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Multiple Species of Distinctiveness in Memory: Separating Task Distinctiveness from Statistical Distinctiveness

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MULTIPLE SPECIES OF DISTINCTIVENESS IN MEMORY: SEPARATING TASK DISTINCTIVENESS FROM STATISTICAL DISTINCTIVENESS

by

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ABSTRACT

Distinctiveness refers to the memorial benefit of processing unique or item-specific features of a memory set relative to a non-distinctive control. Traditional distinctiveness effects are accounted for based on qualitative differences in how distinctive items are encoded at the time of study. This thesis project aims to evaluate whether a different species of distinctiveness—statistical distinctiveness—may provide a separate contribution to memory beyond traditional encoding-based processes. Statistical distinctiveness refers to the relative frequency with which a specific memory item or set is processed. The current study evaluated statistical distinctiveness through a series of *mixed groups* in which DRM lists were studied using two of the following three tasks to promote either shallow ("E" identification), neutral (reading silently), or deep/distinctive (pleasantness ratings) levels-of-processing followed by a final recognition test. Participants studied lists in which these tasks were used frequently (80% of lists), equally (50% of lists), or infrequently (20% of lists) which were further compared to a set of *pure groups* in which all lists were studied using a single task. No recognition advantage was found when tasks were completed infrequently versus frequently. Rather, recognition was greatest for the deep/distinctive task—a pattern consistent with encoding but not statistical distinctiveness.

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DEDICATION

To my mom and dad,

who have supported every endeavor.

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CHAPTER I – INTRODUCTION

Distinctive information often receives a memorial benefit relative to information that is non-distinctive, a pattern referred to as the *distinctiveness effect*. Classically, the distinctiveness effect occurs when a specific group of items lies in contrast to an established cohesive context (Hunt, 2006; Suprenant & Neath, 2009). This context can be established perceptually, such as the presentation of a red-colored item in the context of blue-colored items, or conceptually, such as a number presented in a string of letters. In both cases, items that violate a prevailing context are better remembered. Although distinctiveness effects have been broadly demonstrated over a variety of materials (see Burns, 2006; Hunt & Worthen, 2006, for reviews), a critical question is whether memorial benefits elicited by distinctiveness reflect a simple contrast between an event and the context in which it occurs, or whether a certain *degree* of contrast is required before these memorial benefits are found. The purpose of this thesis is to provide a direct comparison of two possible types of distinctiveness effects in memory and gauge their relative memory benefits.

Item-Level Distinctiveness in Memory

The relationship between an item and the context in which it is presented is foundational for producing distinctiveness effects. In an early demonstration, termed the isolation paradigm (von Restorff, 1933), participants were presented with a list of homogeneous characters with one item (the isolate) differing perceptually from other items. When tested, participants remembered the isolate at a greater rate relative to a control condition in which the isolate was embedded within a heterogenous list.

Importantly, the isolation effect was found when the isolate was presented across all list positions at study, including the first position. This latter effect is important because it demonstrates that the isolate does not need to be distinctive at the time of study and can be inferred retrospectively.

In another demonstration of the isolation effect, Hunt and Lamb (2001) presented participants with either a homogeneous list with a thematically equivalent isolate (e.g., “carrot” placed in a list of vegetable items) or a list with an isolate embedded in a homogeneous list (e.g., “hammer” presented in a list of vegetable names). Overall, memory was greater for an isolate that differed thematically from the homogeneous list, demonstrating that the isolation effect can occur when the isolate differs schematically from the studied context. The researchers concluded that the memorability of the isolate was due to differential encoding of discriminative information based on the contrast between the isolate and the context in which it was presented.

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Encoding-Task Distinctiveness in Memory

Although distinctiveness effects can occur at the item level, they can also occur at the task level, such as when a study task encourages the processing of distinctive features (Hunt, 2006; Hunt & Lamb, 2001; Smith & Hunt, 1998). One such example is the generation effect, or the memory advantage for material that is self-generated versus material that is merely provided. In an early demonstration, Slamecka and Graf (1978) presented participants with related cue-target pairs for study that were either intact (e.g., rapid-fast) or incomplete (e.g., rapid-f___), in which case participants were instructed to generate the related target word from a stem. At test, recognition was greater following the study of generated pairs than intact pairs. The act of generating words was argued to differentiate words from not only other generated items, but from items that were read aloud. Generation has been argued to promote the processing of item-specific information, or the processing of distinctive or unique features of generated items (Huff & Bodner, 2013; Hunt & Einstein, 1981).

Similar generation results have also been found implicitly by using memory tasks that do not rely upon the conscious use of memory. Specifically, Gardiner (1989) had participants study lists of words in which half were generated using a cued fragment-completion task (e.g., Political Killer: A-S-S-I) and half were read intact (e.g., Political Killer: ASSASSIN). After study, participants completed an unrelated assessment for verbal knowledge which consisted of word fragments, definitions, and anagrams. Unbeknownst to the participants however, this assessment actually evaluated memory for items that were initially studied. For instance, a definition used in the assessment was “a person who kills for political motives,” whereas an example of an anagram used was “SSINASSA.” Thus, the assessment was designed to operate as an implicit memory test, as participants were not explicitly attempting to recall studied information. A robust generation effect was similarly found on this implicit test, suggesting that generation benefits extend beyond conscious retrieval.

The memory benefits of generation have similarly been reported for study items that are read aloud versus items that are read silently, a benefit termed the production effect (MacLeod, Gopie, Hourihan, Neary, & Ozubko, 2010; see too Gathercole & Conway, 1988 for review). Participants studied a list of words in which half were read aloud and half read silently. On a final test, aloud words were recognized at a higher rate than silent words. Similar effects were also found in the absence of verbal production. For instance, participants who mouthed words but did not say them aloud similarly showed a memory advantage over words read silently.

Though generation and production benefits have been found across a variety of materials and delays, the magnitude of their effects is sensitive to between versus within-subject designs. Begg and Snider (1987) reported that the generation effect was diminished when generation versus reading was completed between- versus within-subjects—a pattern that was echoed by MacLeod et al. (2010) who reported a smaller production effect for pure lists, in which all study items were read aloud or silently, than mixed lists. Further, Bodner and Taikh (2012) reported that the production effect was eliminated when a between-subject design was employed. Collectively, these results suggest that the relative proportion of items that receive distinctive processing, either through generation or production, may be related to how distinctiveness effects manifest in memory.

Despite findings that generation and production benefits can be eliminated in between-subject designs, meta-analyses have reported that these tasks do produce memory benefits under between-subject conditions, with a smaller effect. Only moderate effect sizes have been reported for between-subjects generation ($g = 0.28$) and production ($g = 0.37$), which are approximately half the size found in within-subject designs (Bertsch, Pesta, Wiscott, & McDaniel, 2007; Fawcett, 2013, respectively). Larger within-subject effects have been attributed to greater emphasis placed on distinctive versus non-distinctive items, due to an available comparison between the two item types. This comparison provides enhanced discrimination that is not available in a between-subject design when participants are only exposed to a single item type. Another explanation, evaluated in this study, is that distinctive items are also statistically less frequent in within- than between-subject designs, as they only account for half of the studied items. This pattern suggests that the relative proportion of distinctive to non-distinctive items may be related to the magnitude of distinctiveness benefits. In both cases, however, the presence of both generate/production and non-distinctive items may make it easier for participants to discriminate between the two item types in favor of the former. Thus, the statistical rarity of distinctive items or tasks appears to be related to the presence and magnitude of distinctiveness benefits.

Statistical Distinctiveness in Memory

Given robust within-subject benefits of generation and production, a critical question is whether the relative proportions of distinctive versus non-distinctive items are related to the magnitude of the memory benefit. As an example, using a production-effect paradigm, Bodner, Jamieson, Cormack, McDonald, and Bernstein (2016) manipulated proportions of items that were produced (i.e., typed on a keyboard) versus unproduced (i.e., read silently). Specifically, pure groups studied lists in which 0% or 100% of the list items were typed, whereas mixed groups studied lists in which 20%, 50%, or 80% of the studied words were typed with the remaining proportion read silently. On a final recognition test, a modest between-subject production effect was found for the pure groups, consistent with Fawcett (2013). For mixed groups, recognition was greatest for produced versus unproduced items. However, recognition was equivalent between 20%

and 80% conditions, theoretically due to the encoding similarities between produced and unproduced items.

