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The Influence of Generation & Part-Set Cueing on Memory

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Abstract

Part-set cueing describes the phenomenon in which the presence of cues (i.e., part of the set of to-be-recalled information) influences recall. Part-set cuing inhibition, in particular, describes the presence of cues resulting in a lower performance in recall tasks. The generation effect refers to the finding that, when people are actively involved in creating or generating to-be-recalled information (e.g., solving the fragment, "madne_s" to "madness"), they tend to remember that information better than when that information is merely read. Only a few studies have examined the joint influence of part-set cueing and generation, and these studies have not produced consistent results. The present two experiments explored this combination of variables. Both experiments showed that the magnitude of part-set cueing inhibition did not differ across the read and generated conditions. The implications of these results with present theories of part-set cueing are discussed.

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LAKE FOREST COLLEGE

Senior Thesis

The Influence of Generation & Part-Set Cueing on Memory

by

Alexa N. Hemmer

April 15, 2016

The report of the investigation undertaken as a Senior Thesis, to carry one credit in the
Psychology Department and one credit in the Neuroscience Program

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Krebs Provost and Dean of the Faculty

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Abstract

Part-set cueing describes the phenomenon in which the presence of cues (i.e., part of the set of to-be-recalled information) influences recall. Part-set cuing inhibition, in particular, describes the presence of cues resulting in a lower performance in recall tasks. The generation effect refers to the finding that, when people are actively involved in creating or generating to-be-recalled information (e.g., solving the fragment, "madne_s" to "madness"), they tend to remember that information better than when that information is merely read. Only a few studies have examined the joint influence of part-set cueing and generation, and these studies have not produced consistent results. The present two experiments explored this combination of variables. Both experiments showed that the magnitude of part-set cueing inhibition did not differ across the read and generated conditions. The implications of these results with present theories of part-set cueing are discussed.

Dedication

This thesis is dedicated to my parents, for without their unconditional love and support, none of my successes, academic or otherwise, would have been possible.

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I would like to thank Dr. Kelley for his endless guidance and support that made this thesis possible. Words cannot express my gratitude. I would also like to thank my committee, Dr. Dohrmann and Dr. Houde, for their assistance in this process.

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Introduction

When provided with the option, most students would prefer to take a test with hints. Students commonly believe that being given hints will help them remember the information needed on the test and ultimately improve their grade. However, research has shown that hints can often hurt memory (e.g., Basden & Basden, 1995; Bauml & Aslan, 2006; Nickerson, 1984). Contrary to popular belief, the presence of certain kinds of hints, known as part-set cues, inhibits memory performance. In order to study this effect, participants in an experiment are asked to study a long list of words. Then, when the participants are tested via free recall, they are either given a part of the original series of words as cues at test or they receive an uncued free recall test. Those participants who are given cues perform worse than those who are not given any cues at all. In other words, part-set cueing inhibition is commonly found with a free recall task.

The initial finding of cues having an inhibitory effect on free recall came from Slamecka in 1986. In a series of experiments, Slamecka had participants review 30-item word lists two times and then asked the participants to recall as many words as possible. Those who received part-set cues at test recalled a significantly smaller proportion of the remaining words than those who were given no cues at all. Another interesting finding from these studies was that the number of cues given appeared to have no effect. That is, the mere presence of any part-set cues had an inhibitory effect and the total number of cues did not matter.

Part-set cueing inhibition has been found using both categorized and uncategorized word lists. Roediger (1978) conducted an experiment in which participants were first asked to study a series of categorized word lists, and then were later asked to recall these lists. These categorized lists consisted of 8 blocked words all coming from a

similar grouping (e.g., a kitchen utensil, a fruit, a city, etc.). In one condition, the

participants were given some (but not all) of the category names from the study portion

as cues during recall and were asked to recall as many words as they could from all lists.

These recalled significantly fewer words than the control group who received no cues at

all. The fully cued group also performed worse than a group that received some category

names but were asked to recall words that were not in those categories. The finding that

cues are inhibitory during free recall tasks has been replicated across a variety of designs

over the last forty years (Allen, 1969; Bauml & Aslan, 2006; Parker & Warren, 1974;

Roediger et al., 1977).

