.6	5.4	1.1
Mental Arithmetic	12.8	2.8	11.5	2.5	13.7	3.5	10.9	3.7

* mWCST = Modified Wisconsin Card Sorting Task. COWAT = Controlled Oral Word Association Task. FL = Frontal Lobe. YA = Young adults. OA = Older adults.

Analysis of the factor scores suggest that the median split produced a meaningful difference between groups, F (3,76) = 45.84, $p < .001$. Planned comparisons suggested that both low-FL groups significantly differed from the high-FL groups (both p's < .001). Moreover, the low-FL groups did not differ from each other (p = .99) nor did the high-FL groups (p = .95)

All omnibus tests were significant at the $p \leq$ .034 level. For the variable of mWCST, planned comparisons suggested that high-FL young adults performed better than high- (p = .003) and low-FL ($p < .001$) older adults. There was a trend for a difference between the high-FL older adults and low-FL young adults (p = .096) but there was no difference between the older adults groups (p = .178). For Mental Control, high-FL young adults out performed low-FL young (p = .048) and older (p = .040) adults. No other comparisons were significant. For the COWAT, high-FL young adults out performed low-FL young (p = .032) and older (p = .004) adults. High-FL older adults also performed better than low-FL young and older adults (both *p*'s < .001). For Backward Digit Span, High-FL young and older adults also performed better than low-FL young and older adults (all *p*'s < .001). No other comparisons were significant. Finally, on Mental Arithmetic, the only significant comparison was the high-FL older adults performing better than low-FL older adults ($p = .037$).

Distinctiveness Effects

Performance on the various measures of distinctive processing is presented in Table 3.10.

Table 3.10. Recognition Memory Performance by FL Group and Distinctiveness Type

	Recognition Memory Measures			
Group	Hits	False Alarms	Corrected Recognition	d'
	Distinctive Items			
High-FL OA	.90 (.03)	.22 (.04)	.68 (.05)	2.26 (.19)
High-FL YA	.89 (.03)	.25 (.05)	.64 (.05)	2.17 (.18)
Low-FL OA	.82 (.04)	.25 (.05)	.56 (.05)	1.85 (.17)
Low-FL YA	.91 (.03)	.24 (.04)	.67 (.05)	2.21 (.17)
	Non-Distinctive Items			
High-FL OA	.75 (.04)	.12 (.02)	.63 (.04)	1.68 (.20)
High-FL YA	.77 (.04)	.19 (.04)	.58 (.05)	1.68 (.20)
Low-FL OA	.73 (.04)	.14 (.04)	.59 (.04)	1.49 (.16)
Low-FL YA	.74 (.04)	.15 (.03)	.59 (.05)	1.53 (.17)

* Standard errors are presented in parentheses. FL = Frontal Lobe. YA = Young adults. OA = Older adults.

For hits, distinct items (*M* = .88; *SD* = .13) received more hits than non-distinct (*M* = .75; *SD* = .17) items, *F* (1,76) = 56.61, *p* < .001. There were no differences across groups, nor was there any interaction, both *F'*s < 1. False alarms were more prevalent to distinct items (*M* = .24; *SD* = .19), compared to non-distinct items (*M* = .15; *SD* = .15), *F* (1,76) = 47.43, *p* < .001. There were no differences across groups on average, and there was no interaction, both *F*s < 1.

Using the corrected recognition metric, distinct items (*M* = .64; *SD* = .21) were recognized with a greater probability than non-distinct items (*M* = .60; *SD* = .20), however, the effect fell just short of significance, *F* (1,76) =3.57, *p* = .06. There were no differences across groups on this measure, *F* < 1. Additionally, the interaction failed to reach significance, *F* (3,76) =1.13, *p* = .34. When *d'* was used as the metric, distinct items (*M* = 2.12; *SD* = .79) were recognized with a higher probability than non-distinct items (*M* = 1.6; *SD* = .80), *F* (1,76) =71.8, *p* < .001. Once again, there were no apparent differences across groups, *F* < 1, and the interaction did not reach significance, *F* (3,76) =1.22, *p* = .31.

Estimates of Recollection and Familiarity

Next, recollection and familiarity were examined to determine if both processes contributed to the distinctiveness effect. Regarding recollection, distinct items (*M* = .52; *SD* = .24) were given a higher proportion of 'Type A' responses, in comparison to non-distinct items (*M* = .38; *SD* = .24), *F* (1,76) = 63.09, *p* < .001. There were no differences across groups, *F* (3, 76) =1.85, *p* = .15, and the interaction was not reliable, *F* < 1. These data are presented in Figure 3.3.

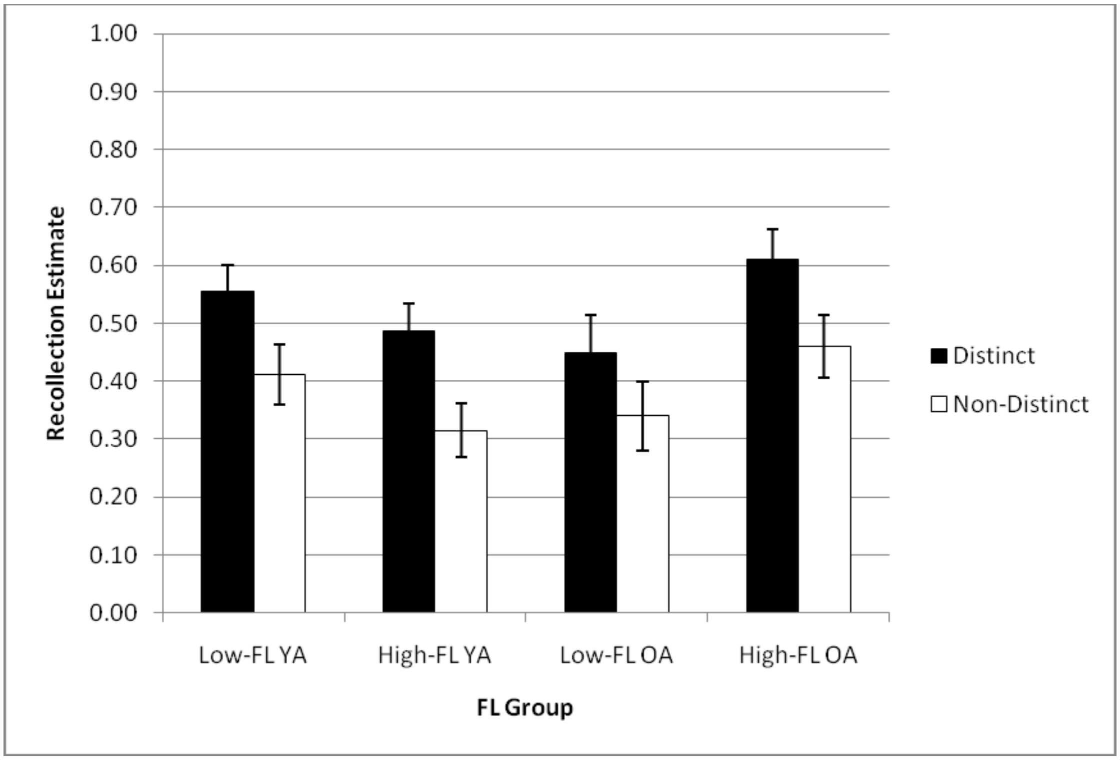

Figure 3.3. Recollection Estimates by FL Group. The error bars represent standard error.

For completeness, recollection was calculated using *d'*. The estimates for recollection using this metric are presented in Table 3.11. Distinct items (M = 1.64; SD = .76) were associated with higher estimates than non-distinct items (M = .71; SD = 1.1), F (1,76) = 70.46, $p < .001$. On average, there were no differences across groups, F (3, 76) = 1.83, p = .148. The interaction was also not reliable, $F < 1$.

Table 3.11 Recollection Estimates for Distinct and Non-Distinct Items Using d'

Group	Distinct	Non-Distinct
High-FL OA	1.91 (.16)	1.05 (.27)
High-FL YA	1.85 (.15)	0.46 (.20)
Low-FL OA	1.36 (.21)	0.69 (.25)
Low-FL YA	1.50 (.13)	0.73 (.25)

* Standard errors are presented in parentheses. FL = Frontal Lobe. YA = Younger adults. OA = Older adults.

With familiarity, distinct items ($M = .71$; $SD = .31$) generated higher estimates relative to non-distinct items ($M = .58$; $SD = .24$), $F(1, 76) = 23.65$, $p < .001$. There were no differences across groups, $F(3, 76) = 1.5$, $p = .22$. The interaction was also not statistically reliable, $F(3, 76) = 2.4$, $p = .074$. These data can be seen in Figure 3.4.

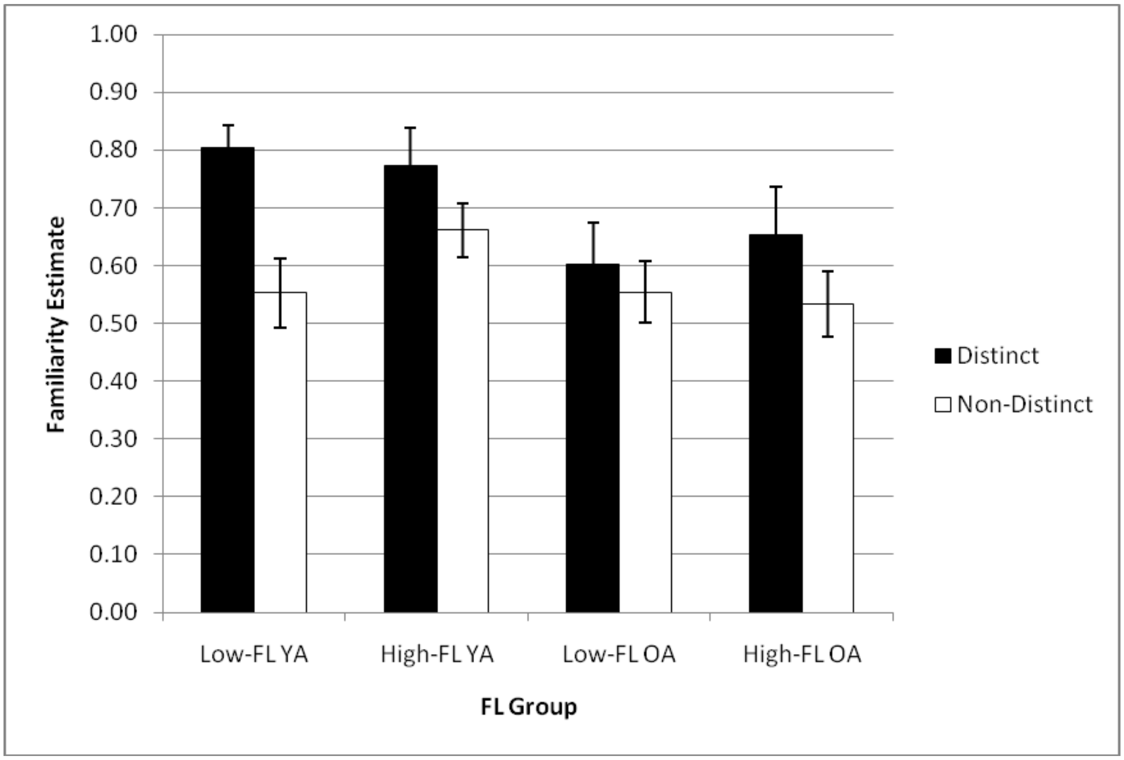

Figure 3.4. Familiarity Estimates by FL Group. The error bars represent standard error.