In a second experiment, Bodner et al., (2016) attempted to equate encoding for produced and unproduced items by increasing the study duration of silent words three-fold (9s vs. 3s study duration). Under these conditions, the production effect was eliminated (but not reversed) in the pure-list group and also in the 50% and 80% production. A production effect was only found in the 20% production group, in which production was statistically rarer than the other conditions, providing some evidence for statistical distinctiveness in a production effect paradigm.

Given the statistical distinctiveness pattern that only occurred in the rarest 20% production group in Bodner et al. (2016), an important question is: Can a non-distinctive task produce a memory advantage if the task is used infrequently? To address this question, Icht, Mama, and Algom (2014) suggested that distinctiveness originates from two sources: Distinctiveness due to encoding processes at the task level, and distinctiveness due to the statistical frequency in which a task is utilized. Encoding distinctiveness refers to a specific mode of processing that can qualitatively affect encoding processes at study or monitoring processes at test, likely through item-specific processing (Huff, Bodner, & Fawcett, 2015; Hunt & Einstein, 1981). In contrast, statistical distinctiveness refers to the relative distribution of distinctive versus nondistinctive information. Importantly, Icht et al. argued that these two types of distinctiveness are not mutually exclusive, such that distinctive tasks that would normally yield a memory improvement can become more or less effective depending on frequency of use.

To evaluate the differences between encoding and statistical distinctiveness, Icht et al. (2014) used a production effect paradigm in which proportions of study items that were read aloud (vs. read silently) in mixed groups were 20%, 50%, or 80% of list items as in Bodner et al. (2016). According to the encoding distinctiveness account, items processed using distinctive tasks should be better remembered than non-distinctive items, regardless of item frequency. However, the statistical distinctiveness account posits that items that occur less frequently should be better remembered than more frequent items, regardless of encoding task. It was found that recall for aloud items was greatest in the 20% condition but declined across the 50% and 80% conditions. Indeed, correct recall in the 80% aloud condition actually produced a reversed production effect, such that correct recall was *greatest* for silent than aloud items given that silent items made up 20% of the list. Researchers concluded that the benefits of reading aloud were diminished when silent items were infrequent and, therefore, more distinctive. In their second experiment which used recognition, statistical distinctiveness was muted for the 20% unproduced and 80% produced mixed group. However, evidence for encoding distinctiveness remained, as recognition greatest for 20% produced versus 80% unproduced items. Thus, benefits of distinctive processing via production can be affected by distinctive processing induced by the task and the relative frequency with which the distinctive task is employed.

Though not discussed by Icht et al. (2014), an additional theoretical account for their findings of declining production benefits when production was completed more frequently, may be the result of the cue-overload principle (Suprenant & Neath, 2009; Parkin, 1980). The cue-overload principle states that cues established at encoding are less beneficial at retrieval when the same cue is employed for many versus few items. For instance, Keppel and Underwood (1962) reported that recalling word lists that were taken from the same category decreased across successive study/test trials caused by the category cue becoming less effective due to overuse (a phenomenon termed proactive interference). Therefore, it is possible that the benefits of a given distinctive study task may show diminishing returns when used frequently due to the task failing to provide distinguishable retrieval cues at test, such as the case in Bodner et al. (2016) and Icht et al. (2014). Since memory is argued to be largely cue-driven (see Surprenant & Neath, for review), the effectiveness of cues for prompting retrieval is critical.

The Effects of Distinctive Processing on Memory Errors

Despite vast benefits of distinctive processing on correct memory, it is equally important to evaluate overall memory accuracy, which includes memory errors. A common method for creating and evaluating memory errors is through the Deese-Roediger-McDermott (DRM) paradigm (Deese, 1959; Roediger & McDermott, 1995). In this paradigm, participants study lists of associated words (e.g., *bed, rest, tired, dream, slumber,* etc.) which all converge upon a single non-presented critical lure (e.g., *sleep*). At test, participants often incorrectly remember that the critical lure was studied, a phenomenon termed the *DRM illusion*. The DRM illusion is robust: False recall often reaches levels greater than 50% and false recognition has been shown to meet or exceed hit rates (see Gallo, 2006; 2010, for reviews; Lampinen, Neuschatz, & Payne, 1999). Given these elevated rates, researchers have since examined several methods in order to reduce the illusion. Successful methods include increasing study repetitions for DRM lists (Benjamin, 2001; McDermott, 1996) and by presenting warnings about the DRM illusion prior to study and/or test (Gallo, Roediger, & McDermott, 2001; McCabe & Smith, 2002), though following each of these methods, the DRM illusion was not eliminated.

Relevant to the present study, the DRM illusion has also been shown to be reduced following the processing of distinctive features of list items at study. In one example, Israel and Schacter (1997) presented participants with DRM lists that were either presented as words in isolation, or as words that were accompanied by a picture of each word's referent. At test, false recall of critical lures was reduced when lists were studied with pictures versus lists studied as words, presumably because pictures provide distinctive retrieval cues for each word. A similar reduction has been found using a variety of other distinctive manipulations including studying lists of words in a unique (vs. same) font type (Arndt & Reder, 2003), generating words from anagrams (Gunter, Bodner, & Azad, 2007; McCabe & Smith, 2006), creating mental images of list words (Foley, Wozniak, & Gillum, 2006; Oliver, Bays, & Zabrucky, 2016; Robin, 2010), and critically, processing the unique or distinctive features of study words via item-specific processing (Huff & Bodner, 2013; McCabe, Presmanes, Robertson, & Smith, 2004; Smith & Hunt, 1998). These benefits are particularly noteworthy because they often induce a mirror effect (Glanzer & Adams, 1990)—an increase in correct memory coupled with a decrease in false memory relative to a nondistinctive or processing-neutral task.

Reductions in the DRM illusion can be attributed to the encoding strategies use at study and/or the monitoring strategies participants use at test. Tasks that require item-specific processing subsequently disrupt the thematic consistency or associated strength between items, resulting in impoverished relational encoding (Hege & Dodson, 2004).

Alternatively, participants may employ a distinctiveness heuristic—a test-based monitoring strategy in which recollections of distinctive details at the time of test can serve as diagnostic evidence that a studied item was either studied or not studied (Gallo, 2004; 2010). Given DRM critical lures are not paired with distinctive details because they were not studied, the distinctiveness heuristic aids in screening critical lures from being reported as studied (Gallo, 2004; 2010). Impoverished relational encoding and the distinctiveness heuristic have been argued to be competing explanations for the reduction in the DRM illusion following distinctive processing (e.g., Dodson & Schacter, 2001; Hege & Dodson, 2004). However, evidence has also shown that the two can operate in tandem (Huff & Bodner, 2013; Huff & Aschenbrenner, 2018).

Given the benefits of distinctive processing at the task level on reducing the DRM illusion, a remaining question is whether statistical distinctiveness may show similar benefits. The purpose of the current study was to compare encoding and statistical distinctiveness accounts in order to correctly attribute distinctive processing to the task or item-presentation level. Furthermore, the present study examined the interaction between encoding and statistical distinctiveness by examining whether encoding distinctiveness effects would be magnified when distinctive tasks are completed infrequently. A common method for examining deep task processing is by using a deep LOP task from the levels-of-processing framework (Craik & Lockhart, 1972). Of note, the levels-of-processing framework is confounded by both deep and distinctive processing. Certain tasks may promote deep encoding (i.e., relational processing), but may not promote distinctive processing, which requires encoding unique features of stimuli (i.e., item-specific processing; Huff, Bodner, & Gretz, under review; Hunt & Einstein, 1981). However, it remains unclear whether deep tasks may be more potent when such tasks are completed relatively infrequently. This current study sought to confront both encoding and statistical accounts independently and interactively in order to examine the overarching mechanism of distinctiveness.

The Current Study

The purpose of this experiment was to further evaluate the effects of distinctive processing on memory accuracy by unpacking two types of distinctiveness that have shown memorial benefits in the literature: Encoding distinctiveness and statistical distinctiveness. In both cases, distinctiveness produces a memory benefit, however, this experiment examined whether non-distinctive tasks (e.g., reading or shallow levels-of-processing, Craik & Lockhart, 1972) may yield distinctiveness benefits on both correct and false recognition when these tasks are statistically rare. Therefore, my experiment sought to isolate the contributions of two types of distinctiveness by critically comparing both within the same experiment.