Early Explanations & The Strategy Disruption Hypothesis

Several hypotheses have attempted to explain part-set cueing inhibition, each with

various amounts of empirical support (e.g., Basden & Basden, 1995; Bauml & Aslan,

2006; Roediger, Stellon, & Tilving, 1977). One early hypothesis developed by Roediger

and Tolving (1974) is known as the editing task hypothesis. This hypothesis suggests that

the presence of cues causes participants to check if their responses have already been

provided. This extra time and energy spent checking has an inhibitory effect because

participants run out of time before all information can be recalled. The editing task

hypothesis received limited support: a number of studies have shown that when

participants are given an adequate amount of time to respond, the extra burden of

checking the cues did not affect overall recall and performance (e.g., Roediger, Stellon, &

Tulving, 1977). If anything, the cues would merely slow down the participant rather than

negatively impacting overall recall.

Another early theory, known as the increased-list-length hypothesis (Watkins,

1975), suggested that the presence of cues essentially increases the overall length of the

list a participant is asked to recall, making it more difficult to recall any of the words on the list in total. The overall number of items recalled typically decreases as the list size increases, which is presumably the basis for this hypothesis. As with the editing task hypothesis, the increased-list-length hypothesis has little empirical support and is not considered a viable explanation (e.g., see Nickerson, 1984).

One of the most widely accepted explanations of part-set cueing inhibition is the strategy-disruption hypothesis (e.g., Basden & Basden, 1995). According to this hypothesis, cues hinder a participant's ability to use his or her desired retrieval strategy, and the presence of cues disorganizes items in memory when trying to recall words from a given list. For example, participants are originally led to believe they will be later tested on the entirety of a word list. Thus, participants create their own plan to best recall all of the words on the list. When the participants are later provided with part of the list as cues during the test, the presence of cues often leads them to deviate from their original retrieval plan, which is disruptive. Without cues, the original retrieval plan can be carried out effectively and memory is relatively better than in the cued condition.

In an attempt to test the strategy disruption hypothesis, Basden and Basden (1995) designed four separate experiments. In their first experiment, the participants studied categorized lists presented in two columns. Half of the participants were instructed to subcategorize the two columns, while the other half of the participants received no such instructions. The belief was that those who were given instructions to subcategorize would experience less inhibition from cueing compared to those who did not receive any instructions. Receiving an entire column as a cue would also be less inhibitory for those who categorized the columns during the study portion of the task. Basden and Basden found that when cued with a whole column, the participants who were instructed to subcategorize the list during study experienced no significant inhibition when given a

cue. Participants who did not receive these instructions during the study portion did, however, experience significant part-set cueing inhibition because their strategy was disrupted.

In another experiment conducted by Basden and Basden (1995), participants were divided into three experimental conditions. One set of participants was placed in a control condition where they were given no cues. A consistent control group received the cues, however; the participants were made aware that these cues would be present prior to the start of the experiment. Finally, the inconsistent cues group received cues at test that were different from those described during the initial instructions. Basden and Basden hypothesized that the inconsistent cue group would experience part-set cueing inhibition, while the consistent cue group would not. The results of this experiment confirmed their hypotheses, and provided further support for the strategy disruption hypothesis of part-set cueing inhibition.

In conclusion, Basden and Basden (1995) found support through several experiments for the strategy disruption hypothesis. Inhibition was found significantly during the test portions of Basden and Basden's experiments when the cues disrupted the participants' retrieval strategies and this inhibition disappeared when the cues at test were removed. The presence of cues at test may cause participants to discard the retrieval strategy originally designed during the study portion and resort to a less effective strategy in order to recall.

Part-Set Cueing Facilitation

Despite the prevalence of part-set cueing inhibition, this is not the only effect of part-set cues, as multiple experiments have demonstrated the more intuitive effect of part-set cueing facilitation. For instance, in order to investigate the effects of part-set cueing

when recalling items in a particular order, Serra and Nairne (2000) showed participants a series of words, followed by a distractor task. The participants were then asked to complete either a cued or uncued reconstruction of order task in which they were given the words in a new random order and asked to replace those items into their original serial positions. On cued tests, half of the words were already placed in their original positions, whereas on uncued tests, half of the positions contained Xs and the remaining words were to be reconstructed. In contrast to previous part-set cueing inhibition findings, the presence of cues at test during this experiment aided in performance (i.e., part-set cueing facilitation).