For a final analysis, both recollection and familiarity were entered into a mixed-factorial ANOVA. As was previously the case, the Recollection x Familiarity interaction was not found reliable, $F < 1$, nor was the three-way interaction, $F\ (3, 76) = 1.50$, $p = .22$.

Objective Source Memory Performance

On average, previous analysis indicated that scores on the objective source measures did not differ from zero. Nevertheless, the possibility of differences between groups was analyzed with a 4 (Group) x 2 (Recollection) x 2 (Familiarity) mixed factorial ANOVA. These data are presented in Table 3.12.

Table 3.12. Source Memory Accuracy Performance Separated by FL-Group, Distinctiveness, and Type of Response

Group	Source Memory Accuracy			
	Distinct		Non-Distinct	
	Mean	SD	Mean	SD
	Recollection			
High-FL OA	.07	.56	.02	.51
High-FL YA	-.03	.55	-.08	.74
Low-FL OA	-.20	.53	.10	.65
Low-FL YA	.08	.55	-.15	.64
	Familiarity			
High-FL OA	-.04	.58	-.03	.34
High-FL YA	-.07	.60	-.01	.51
Low-FL OA	.30	.50	-.02	.46
Low-FL YA	-.01	.44	.00	.41

* SD = Standard deviation. FL = Frontal Lobe. YA = Younger adults. OA = Older adults.

All effects were unreliable except the three-way interaction, F (3,66) = 3.21, p = .029. Interpretation of this effect is diffiuclt given that most scores are around chance. Moreover, since scores on average are not different than chance, the practical significance of this finding is suspect.

Discussion

There were several noteworthy results from this experiment. All participants showed evidence of the orthographic distinctiveness effect, regardless of age, MTL-function, or FL-function. While previous research has shown orthographic distinctiveness effects in young adults in a variety of formats (e.g., recall, recognition, etc.) this is the first study to demonstrate this effect in a sample of older adults. This finding is consistent with past research with other secondary distinctiveness paradigms (e.g., Black et al., 2004; Nicolas & Worthen, 2009). This finding together with the previous experiment strengthens the argument that normal aging does not negatively affect the ability to benefit memorially from the presence of distinctive information, if slowing is controlled. In a study of bizarreness, Nicolas and Worthen (2009) reported no distinctiveness effect in the old-old segment of their sample. Given the age cutoff for the current study was 80 in the current study, it is probable that this kind of effect was not able to be observed.

Concerning recognition performance, one finding that was unique was the false alarm rates. Specifically, in a similar paradigm, Rajaram (1998) found low false alarm rates overall. Moreover, false alarm rates were lower for distinctive items in comparison to orthographically common items. In the current experiment, false alarm rates were high and elevated for distinct lures relative to common lures. One reason that can potentially explain this discrepancy is the present experiment included more words, which served as primacy and recency buffers that were not tested. Rajaram (1998) did not have participants study these extra words. Thus, one potential reason for this finding is that more words created a greater memory load for participants, and in turn, created more errors.

The second major finding, consistent with Experiment 1 and past research from other laboratories (e.g., Rajaram, 1998), was that memory for orthographically distinct items was associated with higher levels of recollection and familiarity, relative to memory for orthographically common items. Once again, because both estimates were elevated it is difficult to determine what each of these processes are doing in terms of the distinctiveness effect. Although, it further supports the notion that neither process alone can account for novelty-related effects in memory.

What is particularly interesting is that older and younger adults showed once again equivalent levels of recollection, an atypical finding in the episodic remembering literature (e.g., Hoyer & Verhaeghen, 2006). This finding dovetails with what was reported in Experiment 1. The importance of age invariance in recollection judgments across these experiments as well as how distinctive processing may allow for such good performance will receive additional attention in the General Discussion.

Third, the objective source judgments were not significantly different from zero suggesting the source of the recollection judgments given by participants did not contain temporal information about what list a particular distinct item appeared on. Once again, this is a replication of what was found in the previous experiment with spatial information save for young adult's recollection judgments to distinct items. This generally argues against the hypothesis that the presence of distinct information enhances the processing of the context (Hirshman et al., 1989). Of course, this result does not fully argue against this proposition as it might be the case that participants are basing their 'Type A' judgment on some other characteristic. It is plausible to predict that in the isolation effect paradigm, individuals might recall what the distinctive color was (given that it was varied during presentation). However, it is not immediately clear what participants would plausibly remember with an orthographically distinct item. Perhaps future studies should simply ask what participants are specifically remembering with any given item. These data would give researchers an idea as to what characteristics of the remembering situation individuals are remembering. This would also give researchers a chance to rule out the idea that recollection judgments are just high-confidence memory judgments (e.g. Yonelinas, 2002). For instance, if there were a prevalence of trials in which people gave a 'Type A' judgment but could not accurately recall any contextual detail, it would give some credence to the above hypothesis.

CHAPTER 4

PRIMARY DISTINCTIVENESS UNDER INCIDENTAL MEMORY INSTRUCTIONS

In the third experiment, the impact of incidental encoding as opposed to intentional encoding on distinctiveness and estimates of recollection and familiarity was examined. This was done to establish if older adults could show distinctiveness effects under incidental conditions and to also examine how this type of manipulation would affect estimates of recollection and familiarity. In one previous study, Kishiyama and Yonelinas (2003) reported that under incidental encoding instructions, there was evidence of a distinctiveness effect that was only mediated by increases in familiarity and not recollection. Finding a type of dissociation such as this should help provide some idea of what recollection and familiarity are doing in the establishment of the distinctiveness effect. Their experiment was performed only on a sample of younger adults and as such the current study will try to extend those findings by testing a sample of older adults. Additionally, this experiment used verbal stimuli in contrast to pictoral stimuli. Given previous results, if familiarity is operating solely operating in the distinctiveness effect, one would expect that both older and young adults would demonstrate the distinctiveness effect, given that familiarity is well maintained with normal aging.

Once again, MTL and FL-function were assessed. In the previous experiments, there were no consistent differences among these groups on measures of distinctiveness or recollection and familiarity. Given the incidental nature of the memory task, it is possible that differences among these groups may arise in this experiment.

Once again, objective source memory was examined. Unlike the previous studies however, there was an encoding task that helped participants encode items, allbeit in a shallow manner. One of the encoding tasks directed participants attention to the source memory question that would be asked later in the experiment. The other task oriented participants away from the source question. Of interest with this manipulation, however, is the extent to which this could potentially affect objective source memory performance. Specifically, the notion is that simply directing attention to the relevant source features might help older adults overcome their source memory deficits. While incidental encoding should seemingly produce even poorer objective source performance, it is possible that the encoding task may improve it.

Method

Participants

Sixty-nine younger adults and 50 older adults participated in the study. Three younger adults were removed from the analysis for having excessively high false alarm rates (≥.8)[4]. Three older adults were removed from the analysis for committing an excessive amount of false alarms and 4 others were removed for having extremely low hit rates (i.e., 0). Hence, the final analysis was conducted on a sample of 66 younger and 47 older adults. The characteristics of the sample are presented in Table 4.1.

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[4] The false alarm cut off rate was raised here to be able to include more subjects and this was also reasonable given that individuals were not aware of a memory test they were going to be taking.

Table 4.1 Participant characteristics by MTL functioning

Group	N	Age	Range	Education	Health	MTL Score
Low-MTL YA	32	20.1 (1.5)	18 - 24	13.5 (1.2)	4.4 (.56)	-.13 (.15)
High-MTL YA	34	20.2 (1.7)	18 - 24	13.8 (1.4)	4.1 (.74)	.13 (.07)
Low-MTL OA	22	74.9 (5.4)	63 - 81	16.09 (2.8)	3.7 (.70)	-.18 (.09)
High-MTL OA	25	73.0 (4.8)	61 - 80	15.36 (4.0)	3.6 (1.2)	.15 (.13)

* Standard deviations are presented in parentheses. YA = Young adults. OA = Older adults.

There were no differences in mean age among the young adult groups ($p = 1.00$) nor were there differences among the older adults groups ($p = .273$). In terms of education, older adults ($M = 15.71$; $SD = 3.4$) reported more years of education than young adults ($M = 13.66$; $SD = 1.3$), $t(111) = -4.44$, $p < .001$. Young adults' ($M = 4.29$; $SD = .68$), however self-reported better health than older adults ($M = 3.69$; $SD = .95$), $t(111) = 3.94$, $p < .001$. Importantly, for years of education and health there were no differences between high- and low-MTL young adult groups (*p*'s .973 and .46 respectively). This was also the case for the older adult groups (*p*'s .736 and .982 respectively). We also compared age groups on the cognitive measures contained in the neuropsychological test battery. These data can be seen in Table 4.2.

Table 4.2 Performance on the Neuropsychological Test Battery for Older and Younger Adults

Measure and Max Score	Older Adults		Younger Adults		Statistics	
	Mean	SD	Mean	SD	*t* value	*p* value
mWCST (8)	2.61	2.0	4.16	1.6	4.61	< .001
Mental Control (6)	5.12	1.2	5.52	0.7	2.24	.027
COWAT	42.47	12.7	48.42	12.7	2.49	.014
Backward Digit Span (12)	6.49	2.1	8.30	2.0	4.51	< .001
Mental Arithmetic (19)	10.43	4.3	12.70	3.2	3.22	.002
Logical Memory I (50)	21.41	6.3	27.22	6.4	4.87	< .001
Visual Paired Associates I (18)	11.88	4.6	16.98	1.9	8.18	< .001
Verbal Paired Associates I (24)	16.08	3.8	22.48	1.5	12.39	< .001
CVLT - Delayed (16)	9.35	3.3	14.08	1.9	9.68	< .001

*mWCST = modified Wisconsin Card Sorting Test. COWAT = California Oral Word Association Test. CVLT = California Verbal Learning Test.