In this experiment, participants studied DRM lists using encoding tasks that engage either non-distinctive/shallow processing (determining whether a word contains the letter "e"; E-Task), neutral processing (reading silently), or distinctive processing (pleasantness ratings; PR). Participants in the *mixed groups* studied a series of lists in which a certain proportion of items were studied using these tasks. Specifically, participants studied either 20%, 50%, or 80% of the lists using the E, read, or PR tasks (see Table 1). The mixed groups were used to examine the effects of statistical distinctiveness by varying the proportions of lists studied using non-distinctive and distinctive tasks to determine whether non-distinctive lists may reveal memorial benefits when their distribution is infrequent.

Table 1

Study Conditions and Distributions of Tasks used for Mixed and Pure Groups

	Mixed Groups		
List Type/Task Proportion	80/20	50/50	20/80
Deep/Neutral	PR/Read	PR/Read	PR/Read
Deep/Shallow	PR/E	PR/E	PR/E
Neutral/Shallow	Read/E	Read/E	Read/E
	Pure Groups		
Proportion	100	100	100
List Type	PR	Read	E

The mixed groups were also compared to *pure groups* in which the E, Read, and PR tasks were manipulated between-subjects. The pure groups served two purposes. First, they allowed for a confirmation of the benefits of distinctive/deep processing over reading and shallow processing. PR tasks have reliably been shown to induce a mirror effect over reading in the DRM paradigm (Huff & Bodner, 2013; Huff & Aschebrenner, 2018; Hunt, Smith, & Dunlap, 2011), and increase correct recognition (but not reduce false recognition) over shallow-processing tasks (Thapar & McDermott, 2001; Toglia, Neuschatz, & Goodwin, 1999). The comparison of all three tasks within the same experiment has not yet been conducted. The second purpose was to examine how statistical distinctiveness effects in mixed groups compare to distinctiveness effects found in pure groups. Since generation and production effects are typically larger in mixed than pure groups (Bertsch et al., 2007; Fawcett, 2013), a potential combination of both task distinctiveness and statistical distinctiveness, a remaining question is whether the strength of these effects hold when a distinctive task is completed frequently versus infrequently. Comparing different proportions of distinctively studied lists can provide insight into whether the robust distinctiveness effects found in mixed designs reflect a combination of distinctive processing and statistical distinctiveness.

Finally, this experiment sought to examine whether metacognitive individual difference factors are related to recognition performance. Retrieval from memory is likely influenced by one's expectations regarding their own memory abilities (Rummel & Meiser, 2013; Vandenbroucke et al., 2014). As such, metacognition constitutes the beliefs or attitudes attributed to one's memorial capacities, which may influence memory performance at test. Given these metacognitive factors, the need to engage in complex cognitive processing may influence the effectiveness of distinctive processing. These metacognitive factors are theoretically related to personality factors as well, such as Conscientiousness, indicating that memory may be related to individual difference factors in personality (Allik et al., 2017; Jackson & Belota, 2012). To capture these individual differences and their relation to memory, this study employed the Metacognitions Questionnaire (MCQ-30; Wells & Cartwright-Hatton, 2004), the Memory Anxiety Scale (Davidson, Dixon, & Hultsch, 1991; Huff, Meade, & Hutchison, 2011), the NEO-FFI

(McCrae & Costa, 2004), and the Need for Cognition Scale (NFC; Cacioppo, Petty, & Kao, 1984).

Given the comparisons between the mixed groups and pure groups with the goal of separating encoding and statistical distinctiveness and exploring several cognitive moderators, this study has four hypotheses:

*H1: Comparisons Across Pure Groups***.** For correct recognition, a levels-of-processing effect was expected across the pure groups. Correct recognition was expected to be greatest following the PR task, followed by the read task, and then the E-Task. For critical lure false recognition, the PR task and the E-Task were expected to reduce false recognition relative to the read task, consistent with Huff and Bodner (2013) and Toglia et al. (1999). The reduction in false recognition in the PR task is expected to reflect the use of item-specific/distinctive processing, and the reduction in the E-Task is expected to be due to impoverished encoding for correctly studied list items. If list items were not encoded effectively initially, then activation of the critical lure is less likely to occur (Thapar & McDermott, 2001). Therefore, H_1 sought to replicate extant DRM literature using pure-group processing tasks.

*H2: Comparisons Across Mixed Groups***.** An increase in correct recognition was expected for the 20% condition regardless of encoding task, based on the statistical distinctiveness effects reported by Bodner et al. (2016) and Icht et al. (2014). This pattern is critical because it is expected to show a reversed levels-of-processing effect for the E and read tasks, but only when the shallow and read tasks are completed infrequently, a novel contribution. However, in the 50% and 80% conditions, the standard levels-of-processing effect was expected in which the PR task would reduce the greatest correct recognition rate. Further, for false recognition, a reduction was expected in the 20% condition across encoding tasks, demonstrating that statistical distinctiveness can also operate to reduce false recognition of critical lures. In the 50% and 80% conditions, false recognition was expected to be lower following the PR task relative to the read task, consistent with similar PR reductions reported relative to reading (e.g., Huff & Bodner, 2013) and also lower in the E-Task relative to the PR task following Toglia et al. (1999). Following these predictions, it was further expected that false recognition will be lower in the E-Task condition than the read task. To date, no study has compared false recognition between shallow-processing and a neutral-processing read task.

*H3: Comparisons Across Pure and Mixed Groups***.** Correct recognition in the 80% mixed-group conditions was expected to be less than items encoded using the same pure-group task, illustrating a cost to frequent tasks. Additionally, across list types, correct recognition in the 20% mixed-group conditions was expected to be greater than items encoded using an associated pure-group task, a *benefit* to infrequent tasks. Therefore, it was predicted that within-subjects designs encourage statistical distinctiveness effects when items are proportionally rare regardless of encoding task, providing evidence for a dissociation between task and statistical distinctiveness (Bodner et al., 2016; Icht et al., 2014). False recognition patterns were expected to mirror that of correct recognition, consistent with the predictions of $\mathbf{H_1}$ and $\mathbf{H_2}$.

*H4: Relationships with Individual Difference Measures***.** The Metacognitive Questionnaire and the Need for Cognition Scale were predicted to positively correlate with participants' performance at test, indicating that one's self-reported cognitive beliefs may be reflected in recognition performance. The Metacognitive Questionnaire consists of five subscales: Positive beliefs about worry, cognitive self-consciousness (the tendency to focus attention on thought processes), negative beliefs about thoughts concerning uncontrollability and danger, negative beliefs concerning the consequences of not controlling thoughts, and cognitive confidence (assessing confidence in attention and memory; Wells & Cartwright-Hatton, 2004). These subscales all load to a factor examining broad metacognitive tendencies and is used in my analyses. It was expected that overall memory performance would be positively correlated with NFC. This relationship will be stronger for participants in conditions that foster either task distinctiveness or statistical distinctiveness effects (i.e., PR task group or 20% mixed conditions). Additionally, a similar relationship was expected to be found with the Conscientiousness subscale on the NEO-FFI, given Conscientiousness is a measure of task-related vigilance which requires a high level of attentional processing (cf. Jackson & Balota, 2012). In contrast, the Memory Anxiety Scale, in which higher scores indicate greater anxiety levels towards one's memory ability, was predicted to negatively correlate with participants' performance at test.

CHAPTER II – Method

Participants

A total of 293 undergraduates (84% female, M_{age} = 20.01, SD_{age} = 4.49) from The University of Southern Mississippi were recruited for participation and were compensated with partial course credit. Participants were randomly assigned to one of the 12 groups (see Table 1).