In a follow up experiment, Serra and Nairne (2000) showed that accuracy of the cues strongly influenced reconstruction performance. In addition to uncued and consistent-cue trials (as in Experiment 1), they also provided inconsistent-cue trials where the cue words were placed in incorrect locations in an attempt to determine whether these cues would disrupt the way in which participants recalled the lists. They reported that participants relied on associative information to recall items in a certain order so that the inconsistent cues produced an inhibitory effect, whereas the consistent cues produced facilitation. These results support the strategy disruption hypothesis because, in a serial memory task, consistent cues are congruent with a person's serial associative strategy (which does not disrupt memory), but inconsistent cues are not congruent with the serial associative strategy, so memory is disrupted.

Cole, Reysen, and Kelley (2013) set out to determine what effect (if any) part-set cues had on performance when the task dealt with spatial information as opposed to recalling or reconstructing word lists. In Experiment 1, participants viewed the assembly of a snap circuit object and then were asked to recreate the object using the snap circuits. The participants were either in a cued group, in which the board they were given during

the test portion had some of the pieces already in their correct locations, or an uncued group, in which the board they received was blank and the task was to place all of the pieces in their correct location. They found significant part-set cueing facilitation during this spatial memory task, providing evidence that cues aid in the recall of spatial locations.

Experiment 2 further examined the influence of the type of cue provided to the participants. As in Experiment 1, there was a full cue condition (proper piece in proper location) and no cue condition, but Experiment 2 also provided a third cue option provided location-only information (no piece identity). Cole et al. (2013) hypothesized that the fully cued participants would significantly outperform the uncued performance, as seen in Experiment 1, and that the location cues would result in performance better than having no cues at all, but the location cues would not be as facilitating as full cues. The results were consistent with these predictions. This suggests that the presence of full cues provided hints that were most consistent with the retrieval strategies developed by the participants, but even the location-only cues were reasonably consistent and enhanced performance.

The Two-Mechanism Explanation of Part-Set Cueing

Bauml and Aslan (2006) focused on a two-mechanism approach to explain part-set cueing effects. The first mechanism, called strategy inhibition, occurs when the presence of cues disrupts a person's ability to retrieve items from memory because the manner in which the cues are presented is not consistent with the manner in which the participant originally intended on retrieving them. This mechanism is essentially the same as Basden & Basden's (1995) retrieval strategy disruption hypothesis. The second mechanism is retrieval inhibition. Retrieval inhibition suggests that as cue words are

presented, the person begins retrieving these cued words from memory without being aware of it. While the cue words are being retrieved, this stops a person's ability to retrieve the noncue words to complete the list (which is the purpose of the task—recalling the remaining noncued words). The cue words, in a sense, block the retrieval of the noncue words. In situations with a high degree of interitem associations, they hypothesized the degree of strategy disruption will determine whether inhibition or facilitation occurs. Interitem associations describe the degree to which one can easily make connections among the items in the list or how commonly words are found together. However, when there is a lower degree of interitem association, they suggested that retrieval inhibition drives performance and will lead to part-set cueing inhibition.

To extend upon this, Bauml and Aslan (2006) noted that forgetting should be short-lived in situations with a high degree of interitem associations. When words are not recalled, this is due to the inability to use appropriate retrieval processes. If the cues are removed, the words should then be recalled because preferred retrieval processes can be deployed without the burden of the cues. Forgetting, or the inability to recall previously studied information, will be more long-lived in situations that involve a small degree of interitem association because retrieval inhibition is to blame for the forgetting, and retrieval inhibitions has been previously shown to cause more long lasting effects on recall.

In order to test these hypotheses, Bauml and Aslan (2006) conducted a series of experiments in which participants were given lists that contained items with low interitem associations or high interitem associations. After studying the lists, participants were given tests first with cues and then a test without any cues. The first test with cues was given to determine whether any short-term forgetting was present and to provide evidence for participants' inability to use appropriate retrieval processes. The second test

with no cues was given to determine whether the inhibition of cues would be eliminated, as predicted above. These experiments showed that in the presence of cues, forgetting was short-lived in the groups with high interitem associations, however, the inhibitory effect did not occur in the second test when no cues were present. In the groups with item lists that contained a low degree of interitem associations, the forgetting continued even after being tested with no cues and the retrieval inhibition prevailed. This suggests that the degree of interitem associations impacts the type of encoding during the study phase and has an effect on retrieval at test. Therefore, the addition of the second mechanism seems to have helped to explain data that would have been difficulty for strategy disruption alone.