Young adults outperformed older adults on all episodic memory measures (for specific results see Table 4.2). Younger adults, on average, also outperformed older adults on all measures of frontal lobe functioning.

Design

There were three independent variables in this experiment: Group (High young adults, Low young adults, High older adults, Low older adults), Distinctiveness (Distinct, Non-Distinct) and Encoding Task (Away from Source [AS], Direct to Source [DS]). The variable of Distinctiveness was manipulated within-subjects, while the variables of Group and Encoding Task were manipulated between-subjects.

Materials and Procedure

The materials were the same as Experiment 1. The procedure was very similar except for the fact that participants were not told that there would be a memory test. In particular, participants were seated in front of a computer and told the current study was aimed at examining their ability to make decisions about words. In the 'AS' condition, participants were asked to determine which letter the word started with. If the word started with a letter A - M, they were to press the 'm' key on the keyboard. If the word started with a letter N - Z, they were to press the 'z' key. In the 'DS' condition, participants were instructed to press the 'm' key if the word appeared on the top part of the screen and to press the 'z' key if it appeared on the bottom part of the screen. Presentation time was the same as Experiment 1. Participants were further instructed that even after they made a response the word would remain on the screen. Words were broken up into 5 lists of 12 words each. Participants were allowed to take a break between lists. The instructions for the test phase were identical to the previous experiments. The source question was the same as Experiment 1.

Results

The data from the neuropsychological test battery were submitted to a factor analysis. The results can be seen in Table 4.3.

Table 4.3 Factor Loadings for the Neuropsychological Battery of Tasks After Promax Rotation

Measure	Factor 1	Factor 2
mWCST		.13
Mental Control		.77
COWAT		.49
Backward Digit Span		.71
Mental Arithmetic		.85
Logical Memory I	.77	
Verbal Paired Associates I	.79	
Visual Paired Associates II	.81	
CVLT - Delayed	.87	
Eigenvalue	4.15	1.20

* mWCST = modified Wisconsin Card Sorting Test.
COWAT = California Oral Word Association Test.
CVLT = California Verbal Learning Test.

The first factor appears to reflect MTL function as the purported episodic memory measures all loaded highly on this factor. The second factor appears to reflect FL function as there were moderate to high loadings with the purported executive function tasks. In all these data conceptually replicate the two-factor structure reported by Glisky and colleagues (1995). The group differences across the different tasks can be seen in Table 4.4.

Table 4.4. Performance on the MTL Tasks Across Groups

	High-MTL YA		Low-MTL YA		High-MTL OA		Low-MTL OA	
Measure	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Logical Memory I	30.44	5.3	23.79	5.5	25.04	5.8	17.05	3.7
Verbal Paired Associates I	23.09	1.4	21.70	1.5	18.27	2.9	13.45	3.3
Visual Paired Associates I	17.53	0.8	16.39	2.4	14.5	3.1	8.59	4.0
CVLT - Delayed	15.15	1.4	12.79	1.9	11.46	2.8	6.91	1.8

* CVLT = California Verbal Learning Test. YA = Young Adults. OA = Older Adults.

There were differences between MTL factor scores across groups, F (3,111) = 59.97, $p < .001$. Post hoc planned comparisons suggested there were differences between the high- and low-MTL groups for young adult ($p < .001$) and for older adult groups ($p < .001$). However, there were no differences between the high-MTL groups ($p = .93$), nor the low-MTL groups ($p = .49$).

All omnibus tests were significant at the $p < .001$ level, and as such the focus is placed on the planned comparisons for each task. For Logical Memory, high-MTL young adults performed better than all other groups (p's $\leq .001$). High-MTL older adults and low-MTL young adults performed better than low-MTL older adults (p's $< .001$), although there were no differences between these two groups (p = .854). For Visual Paired Associates, high-MTL young adults recalled more paired associates than both older adults groups (p's < .001). Low-MTL young adults also performed better than high-MTL older (p = .032) and low-MTL older adults (p < .001). High-MTL older adults did better than low-MTL older adults on this task as well (p < .001). For Verbal Paired Associates, all pairwise comparisons were significant at the p < .001 level except for the comparison between the young adults groups which did not meet conventional levels of significance (p = .065). Finally for CVLT, all comparisons were significant at the p < .001 level except for the comparison between high-MTL older adults and low-MTL young adults which was shy of significance (p = .098).

Distinctiveness Effects

Evidence for distinctiveness effects was gathered by comparing recognition performance for distinct items to performance for common items. The data were submitted to a 4 x 2 mixed factorial ANOVA. The data are presented in Table 4.5.

Table 4.5 Recognition Memory Measures by MTL group and Distinctiveness Type

Group	Recognition Memory Measures			
	Hits	False Alarms	Corrected Recognition	d'
	Distinctive Items			
High-MTL OA	.60 (.04)	.22 (.04)	.38 (.05)	1.16 (.15)
High-MTL YA	.72 (.04)	.32 (.03)	.40 (.04)	1.21 (.13)
Low-MTL OA	.59 (.04)	.35 (.04)	.25 (.05)	0.72 (.16)
Low-MTL YA	.66 (.04)	.29 (.03)	.36 (.04)	1.05 (.14)
	Non-Distinctive Items			
High-MTL OA	.57 (.05)	.22 (.04)	.35 (.05)	1.06 (.15)
High-MTL YA	.74 (.04)	.34 (.04)	.40 (.04)	1.21 (.13)
Low-MTL OA	.54 (.05)	.35 (.04)	.19 (.05)	0.59 (.16)
Low-MTL YA	.61 (.04)	.35 (.04)	.27 (.04)	0.74 (.14)

* Standard errors are presented in parentheses. YA = Young Adult. OA = Older Adult.

Analysis of the hits revealed, no main effect of Distinctiveness, F (1,109) = 2.30, p = .13. There were differences across groups, F (3, 109) = 4.42, p = .006. Planned post hoc comparisons suggested that performance of the high- and low-MTL young adult groups did not differ (p = .179). However, the high-MTL young adults had higher hit rates than high-MTL older adults (p = .024) and low-MTL older adults (p = .009). There were no differences between high- and low-MTL older adult groups (p = .978). There was also no difference between the low-MTL young adults and the high-MTL older adults (p =.760) nor the low-MTL older adults (p = .521). The Group x Distinctiveness interaction was not reliable, F < 1.

There no difference in false alarm rates between distinct and non-distinct items, $F < 1$. There was a trend for a difference in false alarm rates across groups, F (3, 109) = 2.63, $p = .054$. While none of the post-hoc planned comparisons were significant, the difference may be due to the high-MTL older adults demonstrating lower false alarm relative to the other groups, especially low-MTL older adults ($p = .075$). The Group x Distinctiveness interaction was not reliable, $F < 1$.

Using the metric of corrected recognition, there was no difference between distinct and non-distinct items, F (3, 109) = 2.41, $p = .124$. There were differences across groups, F (3, 109) = 4.01, $p = .010$. Planned post hoc comparisons suggested this was due to differences between high-MTL younger adults and low-MTL older adults ($p = .006$). There were also a trend for a difference between high-MTL older adults and low-MTL older adults ($p = .072$). The Group x Distinctiveness interaction was not reliable, $F< 1$.

Finally using the metric of *d'*, the main effect of distinctiveness fell short of conventional levels of significance, F (3, 109) = 2.95, $p = .089$. On average, there were differences between groups, F (3, 109) = 3.89, $p = .011$. Post-hoc comparisons suggested there were differences between the high-MTL young adults and the low-MTL older adults ($p = .01$). There were also a trend for a difference between high-MTL older adults and low-MTL older adults ($p = .079$). The Group x Distinctiveness interaction was not reliable, $F < 1$.

Estimates of Recollection and Familiarity

In the first analysis, recollection was measured as the raw proportion of 'Type A' judgments. These results can be seen in Figure 4.1.

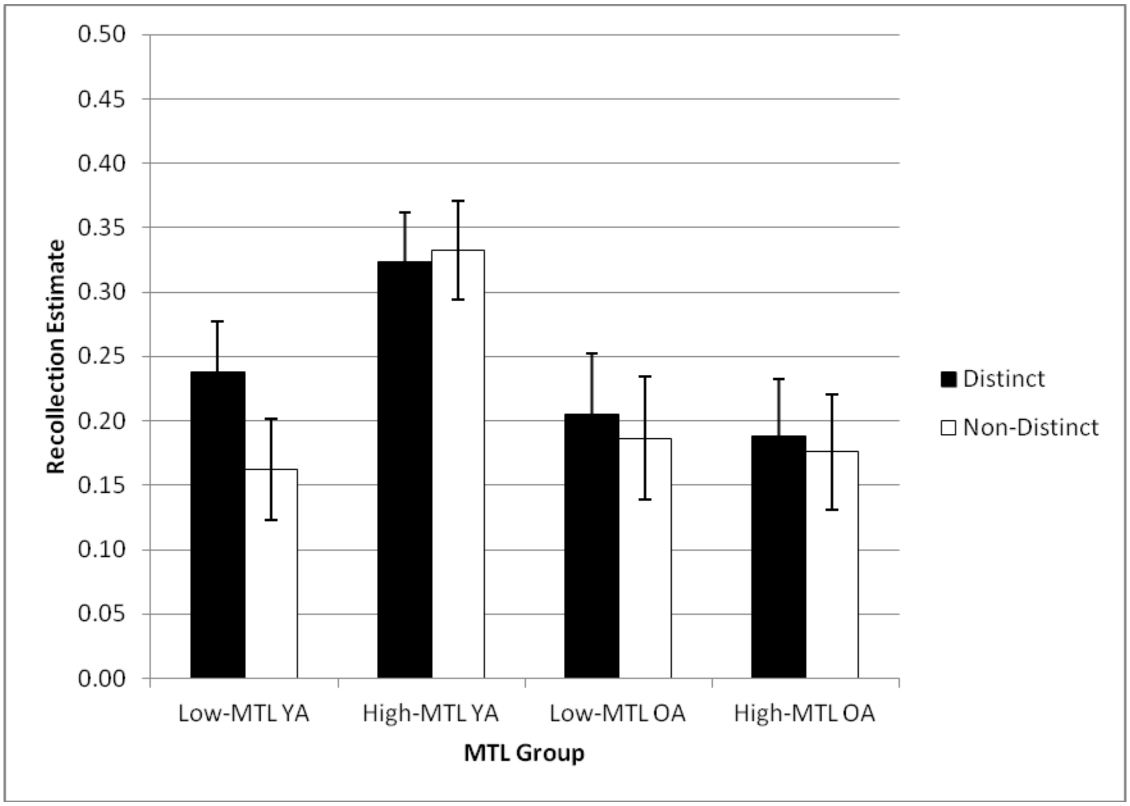

Figure 4.1. Recollection Estimates by MTL Group

There was no difference in the estimates of recollection between distinct and non-distinct items, F (1, 109) = 2.43, p = .122. On average, there were differences across MTL groups, F (3, 109) = 3.38, p = .021. Although none of the post hoc comparisons were significant, the trend was that the high-MTL young adults had higher estimates of recollection, on average than did the other groups (low-MTL young adults: p = .065; high-MTL older adults: p = .043: low-MTL older adults: p = .097). The Group x Distinctiveness interaction failed to reach significance, F (3, 109) = 1.59, p = .157.