Materials

The 20 DRM lists that produced the highest rates of false recognition in Stadler, Roediger, and McDermott (1999) were used. These lists were divided into 2 sets of 10 lists and matched on backward-associative strength (BAS), a metric of association from the study lists to the critical lure which has shown to be a strong predictor of later false recognition (Roediger, Watson, McDermott, & Gallo, 2001). Across participants, one set was studied, and the other was not and served as the control set. The studied versus non-studied set was counterbalanced across participants. Each list contained 15 total study words, that were presented in random order at study. An 80-item recognition test was then created which comprised of 30 list items (from positions 2, 8, and 10), 30 list item controls (taken from the same positions in non-studied lists), 10 critical lures from studied lists, and 10 critical lures from non-studied lists (see Huff and Bodner, 2013, for a similar list construction). Recognition tests were presented in a newly randomized order for each participant.

The NEO-FFI Personality Inventory Short Form was used to assess Big 5 personality characteristics (Costa & McCrae, 1992; McCrae & Costa, 2004). The NEO-FFI is an established assessment of personality characteristics that requires participants to self-assess tendencies and characteristics based on their adherence to Neuroticism, Extraversion, Openness to Experience, Agreeableness, and Conscientiousness. Participants also completed the NFC Scale, which assesses individuals' perceptions regarding their own cognitive abilities and the effort needed to exercise those abilities (Cacioppo, Petty, & Kao, 1984). Participants completed an adapted version of the Metacognitions Questionnaire, which assesses individuals' meta-cognitive confidence in their memory abilities and assesses self-awareness regarding one's memory capacities (Wells & Cartwright-Hatton, 2004). Participants also completed the Memory Anxiety Questionnaire, which assesses anxiety about an individual's own memory abilities (Davidson, Dixon, & Hultsch, 1991; Huff, Meade, & Hutchison, 2011). Questionnaires used in the study are included in the Appendix.

Procedure

The study was conducted using a computer running E-Prime software (Schnieder, Eschman, & Zuccolotto, 2002). Participants were tested individually. Following informed consent, participants were randomly assigned to 1 of 12 groups consisting of 3 pure and 9 mixed groups (see Table 1). Depending on the study condition assigned, participants were asked to use either one or two study tasks that were provided by the experimenter. In the E-Task, participants were asked whether each list word contained the vowel "e" by responding "yes" or "no" on a labeled keyboard. In the read task, participants were asked to read each word silently. In the PR task, participants were asked to rate each word for its pleasantness on a 5-point scale (1 = extremely unpleasant; 5 = extremely pleasant). In the *pure groups*, participants used either the E, read, or PR tasks to study all 10 DRM lists. In the *mixed groups*, participants used a combination of two tasks and the distribution of these tasks depended on the specific condition. In the 80% PR versus 20% read group, participants studied 8 lists using the PR task and 2 using the read task. In the 50% PR versus 50% read group, participants studied 5 lists using the PR task and 5 using the read task. In the 20% PR versus 80% read group, participants studied 2 lists using the PR task and 8 using the read task. These same distributions were used for the PR/E mixed groups and the Read/E mixed groups. The tasks that were completed for each list in the mixed groups occurred randomly, and were interleaved, to ensure that tasks were not attributed to any one DRM list.

Across conditions, study lists were studied back-to-back and the recognition test was completed immediately after study of the final list. The recognition test was an old/new recognition test in which participants were instructed to press an “old” labeled key on a keyboard for each item that was studied, and a “new” labeled key for each word that was not studied. Participants were instructed to respond quickly and accurately and were not informed about the presence of critical lures on the recognition test.

Immediately following the recognition test, all participants completed assessments of personality and demographic questionnaires. Participants completed the NEO-FFI, the NFC Scale, the MCQ-30 Short Form, the Memory Anxiety Questionnaire, and a demographics questionnaire assessing age and education in this order. Following the questionnaires, participants were debriefed and any questions that they had were answered.

CHAPTER III - Results

For all results reported, a $p < .05$ level of significance was used unless noted otherwise. Measures of effect size were calculated by using partial-eta squared (η_p^2) for analyses of variance (ANOVAs) and Cohen's *d* for *t*-tests for all significant and marginal effects. Due to experimenter error, one list in one of the counterbalanced versions (the fruit list), was also used as the practice list across conditions. Due to this repetition, study items from the fruit list and the corresponding critical lure were removed from all analyses in this version.

Pure Groups

*Correct Recognition***.** Analyses were first conducted on correct recognition from the pure groups to verify levels-of-processing and distinctiveness effects on recognition (Table 2). A one-way ANOVA showed a significant difference across the pure groups, $F(2, 72) = 25.45$, mean-square error (MSE) = .02, $\eta_p^2 = .07$, which indicated that correct recognition was greater in the PR group than both the Read (.95 vs. .78), $t(50) = 5.93$, $SEM = .17$, $d = 1.65$, and E-Task groups (.95 vs. .65), $t(47) = 6.81$, $SEM = .44$, $d = 1.89$. Correct recognition was also greater in the Read than the E-Task group (.78 vs. .65), $t(47) = 2.61$, $SEM = .05$, $d = 0.74$. Thus, PR, Read, and E-Tasks showed standard levels-of-processing/distinctiveness effects (Craik & Lockhart, 1972).

*False Recognition***.** Analyses were then conducted to examine false recognition for non-presented critical items (Table 3). A marginal effect was found across the pure groups, $F(2, 72) = 2.50$, $MSE = .05$, $p = .09$, $\eta_p^2 = .07$, which reflected lower false recognition in the E-Task versus Read group (.64 vs. .77), $t(47) = 2.15$, $SEM = .06$, $d = 0.62$, but equivalent false recognition to the PR group (.64 vs. .69), $t < 1$. False recognition did not differ between the PR and Read groups (.69 vs. .77), *t*(50) = 1.38, *SEM* = .06 *p* = .18. Therefore, the E-Task group produced the lowest rate of false recognition and the read group the highest, though both groups did not differ from the PR group. Of course, strong claims are not made regarding these patterns given the omnibus ANOVA was only marginal.

Mixed Groups

*Correct Recognition***.** Analyses were then conducted on the mixed groups to examine the independent and combined contributions of statistical and encoding distinctiveness on correct recognition. Correct recognition for each of the mixed groups is reported in Table 2. A 3(List Type: PR/Read vs. PR/E vs. Read/E) × 3(Proportion: 20/80 vs. 50/50 vs. 80/20) factorial ANOVA was conducted in order to examine the contributions of list type and proportion on correct recognition. A main effect of list Type was found, *F*(2, 208) = 7.67, *MSE* = .02, η_p^2 = .07, which mirrored the levels-of-processing effects found in the pure groups: Correct recognition was marginally greater for the deeper PR/Read group compared to the PR/E group (.80 vs. .76), *t*(143) = 1.84, *SEM* = .02, *p* = .07, *d* = 0.31, and significantly greater than the shallow Read/E group (.80 vs. .71), *t*(143) = 3.82, *SEM* = .02, *d* = 0.63. Correct recognition was also greater for PR/E compared to the Read/E groups (.76 vs. .71), *t*(142) = 2.06, *SEM* = .03, *d* = 0.34. Thus, levels-of-processing effects were found in mixed groups in which deeper task combinations produced greater correct recognition relative to shallower combinations. A main effect for Proportion was also found, *F*(2, 208) = 3.28, *MSE* = .02, η_p^2 = .03, in which correct recognition was greatest in the 50/50 proportion compared to the 80/20 proportion (.79 vs. .73), *t*(142) = 2.63, *SEM* = .02, *d* = 0.44, but equivalent to the 20/80 proportion (.79 vs. .76), *t*(143) = 1.21, *SEM* = .02, *p* = .23. No difference was found in correct recognition between the 20/80 and 80/20 proportions (.76 vs. .73), *t*(143) = 1.23, *SEM* = .02, *p* = .22. Equivalent exposure to tasks in the 50/50 condition, in which tasks are frequently alternated, therefore produced the greatest correct recognition rates. The interaction between List Type and Proportion was not reliable, *F* < 1.