The Generation Effect

The generation effect is the enhancement in recall of words that require self-generation on the part of the person studying (e.g., Mulligan, 2002; Mulligan, 2004; Slamecka & Graf, 1978). In other words, when one is required be actively involved in creating the to-be-remembered information, the probability of later recalling that word is increased relative to non-generated information. In typical generation tasks, participants are given a word with some letters missing (e.g., FR_G) that requires generation or they are simply asked to read an intact word (e.g., FROG), which does not require generation. On a later test, participants will recall more generated words than read words (e.g.,Greenwald & Johnson, 1989; Mulligan, 2002; Slamecka & Graf, 1978).

Slamecka and Graf (1978) conducted five experiments in which participants were tested on their ability to recall words they generated themselves, as well as words they only read. In the generated condition, the participants were shown the first letter of the target word (e.g., rapid-f), while the read condition was shown both words completed

(e.g., rapid-fast). Throughout the five experiments, participants consistently recalled generated words at a significantly higher rate than those words that were read during study. Participants were better able to recall generated words when given hints during test (cued recall), as well as when no hints were present (free recall).

In a series of 12 experiments, Neil Mulligan (2004) set out to determine how the generation effect influences both item memory and context memory. To do so, participants studied lists of paired words where some of the words needed generation (hot-c___), while others were only read (hot-cold). In Experiment 1, the color of the stimuli was varied during the study portion (change in the font color) and in Experiment 2 the presentation location of the word was varied (either left or right side of the screen). Both experiments found that generation aided in the recall of the words themselves, however, the contextual information given during the study portion was negatively impacted by generation for information relating to color. That is, participants were less likely to recall the color of the text in which the word was presented when the item was generated rather than read. In contrast, generation did not influence recall recalling the location of the word; participants were neither helped nor hurt by generation. Consistently throughout the twelve experiments, Mulligan found that generation enhanced item memory, disrupted contextual color memory, and had no effect on contextual location memory.

One theory to explain the generation effect is the trade-off hypothesis (e.g., Jurica & Shimamura, 1999). This hypothesis suggests that generation induces participants to expend more encoding resources on the item itself during generation, and because of this, there are few encoding resources left over to for contextual information surrounding the item. Participants remember generated items at a higher rate because of the increase in item-specific encoding resources used when generating a word. Any information about

the context in which the word/item was presented, however, is not as strongly encoded and is thus recalled at a significantly lower rate during later tests.

This theory finds support from Serra and Nairne (1993), who conducted three experiments to determine what effect generation had on serial memory. In the first experiment, participants studied three lists: a list consisting of entirely read words, one consisting of entirely generated words, and a final lists that had a mix of generated and read words. Participants were then asked to complete a reconstruction of order task in which the studied words needed to be placed back in the order in which they were originally presented. Participants performed significantly better when reconstructing the order for the read words rather than generated (a negative generation effect), while the mixed list showed results worse than the entirely read list, however, better than the entirely generated lists.

In a follow-up experiment, participants were given a free-recall test on the three studied lists prior to the reconstruction task. During free recall, participants recalled significantly more words from the read-only list than the generated-only lists, and a positive generation effect was seen for the generated words in the mixed lists. In other words, when the mixed list words were freely recalled, the generated words within that mixed list were recalled at a significantly higher rate. During the reconstruction task, the results from Experiment 1 were replicated in that the read-only list words were reconstructed significantly better than the generated-only words. These two experiments show that generation has a negative impact on the memory of order information, further supporting previous findings that generation disrupts one's ability to recall contextual information. Generation appears to cause participants to focus too much on item-specific information, leaving the memory of contextual information (including serial order) difficult to encode and later recall.

Generation & Part Set Cueing

As mentioned previously, generation appears to enhance item specific processing, thus allowing participants to better remember the generated word in later recall tasks. Generation also, however, seems to impair one's ability to process relational information as it pertains to the target word. Generation, then, might have interesting implications if combined with part-set cueing, especially when considering the predictions of the two-mechanism account. The two-mechanism account brings together two common theories of part-set cueing (strategy disruption and retrieval inhibition) together to form one comprehensive theory. The two-mechanism account explains that when word lists have a strong number of interitem associations, strategy disruption will drive performance in the presence of cues. In lists with weak interitem associations, however, retrieval inhibition will drive the decline in recall. A question arises from this account as to what happens when the word lists contain both read and generated words, when generation has been shown to disrupt a participant's ability to establish these associations among items.