We also calculated recollection but using the metric of d'. These results are presented in Table 4.6

Table 4.6 Recollection Estimates for Distinct and Non-Distinct Items Using d'

Group	Distinct	Non-Distinct
High-MTL OA	.38 (.12)	.47 (.13)
High-MTL YA	.91 (.10)	.94 (.11)
Low-MTL OA	.29 (.13)	.26 (.14)
Low-MTL YA	.65 (.11)	.27 (.12)

* Standard errors are presented in parentheses. MTL = Medial Temporal Lobe. YA = Younger adults. OA = Older adults.

There was no evidence of a recollection advantage for distinct words, F (1, 109) = 1.41, p = .283. There were once again differences across groups, F (3, 109) = 8.30, p < .001. Post hoc comparisons suggested that the high-MTL young adults had higher estimates of recollection relative to all the other groups (low-MTL young adults: p = .003; high-MTL older adults: p = .003: low-MTL older adults: p < .001). None of the other comparisons were significant (all p's > .582). In contrast to the previous analysis, the Group x Distinctiveness interaction was reliable, F (3, 109) = 3.13, p = .029. To follow up on this, paired t-tests were conducted for each MTL group separately. The analysis suggested that the interaction stems from the low-MTL young adults showing a distinctiveness effect, while all of the other groups showed no difference in recollection for distinct and non-distinct items.

The results for the analysis of familiarity estimates can be seen in Figure 4.2.

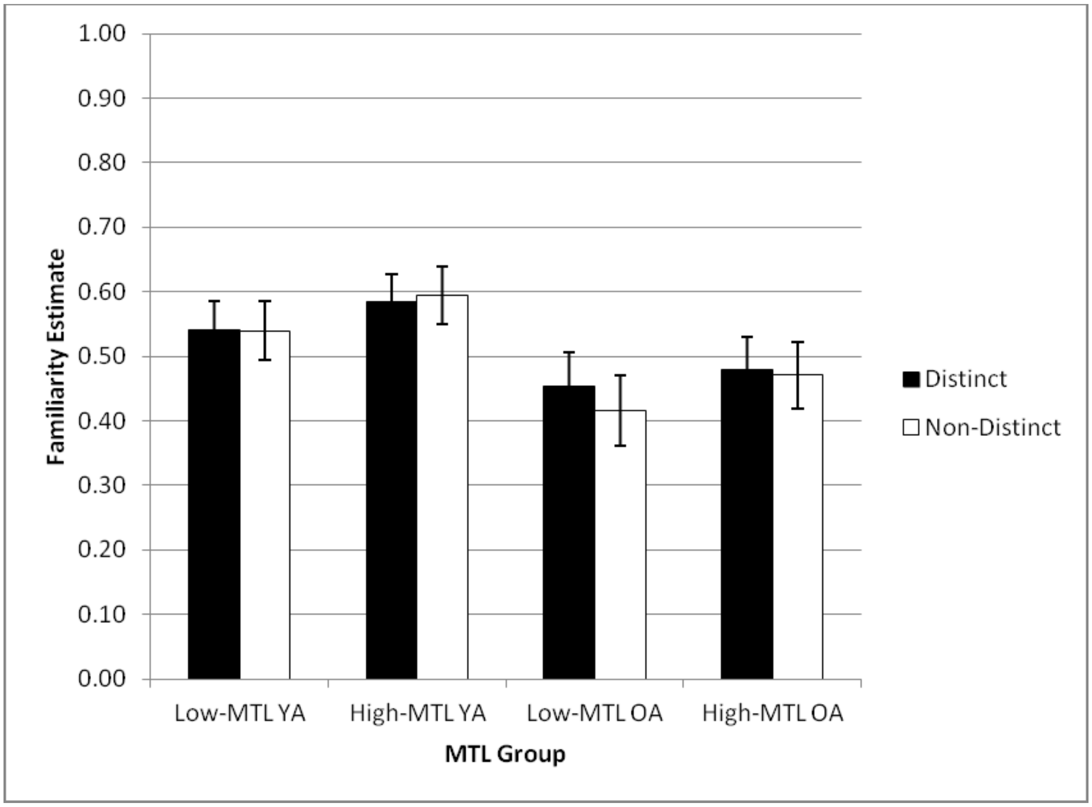

Figure 2.2. Familiarity Estimates by MTL Group

Familiarity estimates for distinct words were not statistically different than estimates for non-distinct words, $F < 1$. There was a trend for differences across groups, F (3, 109) = 2.60, p = .056. Although none of the comparisons reached significance, the one closest to reliability was the elevated levels of familiarity for high MTL young adults compared to the lower levels of the low-MTL older adults (p = .06). The Group x Distinctiveness interactions also failed to reach significance, $F < 1$.

Objective Source Memory Performance

The data for objective source judgments can be seen in Table 4.7, separated by encoding task. First, performance was examined to determine whether performance was different than chance.

Table 4.7. Source Memory Accuracy and Results from Statisitical Analysis Organized by Response Type

Measure	Performance and Statistical Outcomes			
	Mean	SD	*t* - value	*p*- value
	AS Condition			
Distinct Recollection	.03	.47	.48	.635
Distinct Familiarity	-.06	.24	-2.27	.027
Non-Distinct Recollection	.15	.43	2.16	.037
Non-Distinct Familiarity	-.02	.24	-.77	.45
	DS Condition			
Distinct Recollection	.19	.32	3.55	.001
Distinct Familiarity	-.05	.38	-.83	.413
Non-Distinct Recollection	.03	.38	.40	.693
Non-Distinct Familiarity	.03	.26	.76	.450

There were several instances in which performance on the objective source memory was above chance. Most notably, in the 'DS' condition, recollection judgments to distinct items were significantly above chance. This was not the case for the 'AS' condition. Curiously however, recollection judgments to non-distinct items in the 'AS' condition were also reliably above chance. Also of note in the 'AS' condition, familiarity judgments to distinct items were reliably below chance performance. Provided there are several means above chance, it is worth breaking these results down by MTL group to establish if one group is resposible for this level of performance relative to the others. The mean performance by group for the 'AS' condition can be seen in Table 4.8

Table 4.8. Source Memory Accuracy Separated by MTL-Group, Distinctiveness, and Response Type for the 'AS' Condition

Group	Source Memory Accuracy			
	Distinct		Non-Distinct	
	Mean	SD	Mean	SD
	Recollection Responses			
High-MTL OA	.01	.07	-.04	.05
High-MTL YA	-.11	.40	.02	.36
Low-MTL OA	-.05	.08	0.00	0.00
Low-MTL YA	.21	.48	.35	.55
	Familiarity Responses			
High-MTL OA	.09	.12	-.25	.50
High-MTL YA	.01	.09	-.06	.28
Low-MTL OA	-.25	.35	-.063	.09
Low-MTL YA	-.11	.28	.006	.10

* SD = Standard deviation. MTL = Medial Temporal Lobe. YA = Young Adults. OA = Older Adults.

One-way ANOVAs were conducted on each of the four response types. The results from the analysis suggested that the sole reliable effect concerned familiarity judgments to distinct items, which were reliably below chance, F (3, 61) = 2.81, p = .047. Because this effect was below chance, planned comparisons will not be discussed. The data for the 'DS' condition can be seen in Table 4.9.

Table 4.9. Source Memory Accuracy Separated by MTL-Group, Distinctiveness, and Response Type for the 'DS' Condition

Group	Source Memory Accuracy			
	Distinct		Non-Distinct	
	Mean	SD	Mean	SD
	Recollection			
High-MTL OA	.20	.21	-.002	.73
High-MTL YA	.043	.10	.11	.14
Low-MTL OA	.49	.48	.17	.43
Low-MTL YA	.30	.46	-.02	.17
	Familiarity			
High-MTL OA	-.17	.55	.10	.14
High-MTL YA	.11	.49	-.08	.35
Low-MTL OA	-.31	.48	.21	.36
Low-MTL YA	-.08	.11	-.02	.05

* SD = Standard deviation. MTL = Medial Temporal Lobe. YA = Young Adults. OA = Older Adults.

One-way ANOVAs were conducted on the outcomes of interest. For recollection judgments to distinct items, which was reliably above chance, there was a marginally significant main effect of Group, F (3, 37) = 2.75, p = .059. Planned comparisons suggested that low-MTL older adults (M = .41; SD = .49) exhibited the highest performance and their performance was reliably different from that of high-MTL young adults who had the lowest performance of the groups. None of the other omnibus tests were reliable. Once again, given the large standard errors that often encompass zero, these effects should be treated with caution.

Next, these data were reanalyzed using differences in FL function instead of differences in MTL function. The results for the group differences across the FL tasks of the neuropsychological battery are displayed in Table 4.10.

Table 4.10. Performance on the FL Tasks Across Groups

	High-FL YA		Low-FL YA		High-FL OA		Low-FL OA	
Measure	Mean	SD	Mean	SD	Mean	SD	Mean	SD
mWCST	4.21	1.2	4.28	1.8	3.04	1.9	2.17	2.1
Mental Control	5.88	0.3	5.19	0.7	5.71	0.6	4.48	1.4
COWAT	51.59	13.5	46.28	10.8	48.5	11.1	35.52	10.5
Backward Digit Span	9.5	1.7	6.94	1.8	7.58	1.7	5.17	1.5
Mental Arithmetic	14.88	2.1	10.31	2.5	13.54	2.4	7.09	3.4

*mWCST = modified Wisconsin Card Sorting Test. COWAT = California Oral Word Association Test. YA = Young Adults. OA = Older Adults.