Statistical distinctiveness is contingent upon the interaction between list type combinations and their proportional manipulations. In order to assess for the presence of statistical distinctiveness within task combinations, the next set of analyses examined individual list types when they were used to study either 20%, 50%, or 80% of the lists (i.e., comparing groups across rows in Table 2). The first analysis examined the PR/E groups using a 2(List Type: PR vs. E) × 3(Proportion: 20/80 vs. 50/50 vs. 80/20) mixed ANOVA. Correct recognition was greater for PR than E lists (.91 vs. .62), *F*(1, 69) = 129.41, *MSE* = .02, η_p^2 = 0.65, and correct recognition was also found to differ across the different proportions, *F*(2, 69) = 3.65, *MSE* = .04, η_p^2 = .10. Follow-up tests indicated that recognition was greater in the 50/50 group than the 80/20 group (.82 vs. .72), *t*(46) = 2.68, *SEM* = .04, *d* = 0.77, but equivalent to the 20/80 group (.82 vs. .76), *t*(46) = 1.59, *SEM* = .04, *p* = .12. Recognition did not differ between the 20/80 and 80/20 groups (.76 vs. .72), *t*(46) = 1.14, *SEM* = .04, *p* = .26. The List Type × Proportion interaction was not reliable, *F*(2, 69) = 1.55, *MSE* = .02, *p* = .22, yielding no evidence for statistical distinctiveness.

The second ANOVA examined the PR/Read groups across the three proportion levels. A significant main effect of List Type, *F*(1, 70) = 85.52, *MSE* = .03, η_p^2 = .55 was similarly found, which indicated that recognition was greatest for the PR versus Read group (.94 vs. .67), $t(72) = 9.31$, $SEM = .03$, $d = 1.55$, but the main effect of Proportion and the interaction were not significant, $F(2, 70) = 1.83$, $MSE = .03$, $p = .17$, and $F < 1$, respectively, again failing to support statistical distinctiveness.

A final ANOVA examined the Read/E groups across the three proportion levels. Main effects of List Type, $F(1, 69) = 1.30$, $MSE = .03$, $p = .26$, and Proportion, $F < 1$, were not reliable, but a marginal interaction was found, $F(2, 69) = 1.55$, $MSE = .03$, $p = .07$, $\eta_p^2 = .08$. Follow-up tests revealed a marginal increase in correct recognition for 20% read lists over 80% E lists in the 20/80 condition (.76 vs. .65), $t(23) = 1.92$, $SEM = .06$, $p = .07$, $d = 0.45$, however, this pattern was not found in either the 50/50 condition (.70 vs. .75), $t(23) = 1.44$, $SEM = .03$, $p = .17$, nor the 80/20 condition (.73 vs. .69), $t < 1$. Thus, in the Read/E groups, a trend was found that was consistent with a statistical distinctiveness pattern. However, the Read task is also a deeper processing task than the E-Task and may simply reflect a LOP effect as a recognition benefit was not found in the reversed condition (i.e., the 20% E-Task/80% Read group).

Table 2

Mean (95% CI) Proportion of Correct Recognition as a Function of Task Group and List Proportion for Mixed and Pure Groups.

	Mixed Groups		
List Type/Task Proportion	80/20	50/50	20/80
PR/E	**.89**(.04) vs. **.54** (.11)	**.95**(.02) vs. **.68**(.08)	**.89**(.06) vs. **.64**(.06)
n	24	24	24
PR/Read	.**90**(.04) vs. .**62**(.11)	.**95**(.03) vs. .**72**(.09)	.**97**(.03) vs. .**66**(.07)
n	24	24	25
Read/E	.**72**(.05) vs. .**70**(.09)	.**70**(.06) vs. .**75**(.06)	.**78**(.12) vs. .**65**(.08)
n	24	24	24
	Pure Groups		
Proportion	100	100	100
List Type	PR	Read	E
Correct Recognition	.**95**(.02)	.**78**(.05)	.**65**(.09)
n	26	26	24

Notes. *N* = 293. PR = Pleasantness Ratings; Read = Silent Reading; E = “E” Judgment Task.

*False Recognition***.** Statistical distinctiveness effects in mixed groups were then analyzed for false recognition using the same analyses as above (see Table 3). A 3(List Type: PR/Read vs. PR/E vs. Read/E) × 3(Proportion: 20/80 vs. 50/50 vs. 80/20) ANOVA yielded a main effect of List Type, $F(2, 208) = 3.12$, $MSE = .06$, $\eta_p^2 = .03$, in which false recognition was greatest for the PR/Read group compared to the PR/E group (.69 vs. .59), $t(143) = 2.57$, $SEM = .04$, $d = 0.43$, but not compared to the Read/E group (.69 vs. .65), $t(143) = 1.13$, $SEM = .04$, $p = .26$. False recognition was also equivalent between the PR/E and Read/E groups, $t(142) = 1.37$, $SEM = .04$, $p = .17$. The effect of Proportion and the interaction were not reliable, Fs < 1.

False recognition was then analyzed separately from each mixed group to examine the contribution of statistical distinctiveness on recognition errors as above. The first 2(List Type: PR/E) x 3(Proportion: 20% vs. 50% vs. 80%) ANOVA showed a main effect for List Type, $F(1, 69) = 34.68$, $MSE = .06$, $\eta_p^2 = .33$, indicating that false recognition was greatest for the PR than E-Task lists (.71 vs. .46). Both the main effect of Proportion and the interaction were not reliable, $F < 1$, and $F(2, 69) = 2.05$, $MSE = .06$, $p = .14$, respectively.

The second 2(List Type: PR/Read) x 3(Proportion: 20% vs. 50% vs. 80%) yielded null effects of List Type, $F(1, 70) = 1.10$, $MSE = .08$, $p = .30$, Proportion, $F < 1$, and a non-significant interaction. $F < 1$.

Finally, a third 2(List Type: Read/E) x 3 (Proportion: 20% vs. 50% vs. 80%) ANOVA showed a marginal effect of List Type, $F(1, 69) = 3.65$, $MSE = .07$, $p = .06$, $\eta_p^2 = .05$, in which false recognition was greater for Read than E-Task lists (.69 vs. .61), however the main effect of Proportion and the interaction, were not reliable, Fs < 1. Thus, mixed groups did not show any evidence for statistical distinctiveness in false recognition.

Table 3

Mean (95% CI) Proportion of False Recognition as a Function of Task Group and List Proportion for Mixed and Pure Groups.

	Mixed Groups		
List Type/Task Proportion	80/20	50/50	20/80
PR/E	**.74**(.10) vs. **.35**(.16)	**.71**(.11) vs. **.51**(.12)	**.69**(.14) vs. **.52**(.09)
PR/Read	.**67**(.10) vs. .**69**(.16)	.**70**(.11) vs. .**66**(.10)	.**77**(.14) vs. .**67**(.11)
Read/E	.**72**(.10) vs. .**61**(.18)	.**70**(.10) vs. .**63**(.10)	.**65**(.16) vs. .**61**(.10)
	Pure Groups		
Proportion	100	100	100
List Type	PR	Read	E
False Recognition	.**69**(.08)	.**77**(.08)	.**64**(.09)

Notes. *N* = 293. PR = Pleasantness Ratings; Read = Silent Reading; E = “E” Judgment Task.

Comparisons Between Mixed and Pure Groups

Given the lack of statistical distinctiveness effects in correct and false recognition when comparing across task proportions in the mixed groups, the next set of analyses examined whether statistical distinctiveness effects emerge when compared to pure groups. Pure groups are not affected by statistical distinctiveness given all study lists utilize the same task, whereas even the 80% tasks in the mixed groups may have some degree of statistical distinctiveness given 80% tasks are slightly rarer than the pure groups. To provide another examination of statistical distinctiveness, targeted comparisons compared the 20% task conditions, which were the most likely to produce statistical distinctiveness, to the pure group using the same task.

Correct Recognition

***E-Task Mixed Groups vs. E-Task Pure Group*.** In the PR/E task combination, where the E-Task was used for 20% of list items, a marginal reduction was found for 20% lists relative to the pure E-Task group (.53 vs. .66), $t(46) = 1.74$, $SEM = .07$, $p = .09$, $d = 0.50$, a pattern in the opposite direction of statistical distinctiveness. In the Read/E task combination, where the E-Task was used for 20% of list items, no differences in recognition between the 20% group and the pure group were found (.70 vs. .66), $t < 1$.

***Reading vs. Reading Pure*.** In the PR/Read task combination, where Reading was used for 20% of list items, a significant reversed statistical distinctiveness effect was found in which correct recognition was lower in the 20% Read lists versus the Read pure group (.63 vs. .78), $t(48) = 2.42$, $SEM = .06$, $p = .02$, $d = 0.68$. This pattern did not occur however when comparing the 20% Read lists in the Read/E combination, as there was no difference relative to the pure group (.76 vs. .78), $t < 1$.