To examine the effects of part-set cueing and generation on recall tasks, Muntean and Kimball (2011) conducted an experiment in which participants were split into two groups: standard encoding or generation. Those in the standard encoding group were shown a series of synonym pairs intact, while those in the generation group were shown a series of words and needed to type the appropriate antonym. These two groups were then further divided into another two groups based on test condition, in which one group received one-letter cues while the other group received half of an antonym pair as a cue. In the presence of cues, those in the generation group saw significant impairment compared to those in the read-only group. The problem with this study, however, is that no group underwent true free recall, which is the standard comparison group in the part-

set cueing literature. The participants were either given half an antonym pair or the first letter of a target word.

Basden, Basden, Church, and Beaupre (1991) conducted two experiments in which part-set cueing and generation were combined to assess their influence on recall. In the first of two experiments, Basden et al. examined the effects of encoding type (read or generate), the presence of cues (uncued or cued tests), and the type of test (fragment completion or free recall). The results found no significant effects of generation on later recall. Performance during the recall tasks was not significantly impacted by generation. That is, those who were required to generate test items did not perform any better or worse than those participants who only read the items during study and the type of test did not matter either. The lack of a generation effect in these experiments was surprising given that it is such an easily replicable effect. Cues, however, significantly reduced performance during free recall test and not the fragment completion tests. These last results support the strategy disruption theory, as cues only hindered performance on free recall.

The Present Experiments

Although previous research has attempted to examine the effects of part-set cueing and generation when used together (e.g., Basden et al, 1991; Del Missier & Terpini, 2009; Muntean & Kimball, 2012), the answer to the question of how generation influences part-set cueing remains unclear. These studies produced contradictory results and used methods that were either overly complex, incomplete, or were only peripherally related to the key question. The purpose of the present study is to examine the effects of part-set cueing and generation tasks on recall performance using a cleaner design to more clearly answer the question at hand. In this study, participants were shown lists of items

consisting of both complete (read) words as well as fragmented (generated) words, and they had to read and generate the items aloud as they were presented. On some trials, participants received an uncued recall test, whereas on other trials, they received a cued recall test. Based upon the predictions of the two-mechanism approach (Bauml & Aslan, 2006) and the trade-off hypothesis (e.g., Jurica & Shimamura, 1999), we expected that part-set cueing inhibition would be stronger with the items that needed to be generated during the study portion of the experiment than those words that were not fragmented. According to these theories, retrieval inhibition should drive performance in the generation condition because the interitem associations will be weak as a result of the generation trade-off. In contrast, the strategy disruption mechanism will drive performance in the read condition because the interitem associations should be relatively stronger.

Experiment 1

In order to test the effects of both part-set cueing and generation on recall performance, participants were shown four PowerPoint presentations and presented with a recall test after the completion of each individual presentation. Half of the words on each PowerPoint were fragmented and were presented with one letter missing (e.g., fr_g), whereas the other half of the words were presented with no letters missing (e.g., frog). The participants were asked to read each word aloud as it was shown, filling in the correct missing letter when required. The participants were then given one of two types of test: cued or uncued. For the cued test, a random half of the words were given back as cues. For the uncued test, participants were simply asked to write down as many words as they could recall with no hints given. As explained above, we predicted that part-set cueing inhibition would be higher for the generated words than the read words, with the number of generated words declining in the presence of cues.

Method

Participants & Setting

Forty eight students enrolled in an introductory psychology course at Lake Forest College participated in this experiment and received extra credit as compensation. Participants observed the slideshows seated at one computer desk, and then completed the test portions at separate desk cubicles stationed around the room.

Materials & Design

The study utilized a 2 (word presentation type: fragment, complete) x 2 (test type: cued, uncued) repeated-measures, within subjects design. One hundred forty four words and their corresponding fragments (with one letter missing) were randomly selected from the materials used by Kelley & Nairne (2001). These 128 words were randomly divided

into four lists of 32 words each on which a random half of the words were presented in their complete form, while the other half appeared as fragments (see Appendix A). Each list of these four lists was counterbalanced such that fragmented words appeared in their complete forms and vice versa. The word presentations were created using Microsoft PowerPoint. Black text was presented on a white background in Calibri font, size 44.