There were differences in FL factor scores, F (3, 109) = 64.83, $p < .001$. High-FL young adults had higher factor scores than low-FL young adults ($p < .001$) and older adults ($p < .001$), but did not score differently than high-FL older adults ($p = .998$). As expected, high-FL older adults also had a higher average factor score than both low-FL groups (both p's < .001). There were no differences between the low-FL groups (p = .786).

All omnibus tests were significant at the $p < .001$ level and as such only the planned comparisons will be discussed further. For the mWCST, high-FL and low-FL young adults performed better than low-FL older adults (p's < .001). Low-FL young adults also out-performed high-FL older adults (p = .043). This was also the same trend for high-FL young adults (p = .059). No other comparisons were significant. For Mental Control, high-FL young adults performed better than low-FL young (p = .003) and older adults ($p < .001$). High-FL older adults also performed better than low-FL older adults ($p < .001$) but not young adults (p = .079). Also, low-FL young adults exhibited superior performance relative to low-FL older adults (p = .008). On the COWAT, all groups performed better than low-FL older adults (all p's ≤ .006). There were no other significant differences between groups. On the Backward Digit Span Task, high-FL young adults demonstrated superior performance relative to all groups (all p's < .001). High-FL older adults performed better than low-FL older adults ($p < .001$) as did low-FL young adults (p = .002). For Mental Arithmetic, high-FL young and older adults correctly solved more math problems than low-FL young and older adults (all p's < .001). There was no difference between the high-FL groups (p = .216), although the low-FL young adults did better than low-FL older adults ($p < .001$).

Distinctiveness Effects

Next, differences in recognition memory performance for distinct and non-distinct items were examined.

Table 4.11 Recognition Memory Measures by FL group and Distinctiveness Type

Group	Recognition Memory Measures			
	Hits	False Alarms	Corrected Recognition	d'
	Distinctive Items			
High-FL OA	.57 (.04)	.24 (.04)	.33 (.05)	1.00 (.16)
High-FL YA	.69 (.04)	.30 (.03)	.39 (.04)	1.17 (.13)
Low-FL OA	.63 (.04)	.33 (.04)	.30 (.05)	.90 (.16)
Low-FL YA	69 (.04)	.32 (.04)	.37 (.05)	1.10 (.14)
	Non-Distinctive Items			
High-FL OA	.52 (.05)	.26 (.04)	.26 (.05)	.81 (.16)
High-FL YA	.69 (.04)	.33 (.04)	.36 (.04)	1.06 (.14)
Low-FL OA	.59 (.05)	.30 (.04)	.29 (.05)	.86 (.16)
Low-FL YA	.67 (.04)	.36 (.04)	.32 (.05)	.91 (.14)

* Standard errors are presented in parentheses. YA = Young Adults. OA = Older Adults.

For hits, there was no evidence of a distinctiveness effect, F (1, 109) =2.14, p = .147. On average, there were differences across groups, F (3, 109) = 3.39, p = .021. Planned comparisons suggested this effect was driven by differences between high-FL older (who had the lowest hit rate) and young adults (p = .02) as well as between low-FL young adults and high-FL older adults (p = .05). The Group x Distinctiveness interaction was not reliable, $F < 1$.

There were no differences in false alarms for distinct or non-distinct items, $F < 1$. There were no differences between groups, F (3, 109) = 1.24, p = .30. The Group x Distinctiveness interaction was not reliable, $F < 1$.

With corrected recognition, there was no evidence of a distinctiveness effect, *F* (1, 109) = 2.24, *p* = .137. On average, there were no differences between groups, *F* < 1. The Group x Distinctiveness interaction was no reliable, *F* < 1.

Finally, using *d'*, the distinct items were better remembered than non-distinct items but this effect fell short of conventional levels of significance, *F* (1, 109) = 2.77, *p* = .099. On average, there were no differences across groups, *F* < 1. The Group x Distinctiveness interaction also was not reliable, *F* < 1.

Estimates of Recollection and Familiarity

The results for recollection using the raw proportion of 'Type A' judgments are shown in Figure 4.3

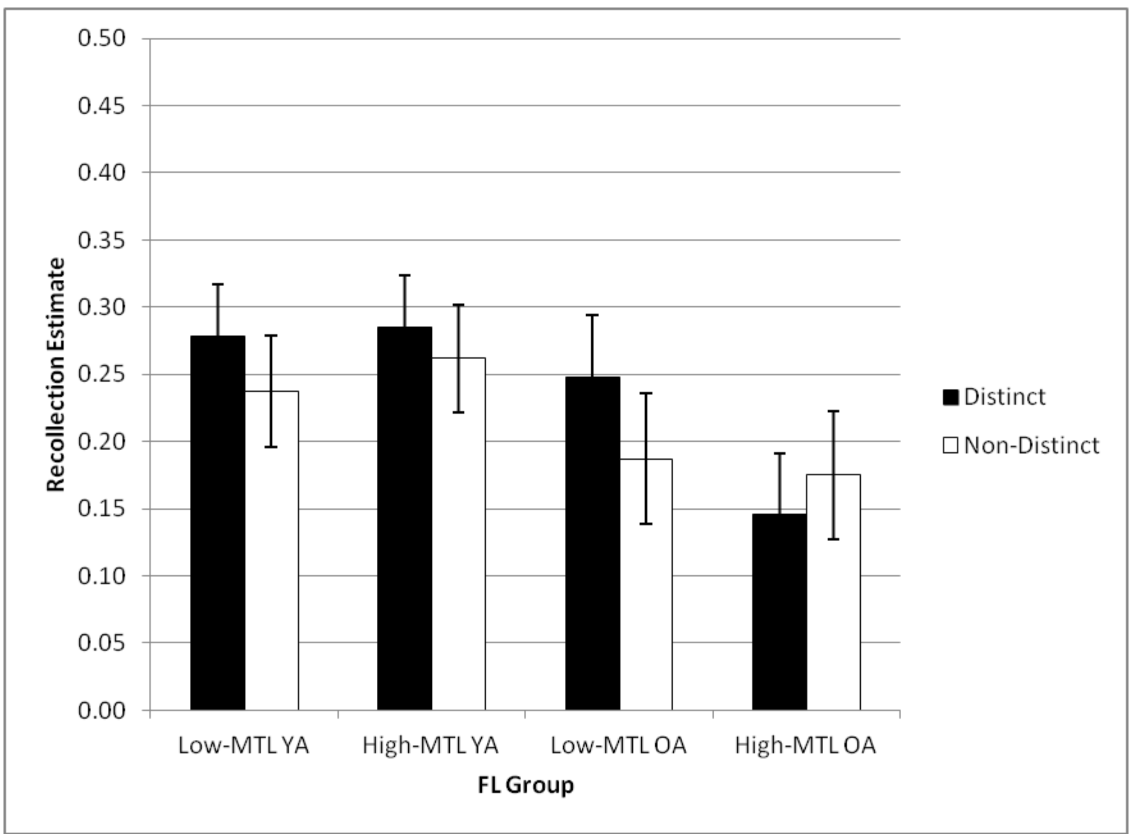

Figure 4.3. Recollection Estimates by FL Group

There were no differences in estimates of recollection for distinct and non-distinct items, *F* (1, 109) = 2.40, *p* = .124. There were also no differences across groups, *F* (3, 109) = 1.53, *p* = .211. The Group x Distinctiveness interaction also was not reliable, *F* (3, 109) = 1.37, *p* = .256. Recollection was computed using *d'* and these results can be seen in Table 4.12

Table 4.12 Recollection Estimates for Distinct and Non-Distinct Items Using d'

Group	Distinct	Non-Distinct
High-FL OA	.26 (.12)	.30 (.14)
High-FL YA	.78 (.10)	.73 (.12)
Low-FL OA	.42 (.13)	.43 (.15)
Low-FL YA	.79 (.11)	.50 (.12)

* Standard errors are presented in parentheses. FL = Frontal Lobe. YA = Younger adults. OA = Older adults.

There was no advantage for distinct items over non-distinct items in recollection estimates, *F* (1, 109) = 1.25, *p* = .266. There were however differences across groups, *F* (3, 109) = 3.95, *p* = .01. Planned comparisons suggested the omnibus main effect was primarily driven by the difference between the high-FL younger and older adults (*p* = .011). The Group x Distinctiveness interaction was not reliable, *F* (3, 109) = 1.51, *p* = .214.

The results for familiarity can be seen in Figure 4.4.

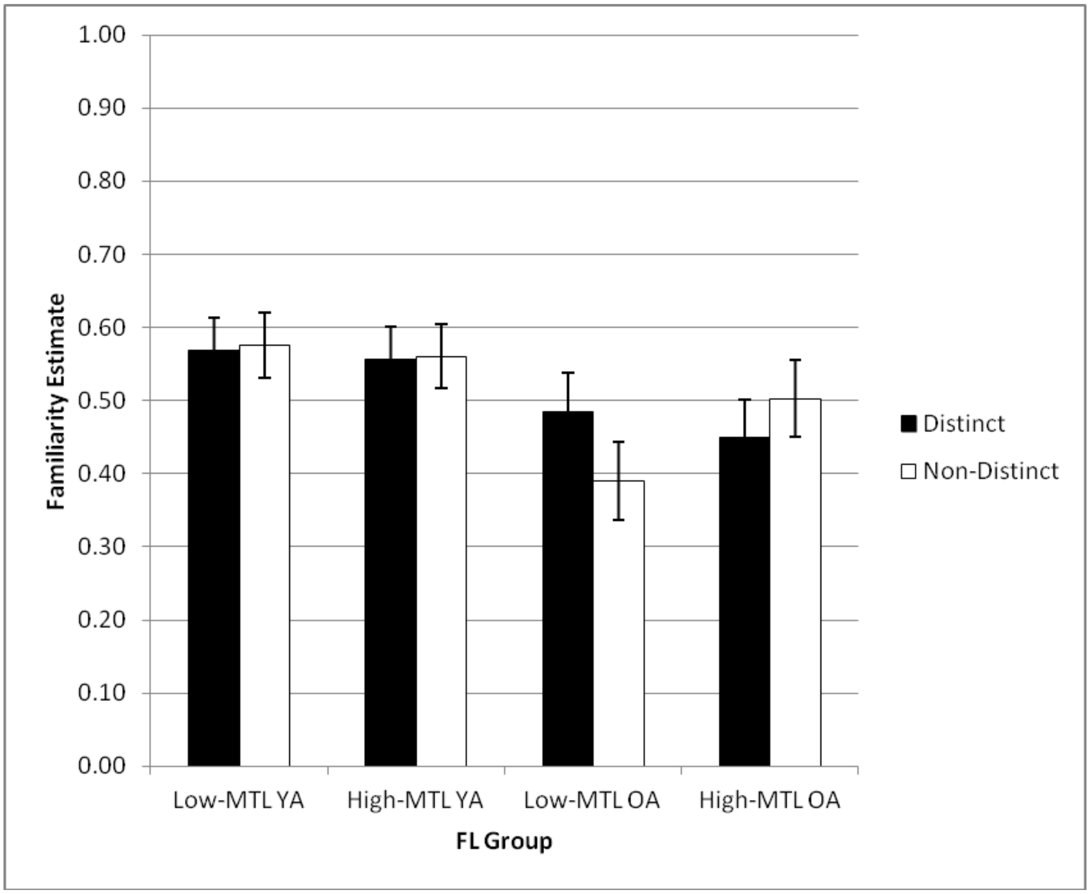

Figure 4.4. Familiarity Estimates by FL Group

There were no differences in estimates of familiarity across distinct and non-distinct items, $F < 1$. The main effect of group failed to reach conventional levels of significance, F (3, 109) = 3.23, $p = .079$. The Group x Distinctiveness interaction was also not reliable, F (3, 109) = 1.53, $p = .212$.