*PR vs. PR Pure***.** In the PR/E task combination, where PR was used for 20% of list items, a reversed statistical distinctiveness pattern was again found (.88 vs. .95), $t(48) = 1.98$, $SEM = .03$, $d = 0.55$, for the 20% PR lists and PR pure group, respectively. In the PR/Read task combination, correct recognition was equivalent between the 20% group and the pure group (.97 vs. .95), $t < 1$. Collectively, across list types, comparisons between the 20% mixed lists and their corresponding pure group revealed no evidence of statistical distinctiveness and indeed, some comparisons showed a reversed statistical distinctiveness pattern.

False Recognition

*E-Task Mixed Groups vs. E-Task Pure Group***.** In the PR/E task combination, where the E-Task was used for 20% of list items, analyses revealed a significant reduction in false recognition for 20% lists relative to the pure E-Task group (.39 vs. .64), $t(47) = 2.78$, $SEM = .09$, $d = 0.80$. In the Read/E task combination, where the E-Task was used for 20% of list items, no differences were found in recognition between 20% E-Task list items and the E-Task pure group (.58 vs. .65), $t < 1$.

*Reading vs. Reading Pure***.** In the PR/Read task combination, where Reading was used for 20% of list items, no differences were found in recognition between the 20% Read lists and the Read pure group (.69 vs. .77), $t < 1$, as was the case when comparing 20% Read lists in the Read/E combination (.67 vs. .77), $t(48) = 1.19$, $SEM = .09$, $p = .24$.

*PR vs. PR Pure***.** In the PR/E task combination, where PR was used for 20% of list items, analyses revealed no differences in recognition for 20% PR lists compared to

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the PR pure group (.69 vs. .69), $t < 1$, as was the case in the PR/Read task combination, where PR was used for 20% of list items, (.97 vs. .95), $t(49) = 1.11$, $SEM = .08$, $p = .27$. In summary, statistical manipulations yielded minimal benefits in reduction to false recognition when compared to equivalent pure tasks.

Recognition and Individual Differences

Individual difference assessments were then evaluated to provide a qualitative understanding of individuals' metacognitive tendencies. Means and bivariate correlations for each of the measures are presented in Table 4. In order to maintain sufficient power to detect relationships, these analyses collapsed across all task combinations and proportional groups. Due to an experimenter error, data from 13 participants were excluded from the analyses. These data were missing identification labels and could not be accurately matched to associated recognition performance.

Analyses showed a marginal negative relationship between false recognition and Agreeableness, $r = -.11$, $p = .06$. No other individual difference factors correlated with recognition, *r*s <.09, *p*s > .12, including the NFC Scale, Conscientiousness subscale of the NEO-FFI, and Memory Anxiety Scale.

Since no individual difference measures were found to be related to recognition, the correlations between the metacognitive measures (Memory Anxiety, NFC, and MCQ-30) were examined. Memory Anxiety was negatively related to the NFC and positively related to the MCQ-30, *r*s > .17, *p*s < .01. The NFC showed no relationship to the MCQ-30, $r = .01$, $p = .87$. These results indicate that anxiety regarding one's memorial ability seems to be related to metacognitive awareness.

The correlations between the Big Five traits were then examined in the following order: Neuroticism, Extraversion, Openness, Agreeableness, and Conscientiousness. Neuroticism was negatively correlated with Agreeableness and Conscientiousness, rs $< -.22$, ps $< .001$. Extraversion was negatively correlated with Openness, $r = -.13$, $p = .03$, and positively correlated with Conscientiousness, $r = .16$, $p = .01$. Openness was only negatively correlated with Extraversion, $r = -.13$, $p = .03$. Agreeableness was also positively correlated with Conscientiousness, $r = .18$, $p <.01$. Conscientiousness was positively correlated with Extraversion, $r = .16$, $p = .01$, and Agreeableness, $r = .18$, $p <.01$. All trait correlations aligned in accordance with previous literature as anticipated (Steele, Schmidt, & Schultz, 2008), save for the small negative relationship between Openness and Extraversion, which deviates from findings in the literature (Matthews, Deary, & Whiteman, 2009; Aluja, Garcia, & Garcia, 2003; Steele et al.).

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Finally, relationships between the Big Five traits and metacognitive measures were then examined using the same order as above. Neuroticism was positively correlated with the MCQ-30 and Memory Anxiety, rs $> .49$, ps $< .001$, indicating that metacognitive awareness increases as both emotional instability and anxiety towards memory increase. Extraversion was not related to any of the metacognitive measures, rs $< .08$, ps $> .18$. Openness was positively related to the NFC, $r = .51$, $p < .001$, and was negatively related to Memory Anxiety, $r = -.14$, $p = .02$. This finding suggests that highly open individuals express a greater need to engage in cognitively demanding tasks and exhibit less anxiety regarding their memory abilities. Agreeableness was negatively correlated with the MCQ-30 and Memory Anxiety, rs $< -.18$, ps $< .01$, indicating that agreeable individuals express less metacognitive awareness and less anxiety regarding their memorial abilities. Conscientiousness was positively correlated with the NFC, r = .27, $p < .01$, and was negatively correlated with Memory Anxiety, r = -.27, $p < .01$, indicating that conscientious individuals express greater need to exercise their cognitive abilities and also express less memorial anxiety when doing so. These findings suggest that certain metacognitive measures are also related to Big Five traits.

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Table 4

Descriptives and bivariate correlations between Individual Difference Measures and Recognition.

	Correct Recog.	False Recog.	N	E	O	A	C	NFC	MCQ-30	Memory Anxiety
Correct Recognition	-	.37**	-.04	.11†	-.04	-.02	.07	.03	-.07	-.06
False Recognition		-	-.01	.07	-.07	-.12*	.02	-.02	-.01	.07
N			-	-.10†	-.04	-.22**	-.38**	-.12†	.56**	.50**
E				-	-.14*	.00	.15*	.05	.11†	-.04
O					-	.08	.09	.51**	.03	-.15*
A						-	.18**	.06	-.22**	-.18**
C							-	.31**	-.09	-.27**
NFC								-	.06	-.19**
MCQ-30									-	.58**
Memory Anxiety										-
M (*SD*)	.77 (.16)	.66 (.24)	36.74 (7.88)	39.88 (4.24)	39.06 (6.16)	41.04 (4.67)	45.55 (6.37)	36.38 (11.32)	2.30 (.44)	2.92 (.63)

Note: * $p < .05$, ** $p < .01$, † $p < .10$; $N = 280$

CHAPTER IV - General Discussion

The purpose of this study was to evaluate separate contributions of two types of distinctiveness that are often confounded when evaluating the effects of distinctive study tasks on memory. Encoding distinctiveness refers to the memorial benefits that originate from processing within an encoding task, whereas statistical distinctiveness refers to the benefits found for tasks used infrequently. In a single experiment, encoding distinctiveness was manipulated through the levels-of-processing framework by employing a distinctive/deep task (Pleasantness Ratings) and comparing differences in recognition relative to a neutral task (silent reading), and a shallow task (“E” identification). Statistical distinctiveness was then examined by manipulating the frequency with which participants utilized a given study task in a set of mixed groups. Participants studied lists of words using one task for 20%, 50%, or 80% of lists and another task for the remaining percentage, making the task used for 20% of the lists statistically distinctive. These mixed groups were compared to a set of pure groups in which the same task was used for all study lists.

Reliable evidence for encoding distinctiveness was found in correct recognition. As predicted by **H_1**, a standard levels-of-processing effect emerged in which the deeper and more distinctive PR task led to greater correct recognition than the neutral read task and the shallow E-Task. Of note, these processing patterns were also found in mixed groups, in which deeper task combinations (i.e., PR/Read) led to an increase in correct recognition relative to more neutral or shallow task combinations (i.e., PR/E-Task and

Read/E-Task)—a novel result. The combined task effects of pure and mixed groups demonstrate powerful benefits of encoding distinctiveness as the distinctive PR task, and any mixed group combination that included this task, produced elevated correct recognition.