On a cued test, participants received a paper with instructions and half of the words were given back as cues. Eight of the 16 words provided as cues were completed words from the study portion, while the other 8 cues were words that were fragmented and required generation during study (see Appendix D). Participants were asked to recall the words not listed. For the uncued test, participants received a paper that only included instructions (see Appendix C). The participants were allowed to freely recall the original list items anywhere on the paper. The lists and tests were balanced using a Latin square to ensure that for every 16 participants all list and test type combinations had been delivered once.

The distracting activity (digit shadowing) consisted of 20 PowerPoint slides, each containing twenty single digit numbers, each presented for 0.8 seconds.

Procedure

After the consent form was completed and the instructions pertaining to the experiment were delivered, participants began the first of four trials. On each trial, the participant viewed a presentation containing thirty-six words (target activity) and twenty numbers (distracting activity). Each word was presented for 2 seconds and participants were asked to read each word and complete each fragment aloud. Immediately following the final word, the distractor task began. Participants were asked to read each digit as it appeared on the screen. As the participants read the words aloud, the

experimenter kept track of whether the word was correctly pronounced and made note of any incorrect pronunciations.

Upon completion of the distracting task, participants were instructed to move to the appropriate desk cubicle to complete the test portion of the trial. The test required the participants to freely recall as many words from the presentation as possible (i.e., 32 words on uncued trials; 16 words on cued trials). The participants were given 90 seconds per test. The entire experiment required roughly twenty minutes for the participants to complete.

Scoring

The participants were scored on their performance reading and generating the words during the presentation phase, as well as on how many words were recalled during the test phase. When scoring the recall tests, participants were only given credit for recalling the exact word that was presented during the study portion of the experiment; participants did not receive credit for misspelled words. Cued tests were scored out of 16 items, because 16 of the 32 had already been provided as cues leaving 16 possible words to recall. The uncued tests were scored out of 32 because no words were provided during the test. These data are referred to as the "unconditional" data.

A separate "conditional" data set was created that included only those words that were correctly read or generated during the presentation phase. The logic is that, if a person missed a word completely during presentation (e.g., failed to read *frog* or generate *fr_g*), then they should not be able to recall that item later because it was not encoded in the first place. By eliminating these encoding failures, one can be more confident that a memory error at test was the result of faulty retrieval. This is especially important for the generated items, which were more prone to error during the presentation phase. The generated items were incorrectly pronounced during the presentation phase 9.68% of the

time, while the words with no letters missing were incorrectly pronounced, on average, 0.61% of the time.

Results and Discussion

Figure 1 displays the mean proportion correct as a function of word presentation type and test type for the unconditionalized data (top panel) and conditionalized data (bottom panel). Two separate 2 (word presentation type) x 2 (test type) repeated measures ANOVAs were used to analyze the data—one for the unconditional data and one for the conditional data.

In the unconditional ANOVA, there was a significant main effect of test type, $F(1, 47) = 55.899$; $p < .001$; $\eta^2 = .543$. Overall, participants showed part-set cueing inhibition—proportion of words recalled was higher on uncued tests (.19) as compared to cued tests (.09). There also was a significant main effect of word presentation type, $F(1, 47) = 6.941$; $p < .05$; $\eta^2 = .129$. Participants showed a small, but significant, positive generation effect where the generated items (.16) were recalled more often than read items (.13). The test type x word presentation type interaction failed to reach statistical significance, $F(1, 47) = 3.643$; $p > .05$; $\eta^2 = .072$.

In the conditional ANOVA, there was a significant main effect of test type, $F(1, 47) = 49.87$; $p < .001$; $\eta^2 = .515$. Overall, participants showed part-set cueing inhibition—performance was higher on uncued tests (.20) as compared to cued tests (.10). There also was a significant main effect of word presentation type, $F(1, 47) = 14.85$; $p < .001$; $\eta^2 = ..240$. Participants showed a significant positive generation effect where the generated items (.18) were recalled more often than read items (.13). The test type x word presentation type interaction again failed to reach statistical significance, $F(1, 47) = 3.669$; $p > .05$; $\eta^2 = .072$.