Objective Source Memory Performance

As reported previously, several of the objective source memory scores were above chance. These data are broken into the 'AS' and 'DS' conditions. The results for the 'AS' condition can be seen in Table 4.13.

Table 4.13. Source Memory Accuracy Separated by FL-Group, Distinctiveness, and Response Type for the 'AS' Condition

Group	Source Memory Accuracy			
	Distinct		Non-Distinct	
	Mean	SD	Mean	SD
	Recollection			
High-FL OA	.06	.06	-.001	.04
High-FL YA	.04	.62	.20	.54
Low-FL OA	.15	.36	-.03	.06
Low-FL YA	-.03	.39	.21	.41
	Familiarity			
High-FL OA	-.08	.28	-.03	.46
High-FL YA	.006	.09	-.04	.24
Low-FL OA	-.18	.33	-.03	.06
Low-FL YA	-.07	.24	.005	.07

* SD = Standard deviation. MTL = Medial Temporal Lobe. YA = Young Adults. OA = Older Adults.

None of the omnibus one-way ANOVAs were significant (all *p*'s ≥ .230), thus planned comparisons will not be discussed. These same analyses were conducted for the 'DS' condition and the results can be seen in Table 4.14

Table 4.14. Source Memory Accuracy Separated by FL-Group, Distinctiveness, and Response Type for the 'DS' Condition

Group	Source Memory Accuracy			
	Distinct		Non-Distinct	
	Mean	SD	Mean	SD
	Recollection			
High-FL OA	.17	.21	.008	.58
High-FL YA	.07	.16	.003	.33
Low-FL OA	.32	.47	.13	.42
Low-FL YA	.20	.33	-.03	.24
	Familiarity			
High-FL OA	-.13	.31	.05	.17
High-FL YA	.05	.49	-.03	.14
Low-FL OA	-.18	.47	.17	.29
Low-FL YA	.02	.10	-.13	.32

The only reliable one-way ANOVA was for familiarity judgments to non-distinct items, F (3, 41) = 2.98, p = .048. Planned comparisons suggested that this was due low-FL older adults (M = .17; SD = .29) having more accurate performance than low-FL young adults (p = .029). On the whole it appears that source performance was better in the 'DS' condition relative to the 'AS' condition for recollection judgments to distinct items. However, because of the large standard deviations that often include 0, these results need to be treated with caution.

Discussion

The primary finding in the current study was the lack of distinctiveness effect under incidental encoding instructions. In the previous experiments, there was clear evidence of distinctiveness effects using the measures of corrected recognition and *d'*, however this was not the case for any of the participants. Kishiyama and Yonelinas (2003) reported that young adults showed distinctiveness effects under incidental encoding instructions, although this was with pictures instead of words. Perhaps because pictures are generally better remembered than words (i.e., picture superiority effect, Weldon & Roediger, 1987), they were able to find a distinctiveness effect in that study.

From a process-level standpoint the finding of no distinctiveness effect may not be surprising. Specifically, distinctiveness is the processing of differences in the context of similarity. The processing being done by the participants in the current task involved simply making a judgment about where the word was located on the screen, or what letter the word started with. This type of shallow processing is not likely to elicit the noticing of differences during the task especially when there are approximately equal numbers of both types (e.g., top, bottom) items. In theory, the idea is that participants would process the difference in color against the backdrop of similarity of the majority of words all appearing in the same color. One would also imagine that a change in color could potentially grab the attention of a participant. Yet, this attention grab would mean nothing if there was no similarity or relational processing ongoing. Given that participants were told that there job was to make judgments and not remember words, it might be the case that they took each trial individually and never engaged in any sort of encoding process (explicit or implicit) directed at noticing similarities among the items. In fact, it is tenable that some participants never even noticed a color change if they were solely focused on the encoding task.

Along with a failure to find distinctiveness effects, estimates of recollection and familiarity were the same for both distinct and non-distinct items. Moreover, it was the case that under incidental instructions that numerical estimates of both processes were reduced. Although the absence of evidence is not evidence, this finding of equivalency with recollection and familiarity does support the notion that both processes are critical for establishing the distinctiveness effect. Postman and Phillips (1954) reported no novelty advantage in a free recall paradigm, under incidental encoding providing some basis for not expecting a recollection-related advantage. As stated previously, Kishiyama and Yonelinas (2003) found a distinctiveness effect which was accompanied by increases in familiarity but not recollection. This would suggest that familiarity is critical factor for establishing distinctiveness. Yet in this study, this was not the case.

Interestingly, there was a trend for differences in recollection estimates across age groups. Although the main effect of Group was not significant it tended to be the case that young adults regardless of MTL function did better than older adults. To follow up on this trend, I conducted independent-sample t-tests with the independent variable of age group, on the 4 recollection variables ('Type A' Hits_Distinct, 'Type A' Hits_Non-Distinct, *d'* Recollection Estimate_Distinct, *d'* Recollection Estimate_Non-Distinct). The results suggested age differences for both of the "Distinct" variables ('Type A Hits: t (111) = 2.24, $p = .027$; *d'*: $t(111) = 4.08$, $p < .001$) although this was only a trend for the "Non-Distinct" variables ('Type A' Hits: t (111) = 1.67, $p = .098$; *d'*: t (111) = 1.92, $p = .058$). This is the expected pattern of findings from the episodic memory literature (Hoyer

& Verhaeghen, 2006) that was not found in the previous experiments under intentional encoding, where distinctiveness effects were observed. This provides some credence to the assertion that there is something unique about the presence of distinct information that allows older adults to use their memory capabilities to their fullest extent. This issue will be further discussed in the General Discussion.

For objective source performance, there were several patterns worth noting. Most prominently, participants in the 'DS' condition had more accurate objective source memory performance on average, than participants in the 'AS' condition. For example, recollection judgments to distinct items were significantly above chance with the 'DS' condition but not for the 'AS' condition. Curiously, however recollection judgments to non-distinct items were above chance in the 'AS' condition. Because source performance was once again low, it is difficult to make much out of these data. This is especially true given the lack of an overall distinctiveness effect. Nevertheless, it appears that the encoding task which directed individuals to the eventual source judgment was effective relative to an encoding task that was unrelated to the source question.

CHAPTER 5

GENERAL DISCUSSION

Across three studies distinctiveness effects were observed only under intentional conditions. Under incidental encoding instructions, there was no evidence of distinctiveness effects. Increases in estimates of recollection and familiarity accompanied distinctiveness effects. This pattern was similar with all subjects and regardless of MTL or FL functioning or integrity. Despite increases in recollection, distinct items were not associated with increases in objective source memory, most of the time. Similar findings were found for the frontal factor, but will not be discussed further. The implications of these findings for understanding cognitive aging and memory, the processes of recollection and familiarity, and distinctiveness in general are discussed below.

Aging and Distinctiveness

In the two experiments with intentional encoding, older adults showed distinctiveness effects equivalent to those of young adults. No distinctiveness effects were found under incidental encoding, however this was the case for both young and older adults. As stated, this is consistent with research to date in this area (Bireta et al., 2008; Geraci et al., 2009; Nicolas & Worthen, 2009; Smith, et al., 2001; Vitali et al., 2006). These previous studies have used recall or cued-recall measures and thus the current study extends this finding to recognition. Also of importance, there was evidence for primary and secondary distinctiveness effects. In fact, this is the first known study of orthographic distinctiveness with an aged sample. The findings reported here add confidence to the idea that normal aging spares the ability to benefit from the presence of distinctive information. Moreover, if the notion of McDaniel and Geraci (2006) are accepted, these findings support the idea that older adults are not impaired at encoding or retrieval of distinctive information.

Reconciling Inconsistencies

If there is a building consensus that aging spares the ability to benefit from the presence of distinctive information, the question needs to be asked: why do the other studies find that older adults are unable to benefit from the presence of distinctiveness? Cimbalo and Brink's (1982) study had several methodological flaws that could perhaps explain this discrepancy. These include having a noticeable enough font size manipulation that older adults could actually perceive, the requirement to recall items serially, and the lack of appropriate control lists (McDaniel et al., 2008; Smith, 2006). However, other studies examining the effect of distinctive processing on reduction of false recall show no benefit for older adults (Butler et al., 2010; Smith et al., 2005).

Butler et al. (2010) had participants use the item-specific encoding instructions of McCabe et al. (2004), requiring them to come up with a unique feature of each item on a DRM list. This technique should encourage item-specific processing in the context of relational processing, which is encouraged in a DRM paradigm. While this manipulation has been effective at reducing false memory in young adults it was not with older adults. Butler and colleagues cite various reasons why this might be the case. Their primary interpretation was that generating distinctive features amplified demands on older adults' diminished source monitoring abilities (Dodson, Bawa, & Slotnick, 2007). Another reason is that consistently generating a distinctive feature of every item may have disrupted relational processing that is critical to obtaining distinctiveness (Hege & Dodson, 2004; McCabe & Smith, 2006). Additionally, there may be concerns with strategy utilization as older adults reported having a hard time implementing the strategy of generating a distinctive feature. In particular, older adults often failed to generate a distinctive feature, and many times the feature that was generated was not distinctive (Butler et al., 2010). In the current experiments, these item-specific judgments were not required and perhaps did not disrupt relational process or did not increase demands on source monitoring. Thus, the extra processing during encoding, while potentially being able to improve memory, may also impair it if it places too many demands on the cognitive system.