Support for statistical distinctiveness however, failed to materialize. This account did not manifest in mixed group comparisons, nor in comparisons between 20% lists and task-equivalent pure groups. Across task combinations, the 20% lists did not show a correct recognition advantage relative to the 50% or 80% groups, in contrast to **H_2**. Further, when compared to pure groups, which did not receive any level of statistical distinctiveness, 20% lists were again not greater, in contrast to **H_3**. These findings do not replicate those found by Icht et al. (2014) or Bodner et al. (2016), whereby memorial benefits were found for statistically rare groups in a production-effect paradigm. The current study does not provide evidence for statistical distinctiveness, but rather broadens the examination of encoding and statistical distinctiveness accounts on memory.

Encoding and statistical distinctiveness effects were also examined for false recognition, in a set of non-studied critical items that were related to the study lists and embedded in the recognition test. Analyses of these items yielded trends consistent with distinctive encoding tasks and **H_1**, but not statistical distinctiveness. False recognition was not reduced for both the PR and E-Task pure groups compared to the Read pure group. The PR task requires the use of item-specific processing, theoretically resulting in a reduction to false recognition. The shallowness of the E-Task reduces the amount of encoded information at study, leading to reduced false recognition as well; however, such results were not found. In contrast to the pure groups, false recognition across mixed

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groups was greatest for PR/Read compared to the Read/E group, which was not expected. In the PR/Read group, Read tended to produce the greatest false recognition because reading was likely to produce relational processing. The processing from the Read task, which was relational in nature, given study lists were strongly associated, may have carried over from the Read lists to the PR lists, increasing false recognition. Indeed, carryover effects of item-specific and relational processing have been shown to affect false recognition in mixed-group designs (Huff, Bodner, & Gretz, under review). Thus, it is unsurprising that false recognition in mixed groups did not show robust effects across encoding task types.

Statistical distinctiveness also did not influence false recognition for mixed-group comparisons, nor for the comparisons between 20% lists and task-equivalent pure groups. Across task combinations, false recognition was equivalent between 20%, 50%, and 80% lists, in contrast to **H_2**. Additionally, false recognition showed no differences between 20% lists and the pure groups, in contrast to **H_3**. The examination of statistical distinctiveness on false recognition in the current study was exploratory. Theoretically, the benefits of statistical distinctiveness found by Bodner et al. (2016) and Icht et al. (2014), should have translated to reductions in false recognition for 20% lists. However, since the current study found no evidence for statistical distinctiveness in correct recognition, it is not surprising that such proportional influences did not extend to false recognition.

The Hunt for Statistical Distinctiveness

Across both PR/Read and PR/E combinations, there was no interaction between List Type and Proportion, suggesting that statistical manipulations do not influence

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correct recognition for these task combinations. For both task combinations, PR lists consistently performed at ceiling, with no change in performance regardless of the frequency in which the task was completed. Although the tasks used in this study exhibited the standard levels-of-processing effect, evidence suggests that the relative difference in encoding strength between individual tasks was not equivalent. As such, the sensitivity of each list type to proportional manipulations differed as well. Clearly, the PR task was not sensitive to these proportional manipulations as indicated by ceiling performance. However, the Read/E group, which did not include the PR task, appeared to be more sensitive towards the proportional manipulations. There was marginally greater recognition exhibited for 20% read lists over 80% E-Task lists, but this pattern was not found in the reverse 20% E-Task lists over 80% read lists. These findings are somewhat consistent with Icht et al. (2014; Experiment 2), in which a "dilution" of the production effect was found for the 80% aloud lists compared to the 20% silent lists. When a distinctive task is used frequently, the statistical benefit of the infrequent task may equate memory performance between both list types.

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The finding of some sensitivity towards proportional effects when the PR task was absent from mixed groups suggests that statistical distinctiveness may be more likely to occur when the two list types are relatively equivalent in encoding strength. To date, studies that have shown statistical distinctiveness patterns have solely used a production effect paradigm. The relative difference in encoding strength between aloud and silent items is typically small (Fawcett, 2013), which may increase the likelihood that statistical distinctiveness effects are detected. Thus, the relative difference between the two tasks used in mixed groups may moderate whether statistical distinctiveness benefits correct recognition, which was not the case for mixed groups that included the powerful PR task.

Although evidence for statistical distinctiveness did not emerge, analyses revealed an interesting proportional effect on correct recognition when collapsed across task type. Specifically, participants in the 50/50 group, significantly outperformed the 80/20 group, and numerically outperformed the 20/80 group. Although the comparison between the 50/50 and 20/80 groups did not manifest statistically, both 20/80 and 80/20 groups, theoretically, should have had greater recognition compared to the 50/50 group. This is because both the 20/80 and 80/20 groups receive benefits from both encoding *and* statistical distinctiveness accounts, whereas the 50/50 group only received a benefit from the encoding distinctiveness account. It is also possible that the randomly alternating tasks within the 50/50 group encouraged deeper processing for all lists, compared to both the 20/80 and 80/20 groups, which only had two task alternations. When collapsing across encoding tasks, findings suggest that the contribution of statistical distinctiveness is potentially costly to overall recognition and is, at best, nominal.

The comparison of mixed and pure groups was designed to provide a more sensitive test of statistical distinctiveness given pure groups could not be affected by statistical distinctiveness. Despite this comparison, evidence for statistical distinctiveness did not emerge for either correct or false recognition. Rather, comparisons between mixed and pure groups exhibited a consistent reduction in correct recognition for all task types when compared to task-equivalent pure groups. No consistent findings were present for false recognition comparisons.

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The methods used to test for statistical distinctiveness patterns were designed to mimic those used in previous studies (Icht et al., 2014; Bodner et al., 2016) with some exceptions. First, as noted above, the present study utilized the levels-of-processing framework to examine statistical distinctiveness, whereas all other studies that have shown statistical distinctiveness effects utilized a production effect paradigm. It is possible that the type of task used may be sensitive to the proportional manipulation needed to manifest statistical effects, and the inclusion of the PR task, which was quite powerful, may have masked the effect. Second, the present study used DRM word lists as study materials versus unrelated word lists used in previous studies to gauge distinctiveness effects on correct and false recognition. The strong association in DRM lists may have muted proportional effects in recognition, as participants may have been more reliant upon thematic cues at test. That is, participants may have utilized associative information in favor of how frequently a task was processed during study to inform their recognition decisions.

Finally, although the same proportions of statistical distinctiveness were followed in the present study, both Bodner et al. and Icht et al. manipulated statistical distinctiveness at the item level, rather than at the list level. At the item level, participants were presented with a single list of items in which distinctive items were randomly encountered. At the list level, however, items that used the same task type were blocked together, so participants used the same task repeatedly on many items. This repetition may have rendered the task less distinctive from a statistical standpoint, as the encoding context would have been more similar. In summary, several possible factors may be

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related to the manifestation of statistical distinctiveness, which may serve as avenues for future research.

An additional difference that may be important for detecting statistical distinctiveness effects is the type of memory test completed. Specifically, Icht et al. (2014) reported a reduction in statistical distinctiveness for recognition versus free recall. Free recall is generally believed to be more sensitive to recollective-based processes which require explicit traces of memory information. In contrast, recognition is a discrimination memory task is highly sensitive to familiarity-based processes (Mandler, 1980; Yonelinas, 2002). It is possible that statistical distinctiveness may affect recollection and may go undetected on recognition. Thus, the smaller distinctiveness pattern reported by Icht et al. (2014) and the lack of support for statistical distinctiveness in the present study, suggests that test type may be an important moderator.

Distinctiveness vs. Deep Processing

The use of the levels-of-processing framework in the present study assumes that the deep PR task used is also a distinctive task. Deep encoding tasks can occur from both item-specific and relational processing (i.e., relational generation; Huff & Bodner, 2013). In the current study, the PR task qualifies as both a deep task, activating the semantic processing of items, and as a distinctive task, by inducing item-specific processing; distinctive processing promotes memory for specific items (Hunt & Einstein, 1981). Item-specific processing is solely associated with distinctive encoding, whereby individuals are asked to identify unique, item-specific features of stimuli at study.