As expected, Experiment 1 replicated the classic findings of part-set cueing inhibition and the generation effect, which provides confidence in the procedure. The lack of significant interactions between test type and word presentation suggests that the magnitude of part-set cueing inhibition was similar for both the generation and read items. Inhibition of roughly 8-12% was present for both word presentation types. Unfortunately, overall performance was quite low, which opens up concerns about a potential floor effect. If a floor effect is present, scores too low to an absolute zero would make detecting a significant variance within the scores difficult. In order to address this possibility, Experiment 2 was designed to eliminate any concerns about floor effects by modifying the design to make the task a bit easier. Namely, in Experiment 2, the number of words presented in the study portion of the experiment was reduced and the distracting activity was shortened.

Experiment 2

Following a similar procedure to Experiment 1, the present experiment examined the effects of word presentation type (fragmented or complete) and test type (cued or uncued) on recall performance in a memory task. The purpose of Experiment 2 was to address the floor effects seen in Experiment 1. In an attempt to increase participant performance, the number of words seen during each study trial was cut down from 32 to 24 and the length of the digit distractor task was cut in half (from 20 to 10 digits) (see Appendix B). Based on the results seen in Experiment 1, both part-set cueing inhibition and a generation effect are expected, and there should be no interaction.

Method

Participants & Setting

Forty-eight introductory psychology students from Lake Forest College received extra credit in exchange for their participation. Participants viewed the PowerPoint presentations on a desktop computer, and then moved to cubicle desks to complete the test portion of the experiment.

Materials

Ninety-six words and their fragments (one letter missing) were again randomly selected from the materials used by Kelley & Nairne (2001). These ninety-six words were then divided into four lists, each consisting of 24 words total. Half of these words were presented as fragments to the participant, while the other half remained intact. All remaining presentation details were the same as those described in Experiment 1. The cued tests for Experiment 2 contained 12 cues total. Six of these cues were presented with one letter missing, while the other six were previously presented as whole words. The

uncued tests had no cues and simply instructed the participants to recall as many words as possible. Similar to Experiment 1, the conditions were counterbalanced.

Procedure

With the exception of the number of words presented being reduced from 32 to 24 and the shortened distractor task, the procedure for Experiment 2 was identical to that of Experiment 1.

Scoring

The unconditional and conditional scoring criteria used in Experiment 1 were used again in Experiment 2, with the exception that cued tests were scored out of 12 items, because 12 of the 24 had already been provided as cues leaving 12 possible words to recall. The uncued tests were scored out of 24 because no words were provided during the test.

Results & Discussion

Figure 2 displays the mean proportion correct as a function of word presentation type and test type for the unconditionalized data and the conditionalized data. Two separate 2 (word presentation type) x 2 (test type) repeated measures ANOVAs were used to analyze the data—one for the unconditional data and one for the conditional data.

In the unconditional ANOVA, there was a significant main effect of test type, $F(1, 47) = 27.646$; $p < .001$; $\eta^2 = .370$. Overall, participants showed part-set cueing inhibition—performance was higher on uncued tests (.23) as compared to cued tests (.15). There also was a significant main effect of word presentation type, $F(1, 47) = 11.471$; $p < .001$; $\eta^2 = .200$. Participants showed a significant positive generation effect where the generated items (.22) were recalled more often than read items (.16). The test

type x word presentation type interaction failed to reach statistical significance, $F(1, 47)$ = .046; $p > .05$; $\eta^2 = .001$.

In the conditional ANOVA, there was a significant main effect of test type, $F(1, 47) = 26.717$; $p < .001$; $\eta^2 = .362$. Overall, participants showed part-set cueing inhibition—performance was higher on uncued tests (.24) as compared to cued tests (.16). There also was a significant main effect of word presentation type, $F(1, 47) = 16.333$; $p < .001$; $\eta^2 = .258$. Participants showed a significant positive generation effect where the generated items (.24) were recalled more often than read items (.17). The test type x word presentation type interaction again failed to reach statistical significance, $F(1, 47) = .166$; $p > .05$; $\eta^2 = .004$.

Participants in Experiment 2 performed marginally better than those in Experiment 1—shortening the number of words seen during the presentation phase made it somewhat easier for participants to recall a higher number of total words during the test phase. This increase in performance moved away from floor effects; however, performance was still lower than was expected. Experiment 2 replicated similar patterns to Experiment 1 for both the unconditional and conditional data. Part-set cueing inhibition was present in both experiments, as well as a significant generation effect in both experiments. However, the size of the part-set cueing inhibition did not depend on the word presentation type- similar inhibition was seen for both read and generated words. Experiment 1 and Experiment 2 yielded similar results with relatively similar margins, however, neither showed a significant difference in part-set cueing inhibition by presentation type as predicted. Part-set cuing inhibition by presentation type, though not significant, trended in the direction previously predicted. Part-set cuing inhibition was higher for generated words than for read, however; this difference was not statistically significant.