Smith et al. (2005) used differences in the modality of presentation to reduce false memories. Specifically, visual presentation of DRM-list stimuli reduced false memories relative to auditory presentations (e.g., Smith & Hunt, 1998). This so-called modality effect suggests that visual encoding allows for more item-specific encoding of the items, which can then be used at retrieval to endorse "old" items and reject critical lures. However, this manipulation did not affect the performance of older adults. The preferred interpretation of this finding was that older adults lacked the cognitive resources required to engage in distinctive processing or self-initiate distinctive processing (Smith, 2006).This finding is further supported by research with low-working memory capacity individuals who also fail to show a modality effect (Smith & Engle, 2011). This is also similar to the ideas contained in the CSSD model (Smith, 2011), which postulates that "cognitive resources" are required to obtain distinctiveness effects and because older adults exhibit declines in cognitive resources (Craik, 1986) older adults may not be expected to show distinctiveness effects. However, when contextual support is apparent, older adults can show distinctiveness effects..

This finding stands in contrast to related work on the distinctiveness heuristic in which older adults can avoid false memories (McCabe & Smith, 2006; Schacter, Israel, & Racine, 1999).One reason for this difference is that recognition tests typically used with the distinctiveness heuristic may provide environmental support to older adults. In Smith et al. (2005), recall was used, which requires more "cognitive resources". Because recognition tests reinstate the context, it reduces demands on self-initiated retrieval processes. Consistent with this interpretation, Gallo and Roediger (2003) reported that older adults did show a modality effect with recognition. In the current experiments, recognition tests were used which may explain the difference in findings between these studies. While a failure to engage spontaneously in distinctive processing may be a consequence of reduced resources, it could also be a metacognitive or strategic failure to engage in these processes.

However, other studies that used recall also found no age differences (e.g., Smith, 2011 - Experiment 1; Vitali et al., 2006). In these studies which all used late isolates, it is reasonable to suggest that the buildup of a strong background of similarity served as support at encoding, which reduced the need for support at retrieval (Smith, 2011). Thus, a strong background of similarity which encourages relational processing may alleviate the need for support at retrieval. Consistent with the interpretation, Smith (2011) found that older adults did not show an early isolation effect with recall. In other words, when there was not support at encoding in the form of encouraging relational processing nor at retrieval through use of a recognition test, age differences were evident. Thus, it is possible that reduced resources for encoding and retrieval could explain this effect.

Additionally, rehearsal of the isolate that occurs after its presentation may also require cognitive abilities that older adults lack.

The (CSSD) framework (Smith, 2011) nicely accounts for the above interpretation and attempt to reconcile a mixed literature on the effects of aging on the presence of distinctiveness effects. However, there are several ambiguities in the model that cast doubt on the usefulness of the model. For instance, the notion of exaggerating the difference between distinct and non-distinct items in any experiment is not quantified. According to Smith (2011), a number amongst a background of letters would be an exaggerated difference but a member of one semantic category (e.g., furniture) among members of another category (e.g., fish) is not. Given all the manipulations one could use to make something distinct, it is not clear on what dimensions this exaggeration is taking place. It is also not specified where some other commonly used manipulations would fall, for example changes in color. The notion that the difference between the stimuli could be critical for the presence of age differences in distinctiveness is certainly interesting and plausible but in this model is not spelled out enough to be meaningful.

Another shortcoming of the model is the notion of contextual or environmental support and "cognitive resources" are not quantified. In the model, environmental support can be provided in multiple ways, but until it is quantified it does not further the understanding of distinctiveness in general, and distinctiveness and aging in specific. Identifying the memory mechanisms that are affected by each type of support may provide telling information about how distinctiveness operates. Similarly, the notion of cognitive resources is vague to the point where no mechanisms can be identified. Cognitive resources could be postulated to be cerebral blood flow, the efficiency of neural transmissions, integrity of neural systems, or a variety of other things. Further, resources may be better thought of as other cognitive primitives or fundamental abilities like working memory or speed of processing. Understanding how these types of measureable mechanisms impact distinctiveness would be interesting. Finally, given the importance of individual differences in the measures just described, and presumably "cognitive resources", sweeping statements such as "cognitive resources decline with age" may not be accurate. One could make the same argument about an ability like 'recollection', however this is actually measured behaviorally and neurologically. Furthermore, in the current experiments, steps were taken to ensure that the presence of individual differences was accounted for to a certain extent.

To summarize, in research studies where no age differences are found, participants are presented with late isolates which provide support at encoding or use recognition (e.g., Gallo & Roediger, 2003) which provides support at retrieval. The current experiments provided support at both encoding and retrieval and accordingly, showed no age differences and no differences in the magnitude of the distinctiveness effect as had been reported previously. This conclusion is captured by the principles of the CSSD model and the results of the current set of experiments and research to date are consistent with this model. When there are age differences, there could be several reasons why this is the case. In particular, making judgments during encoding may disrupt relational processing and could place demands on "cognitive resources" that make it difficult to engage in accurate source monitoring or implement the strategy appropriately (Butler et al., 2010). However, relying on the term "cognitive resources" as an explanatory mechanism for age-related differences in distinctiveness is not helpful because it provides no measureable mechanisms through which to understand this phenomenon. Future research should identify the source of this issue using measurable mechanisms. For instance, if the issue is a problem with engaging in relational processing (see below for a further discussion) then researchers should investigate whether this is a function of poor strategies or poor working memory capacity that hinders older adults' ability to keep track of categorical information during encoding. Whatever the proposed mechanism, relying on the idea of "cognitive resources" will not get us closer to understanding why older adults do not show distinctiveness effects in some experimental situations.

Recollection, Familiarity, and Distinctiveness

Across three experiments, when participants intentionally encoded items, estimates of recollection (measured both as 'Type A' hits and *d'*) and familiarity were elevated for distinct items relative to non-distinct items. Under incidental encoding instructions, estimates of recollection and familiarity were similar for distinct and non-distinct items. These findings are mostly consistent with previous studies (e.g., Kishiyama & Yonelinas, 2003; 2006; Rajaram, 1998) who demonstrated the same finding. Although there was considerable variation among groups, estimates of *d'* for example, were quite comparable to those reported in the experiment of Kishiyama and Yonelinas (2003). In those studies, the authors used traditional RK instructions while the current study used source-specific instructions, which also removed the connotation from the terms "remember" and "know" (McCabe & Geraci, 2009). Thus, the current results provide an extension of the original findings by using a different set of instructions.

The notable exception to the consistency of the findings is that Kishiyama and Yonelinas (2003) reported a familiarity advantage for distinct items relative to non-distinct items under incidental encoding which was not exhibited in Experiment 3. There could be various reasons for this including the difference between pictoral and verbal stimuli (Dewhurst, & Conway, 1994; Weldon & Roediger, 1987) and the number of stimuli used. However, even this finding is not contradictory to the idea that recollection and familiarity are both critical to establishing a distinctiveness effect.

A major hypothesis of the project was that since older adults show declines in recollection, it was expected that if they showed distinctiveness effects this would be due to familiarity. This potential conclusion would have provided some information about the importance of each of these processes. However, because both recollection and familiarity were elevated for distinct relative to non-distinct items, a fine-grained understanding of what each of these processes do is still lacking. However, what is very clear is that both are responsible for some activity that allows for the establishment of distinctiveness effects and that neither process alone can be singularly tied to novelty-related effects in memory.

The recollection- distinctiveness hypothesis suggests that distinct items are associated with greater subjective awareness and as such are better remembered than non-distinct information. However, because familiarity is elevated consistently for distinct items under intentional and incidental encoding conditions argues against recollection being the unitary mechanism for distinctiveness effects.

There are several possibilities for the role that recollection plays in distinctiveness effects. For example, recollection could reflect enhanced elaborative encoding of the isolates. The finding of reduced recollection estimates under incidental encoding in the current study, as well as in previous research is consistent with this suggestion. However, elaborative encoding would most likely be present for late isolates that occur after a background of similarity has been established. If this is true, than one would expect that recollection judgments could be elevated for late isolates but not for early isolates, because they have not yet been framed as distinct by the background of similarity. This would be an interesting project to conduct to test this idea. Of course, recollection may still be elevated for these items because of retrieval of the early isolate and enhanced recollection occurring later (Dunlosky et al., 2000).

Another possibility is that enhanced recollection for distinct items reflects a process going on at retrieval. Given the nature of recollection judgments, one would presume this would have to be some type of source information. The results from the objective source memory data however suggest that generally speaking this does not have to do with spatial information (where is the item on the screen) nor temporal information (on which list did the item appear). This, of course, does not rule out the possibility that participants are remembering some other piece of source information.

One possibility is that participants are recalling a sense of discrepancy. This notion is borrowed from the discrepancy plus search model (e.g., McDaniel, Guynn, Einstein, & Breneiser, 2004) in prospective memory. The idea here is that when a certain target stimulus is linked to the retrieval of an intention during study, and that stimulus is encountered during test, it creates a sense of the discrepancy which signals an additional search, usually resulting in retrieval of the prospective intention. In distinctiveness paradigms isolates may create a memory trace of just a feeling of discrepancy, not one with great detail. This would be bound to that item, and when presented with that item during recognition, it is plausible that the feeling of discrepancy is what is being recalled.

In the current experiments, there were multiple distinct items on each list, which is a less common method than the standard one distinct items per list. This may have made it difficult to retrieve specific details about the distinct items. Perhaps if there were only one distinct item per list, source performance might have been improved. Finally the temporal and spatial information may not be part of the details individuals remember. Future studies are needed to determine what exactly individuals are remembering about distinct items.

The other prominent hypothesis is the familiarity-novelty hypothesis (Kishiyama & Yonelinas, 2003, 2006) which states that the same mechanism responsible for detecting distinctiveness may also be the same mechanism responsible for detecting familiar items. While this hypothesis cannot account solely for distinctiveness effects there is still some questions as to what the familiarity process is doing to contribute to distinctiveness effects.

Under this hypothesis, one suggestion is increases in familiarity may be due to the orienting response to presentation of distinct items. While this suggestion receives support from Kishiyama and Yonelinas' (2003) work with incidental encoding, it is not supported by the current study. Nor is this interpretation supported by research using implicit measures of distinctiveness effects (Kishiyama and Yonelinas, 2006). Another suggestion is that familiarity may reflect reduced interference at retrieval or an automatic orienting response to novel items (Kishiyama and Yonelinas, 2006). This is supported by the lower false alarm rates to new distinct items reported in a variety of studies (e.g., Rajaram, 1998). While false alarm rates were fairly low in these experiments it was not always the case that false alarm rates were lower to new distinct items relative to new non-distinct items.