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Relational encoding preserves the thematic consistency across list stimuli, and dilutes distinctive processing at the item level. Therefore, relational processing is equivalent to deep processing, but not distinctive processing. The PR task is the standard item-specific task meant to induce distinctive encoding. However, reading induces relational processing across list items. The E-Task promoted neither items-specific nor relational processing, as is typical for shallow tasks. Therefore, encoding distinctiveness in the current study refers to the influence of both item-specific and relational processing.

Individual Differences in Memory Performance

In addition to separating the contributions of encoding and statistical distinctiveness effects, a secondary goal of the present study was to evaluate potential individual difference factors that may be related to recognition performance. This study used the NFC Short Form, MCQ-30, Memory Anxiety Questionnaire, and the NEO-FFI Short Form. There is evidence finding that Conscientiousness moderates performance on a sustained attention to response task (SART), which suggests that personality factors in the NEO-FFI are related to cognitive processes (cf. Jackson & Balota, 2012).

There were no individual differences measures that strongly correlated with correct or false recognition. Specifically, correct recognition did not show a positive relationship to the NFC Scale and Conscientiousness subscale of the NEO-FFI, nor a negative relationship to the Memory Anxiety Scale, as was originally predicted in **H$_4$**. Again, this may have occurred due to assessing for recognition, which is more familiarity-based and does not require the use of controlled processes, compared to recall which does require controlled processes. If personality factors truly measure individual

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differences on memory, then these measures will likely be more sensitive to memory effects when retrieval processes are more challenging (i.e., recall). Future studies should, therefore, assess for differences in trait expressions between recall and recognition. Additionally, the use of DRM lists in the current study may have muted the relationship between personality traits and recognition. Subjects could have relied on the thematic consistency between list items to inform their recognition decisions, in contrast to the use of unrelated list items which may be more sensitive to personality differences.

Though the individual difference measures did not correlate with recognition, they did correlate with each other. Metacognitive awareness was positively related to Neuroticism and Memory Anxiety, suggesting that such awareness may stem from anxiety regarding one’s memorial capacities and general emotional instability. Individuals who scored high in need for cognition also reported increased tendencies for exploration (i.e., more open, agreeable) and a negative association regarding memory anxiety.

Highly neurotic individuals tended to report being less agreeable and conscientious. These individuals also exhibited greater metacognitive awareness and anxiety towards using their memory. Individuals who exhibited high Openness also reported high need for cognition with less memory anxiety, suggesting that one’s need for cognition may be reflected in their willingness to engage in cognitively demanding tasks. Highly agreeable individuals were also more conscientious. However, these individuals reported less metacognitive awareness and anxiety towards using their memories. Although these individual difference measures did not correlate with recognition, they did contextualize the relationships between metacognitive and personality factors.

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CHAPTER V – CONCLUSION

The purpose of the current study was to separate the contributions of two potential species of distinctiveness: Encoding and statistical distinctiveness on recognition memory performance. Three encoding tasks were used (Pleasantness Ratings, Reading, or "E" Identification) which varied in their use of distinctive/deep processing, and were manipulated to occur relatively frequently when studying a series of lists (100% in the pure groups or 80% in the mixed groups), or relatively infrequently (20% in the mixed groups). Although distinctive encoding tasks produced large correct recognition benefits, no evidence for statistical distinctiveness was found when any of the three tasks were completed infrequently. The absence of statistical distinctiveness may be due to the inclusion of the powerful pleasantness rating task, which may override the benefits of statistical distinctiveness. The use of more moderate tasks, or the use a memory test type that does not yield high levels of performance (e.g., free recall) may be useful for testing whether statistical distinctiveness benefits memory.

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APPENDIX A

NEO-FFI Short Report (Example Questions; Costa & McCrae, 2004)

1. I keep my belongings neat and clean. (Subscale: Neuroticism)

   Strongly disagree   Disagree   Neutral   Agree   Strongly agree

2. I'd like to be where the action is. (Subscale: Extraversion)

   Strongly disagree   Disagree   Neutral   Agree   Strongly agree

3. I often try new foreign foods. (Subscale: Openness)

   Strongly disagree   Disagree   Neutral   Agree   Strongly agree

4. Most people I know like me. (Subscale: Agreeableness)

   Strongly disagree   Disagree   Neutral   Agree   Strongly agree

5. I generally try to be thoughtful and considerate. (Subscale: Conscientiousness)

   Strongly disagree   Disagree   Neutral   Agree   Strongly agree

Need for Cognition Scale (Cacioppo, Petty, & Kao, 1984)

1 = extremely uncharacteristic
2 = somewhat uncharacteristic
3 = uncertain
4 = somewhat characteristic
5 = extremely characteristic

1. I would prefer complex to simple problems.
2. I like to have the responsibility of handling a situation that requires a lot of thinking.
3. Thinking is not my idea of fun.
4. I would rather do something that requires little thought than something that is sure to challenge my thinking abilities.
5. I try to anticipate and avoid situations where there is a likely chance I will have to think in depth about something.
6. I find satisfaction in deliberating hard and for long hours.
7. I only think as hard as I have to.
8. I prefer to think about small daily projects rather than long-term ones.
9. I like tasks that require little thought once I've learned them.
10. The idea of relying on thought to make my way to the top appeals to me.
11. I really enjoy a task that involves coming up with new solutions to problems.
12. Learning new ways to think doesn't excite me very much.
13. I prefer my life to be filled with puzzles that I must solve.
14. The notion of thinking abstractly is appealing to me.
15. I would prefer a task that is intellectual, difficult, and important to one that is somewhat important but does not require much thought.
16. I feel relief rather than satisfaction after completing a task that required a lot of mental effort.
17. It is enough for me that something gets the job done; I don't care how or why it works.
18. I usually end up deliberating about issues even when they do not affect me personally.
19. In the next 5 years, I am more likely to engage in activities that require lots of thinking.
20. In the next 5 years, I am less likely to enjoy solving challenging problems.

Metacognitions Questionnaire (MCQ – 30; Wells & Cartwright-Hatton, 2004)

1 = do not agree
2 = agree slightly
3 = agree moderately
4 = agree very much

1. I do not trust my memory.
2. I have a poor memory
3. I have little confidence in my memory for actions.
4. I have little confidence in my memory for places.
5. I have little confidence in my memory for words and names.
6. My memory can mislead me at times.
7. Worrying helps me to get things sorted out in my mind.
8. Worrying helps me cope.
9. I need to worry in order to work well.
10. Worrying helps me to solve problems.
11. I need to worry in order to remain organized.
12. Worrying helps me to avoid problems in the future.
13. I am constantly aware of my thinking.
14. I pay close attention to the way my mind words.
15. I think a lot about my thoughts.
16. I constantly examine my thoughts.
17. I monitor my thoughts.
18. I am aware of the way my mind works when I am thinking through a problem.
19. My worrying thoughts persist, no matter how I try to stop them.
20. When I start worrying I cannot stop.
21. I could make myself sick with worry.
22. I cannot ignore my worrying thoughts.
23. My worrying could make me go mad.
24. My worrying is dangerous for me.
25. If I could not control my thoughts, I would not be able to function.
26. Not being able to control my thoughts is a sign of weakness.
27. I should be in control of my thoughts all of the time.
28. It is bad to think certain thoughts.
29. If I did not control a worrying thought and then it happened, it would be my fault.
30. I will be punished for not controlling certain thoughts.

Memory Anxiety Questionnaire (Huff, Meade, & Hutchison, 2011)

1 = Strongly Disagree
2 = Disagree
3 = Neutral
4 = Agree
5 = Strongly Agree

1. I would feel on edge right now if I had to take a memory test.
2. When someone I don't know very well asks me to remember something I get nervous.
3. I am usually uneasy when I attempt a problem that requires me to use my memory.
4. I get tense and anxious when I feel my memory is not as good as other people's.
5. I get anxious when I am asked to remember.
6. I do not get flustered when I am put on the spot to remember new things.
7. I feel jittery if I have to introduce someone I just met.
8. I get anxious when I have to do something that I haven't done in a long time.
9. If I am put on the spot to remember names, I know I will have difficulty doing it.
10. I would feel very anxious if I visited a new place and had to remember how to find my way back.
11. I get upset when I cannot remember something.
12. When taking a memory test, I feel it is a more serious memory error to leave something out than it is to write down something.