To add further confidence to these findings, it is important to use other methods for estimating recollection and familiarity. For instance, Prull et al. (2006) reported differing patterns of recollection and familiarity estimates among the same group of subjects by using three different tasks and estimation procedures. This finding should push researchers to validate findings with multiple methods.

An obvious choice would be the use of ROC curves, which ask participants to make confidence ratings on old/new recognition judgments. High-confidence judgments are thought to reflect recollection whereas low-confidence judgments reflect familiarity. For analysis, hits are plotted against false alarms. Symmetrical curves suggest that an individual is relying on familiarity, and asymmetrical curves suggest that a person is relying more on recollection (Daselaar et al., 2006; Yonelinas & Parks, 2007). This kind of approach may give a suggestion as to which process is more critical.

In sum, the current studies reinforce the conclusion that both recollection and familiarity processes are playing a role in establishing distinctiveness effects. This argues against the idea that recollection and familiarity solely align themselves with novelty effects (Kishiyama and Yonelinas, 2006). Past research has highlighted some instances in which dissociations can be observed, although these were not present in the current study. Future research is still needed to further understand the role of each process in establishing the distinctiveness effect.

Aging, Recollection, and Familiarity

One of the most provocative results reported across the three experiments was that under intentional instructions older adults showed equal levels of recollection to young adults. This was true for distinct and non-distinct words. This stands in contrast to the results of the third experiment, wherein there were no distinctiveness effects and older adults on average, displayed declines in recollection relative to young adults. This finding of the third experiment is similar to what has been widely reported in the cognitive aging literature. Moreover, previous research has suggested that high-functioning individuals may show comparable levels of recollection to young adults (e.g., Davidson & Glisky, 2002; Duarte et al., 2007). Yet, this was also not the case as even the low-MTL older adults demonstrated similar levels of recollection to the other groups. Together, these findings suggest that there might be something unique about remembering (given intentional instructions) in a distinctiveness paradigm that obviates age differences in memory, both quantitatively and qualitatively.

An important caveat to this pattern is that older adults in the current experiments were given more time at encoding to account for age-related slowing (Salthouse, 1991). It is plausible that this might have allowed extra time for elaborative encoding that could create distinctiveness effects equal to young adults. Although, past research has used equivalent encoding time and still found this effect in older adults. Extra encoding time might also allow older adults to establish levels of recollection equivalent to young adults. However, there may be reason to expect that encoding time would not dramatically impact the results. For instance, older adults show distinctiveness effects in recall (Smith, 2011).Given that recall is closely linked to recollection abilities (Jacoby, 1991), it may not be surprising that equivalent levels of recollection were observed.

Nevertheless, studies with equal encoding time for young and older adults would clarify this picture.

An intriguing possibility concerning older adults showing equivalent estimates of recollection in distinctiveness paradigms but not with standard is that older adults do not regularly engage in relational processing during typical episodic memory tasks. In a standard isolation paradigm, there is typically a background of similarity that is established, save for early isolation (Smith, 2011). That background could stem from a manipulation in the experiment (e.g., presenting all yellow words), or it could stem from pre-existing knowledge structures (e.g., semantic) as is the case with secondary distinctiveness (Schmidt, 1991). Either way, the design of the experiments encourage relational processing among stimuli. This can be contrasted with a standard memory list paradigm, in which other than all the words being presented in the same color (most likely), typically there is very little relationship between the words. In fact, as a productive strategy individuals often try to make associations between words to aid memory performance. It is in these standard formation memory tests that older adults typically perform worse than young adults, especially on tests of recall and in estimates of recollection.

The difference between these two types of scenarios and their subsequent results support the notion that engaging in spontaneous relational processing is a critical aspect for accurate remembering (Hunt & McDaniel, 1993). The data that examine relational processing (see Smith, 2006 for a review) suggest that in many instances older adults are deficient in this ability, however it can be overcome when there are supportive conditions. For example, A.D. Smith (1977) found no age differences in free or cued recall when category labels were available during encoding, which presumably encourages relational processing. Clustering is another useful measure of relational processing and the data are somewhat mixed in regard to age differences (A.D. Smith, 1980; R.E. Smith, 2006). Several studies report age differences in the amount of clustering (Hultsch, 1971; Smith, 1980) whereas several others report age invariance in such measures (Hertzog, Dixon, & Hultsch, 1990; Park, Smith, Dudley, & Lafronza 1989; Witte, Freund, & Sebby, 1993). To clarify this discrepancy, R.E. Smith (2006) suggests that age differences favoring young adults are typically found when the clustering measure is based on item-order or subjective organization, and when categories are not sufficiently large to spontaneously encourage relational processing. On the other hand, age invariance is likely when item-order clustering is not used and there are sufficiently large categories. According to Hunt and Seta (1984), when categorized lists of to-be-remembered stimuli consist of 4 or more items from each category this will sufficiently encourage relational processing. In summary, using various different measures it seems that older adults can benefit and engage in relational processing when there is enough support, provided through organization during encoding, or having sufficiently large categories.

In future research, it would be interesting to examine the direct contribution of clustering scores (as a measure of relational processing) to the establishment of distinctiveness effects. If relational processing is important, especially for older adults, one would expect to find a significant, positive correlation between memory for distinct items and a measure of clustering. Given that young adults may spontaneously engage in relational processing, this correlation may not be reliable in that group. Moreover, it would be interesting to also see the extent to which relational processing correlates with standard memory tests.

Germane to the current experiments, it would be interesting to determine how these clustering measures may relate to estimates of recollection and familiarity. One idea would be that recollection may reflect item-specific processing, given it is associated with retrieval of contextual details, and familiarity may reflect relational processing. If this hypothesis were correct, then it might be expected that familiarity would be associated with relational processing.

Finally, if relational processing is critical to improving memory, then this might be an interesting target for a training intervention. However, part of the reason for a lack of relational processing may be linked to limitations with working memory capacity and speed of processing. Nevertheless, it could be effective for improving older adults' ability to fully utilize their memory capacity.

Conclusions

In conclusion, older adults are able to benefit from the presence of distinctive information the same as young adults. However, this was only the case when individuals were intentionally preparing for a memory test, and not when the test was a surprise. The mechanisms of recollection and familiarity were important in establishing this effect, and importantly were similar across all age groups. There are several important implications of this finding. First, it suggests that both processes are critical in establishing the distinctiveness effect and that neither can singularly account for novelty-related effects in memory. More research using other estimation measures of recollection and familiarity could be useful in providing insights about what each of these processes are doing with distinctive information. Second, this findings stands in contrast to the majority of findings with recollection, and represents an important qualification to the pattern that older adults normatively experience declines in recollection as a function of age. This might be due to extra encoding time. However, the reason for this exception, I believe, is that distinctiveness paradigms encourage relational processing which is not usually encouraged in typical episodic remembering paradigms. Regardless, this finding suggests that older adults may not demonstrate declines in these processes, but may need optimal conditions to use their abilities effectively. Continued research is needed to determine what these optimal conditions are and try to identify new moderating variables that influence recollection and familiarity abilities in older adults. Even though, recollection was elevated for distinct items relative to non-distinct items, objective source memory performance was not very accurate. Thus, future research is needed to determine exactly what individuals are recalling about distinct information.

APPENDIX A

PARTICIPANT INSTRUCTIONS FOR THE REMEMBER-KNOW TASK

Type A Responses: When you see a word on the test, it may bring to mind the exact thought you had from when you first studied the word at the start of the experiment. If you can recall the exact thought you had from when you studied the word earlier you should press the A key to indicate a Type A response. Often when people give a Type A response it is because they can recall a personal association that came to mind when they first saw the word, or some other details about when they studied the word.

For example, imagine you had studied the word BOOK earlier in the experiment. Imagine also that when you studied the word BOOK that you thought of the title of a book you have recently been reading. If you then saw the word BOOK on the test, and you recalled that when you were studying it you had thought about the title of the book you have been reading, then you would give a Type A response for the word BOOK. There are other details you may recall about studying a word that would lead you to give a Type A response, such as a particular feeling you had when you saw the word, or a mental image that came to mind while you were studying the word. You may also be able to recall that you associated the word with another word that you studied, or you may recall what the word looked like on the screen. If you can be sure you studied the word because you can recollect specific details about when you studied it, then press the A key to indicate a Type A response.

Type B Response: If you see a word on the test and you believe it was presented but you cannot recall any specific association that you made when you studied it, press B to indicate a Type B response. In other words, a Type B response means you ‘‘just know” you studied the word, even though you cannot recall any details from when you studied it.

To summarize, if you see a word on the test and you can recall specific details about when you studied it, press the A key to indicate a Type A response. If you just know the word was presented but you cannot recall any specific details, press the B key to indicate a Type B response. Finally, if the word was not presented press the N key to indicate the word is New to the experiment.

APPENDIX B

ORTHOGRAPHICALLY DISTINCT AND COMMON WORDS

Distinct Word	Length	HAL FREQ		Control Word	Length	HAL FREQ
Afghan	6	7.24		Novelty	7	7.24
Asylum	6	7.44		Offence	7	7.44
Bouquet	7	6.39		Raquet	7	6.39
Buoyancy	8	5.18		Broiler	7	5.18
Calypso	7	5.92		Detour	6	5.92
Chauffeur	9	5.46		Shortstop	9	5.46
Crypt	5	8.26		Applicant	9	8.26
Czar	4	6.11		Mower	5	6.11
Epitome	7	5.91		Bagpipe	7	5.91
Equinox	7	7.54		Crews	5	7.54
Fjord	5	4.56		Lodger	6	4.56
Gawky	5	3.43		Blander	7	3.43
Gnome	5	6.36		Bongo	5	6.36
Gypsum	6	4.93		Mussels	7	4.93
Khaki	5	5.29		Edifice	7	5.29
Lymph	5	6.02		Vixen	5	6.02

Methyl	6	6.04		Trapper	7	6.04
Morgue	6	6.1		Fountain	9	6.1
Physique	8	6.16		Slippers	8	6.16
Pyramid	7	8.45		Bash	4	8.45
Rhyme	5	7.4		Caption	7	7.4
Sequoia	7	5.65		Rawhide	7	5.65
Sphinx	6	7.66		Barber	6	7.66
Subpoena	8	6.24		Moth	4	6.24
Svelte	6	4.42		Lorn	4	4.42
Syringe	7	6.55		Leopard	7	6.55
Typhoon	7	7.43		Lithium	7	7.43
Vinyl	5	8.88		Perception	10	8.88
Yacht	5	6.91		Carving	7	6.91
Zephyr	6	7.62		Cruiser	7	7.62

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