General Discussion

The purpose of the present study was to explore the effects of both part-set cueing and generation on recall performance. We hypothesized that the presence of cues would hinder the ability to recall list items, especially for those items that were generated during the study phase. In the first of two experiments, participants were shown a PowerPoint in which 32 words in total were presented. Half of the words were missing one letter, requiring the participant to generate the word, whereas the other half were presented intact, requiring the participant to simply read the word. After a brief distractor task, the participants were asked to recall as many words from the presentation as they could. During this testing phase, half of the tests contained a set of words from the list as cues and the other half received no cues. Part-set cueing inhibition was present for both the generated and read items, causing a roughly 8-12% decrement to performance when cues were present. The magnitude of part-set cueing inhibition did not differ significantly across the generated and read conditions. Concerns regarding a potential floor effect arose during Experiment 1, as participant performance was quite low.

Experiment 2 was conducted in an attempt to address the concerns regarding floor effects. The procedure for Experiment 2 mirrored that of Experiment 1, however; the number of items presented to participants was reduced to 24 and the length of the distracting activity was reduced with the hopes that performance on later tests would improve. Overall performance in Experiment 2 increased by 5%, which suggests that the changes made the task marginally easier. The results of Experiment 2 replicated those found in Experiment 1 in that part-set cueing inhibition and generation effects were observed in both experiments. Further, Experiment 2 did not yield a significant difference in magnitude of part-set cueing inhibition as a function of the type of word presentation (read vs. generated).

This study yielded results unable to support the original hypothesis. We had originally hypothesized that generation would influence the size of the part-set cueing inhibition effect, in that inhibition would be higher for generated words, however; there was no significant evidence of this in the data. The results showed a trend towards part-set cuing inhibition resulting in lower recall performance for generated words compared to read words, though this trend was not significant meaning the hypothesis could nto be fully supported. Floor effects remain a concern, as performance on both experiments was lower than would be desired in the selected task. If floor effects were present, poor performance could hinder the ability to accurately detect relative differences in the magnitude of part-set cueing across the read and generated conditions.

Future Directions of Part-Set Cueing and Generation Work

The purpose of this study was to provide further insight into the effects of part-set cuing and generation effect in combination on item recall. Previous research utilized methods that were quite complex, incomplete, or unsuccessful in answering the question at hand. In the study conducted by Muntean and Kimball (2011), participants studied word pairs. To manipulate generation, Muntean and Kimball required those in the generation condition to come up with and type the antonym of the cue word to complete the pair. The issue with their study, however, was that participants were never tasked with recalling list information in a free recall task. Similarly, Basden, Basden, Church, and Beaupre (1991) utilized word pairs in which those in the generation condition needed to generate the target word associated with a cue. In contrast to Kimball and Muntean, Basden et al. utilized a cued association test condition as well as a free recall testing condition. These studies both used fragment completion tasks during testing, which leaves a question remaining regarding what effect part-set cuing and generation have on

memory in tasks that do not use fragment completion during a cued trial. This question motivated the current experiments.

The current study used simpler methods for manipulating both part-set cueing and generation. Previous research has shown a mixture of results, leaving the answer to what impact on memory generation and the presence of part-set cues have still unanswered. The present study hypothesized that par-set cuing inhibition would be higher for generated words due to the lowered amount of interitem associations among generated words compared to read. Muntean and Kimball (2011) found that the presence of cues caused a greater inhibition for generated words. In contrast, Basden et al. (1991) found that the presence of cues impacted both read and generated words equally. The results of the current experiments mirror those found by Basden and colleagues. Though the present results are similar to those found by Basden et al, both studies yielded results that are contradictory to those found by Muntean and Kimball. Therefore, further research is critical to provide greater support for the results found in the present study and to determine whether these results can be replicated further.

Future studies can be designed in order to improve upon the current study, as well as expand upon previous research concerning generation and part-set cueing. In order to address concerns regarding a potential floor effect in the present study, future studies can be designed in an attempt to raise overall participant performance to better detect significant differences. The words within Kelley and Nairne's (2001) list are rated for things such as concreteness, imageability, and frequency. Higher values on these criteria tend to lead to better memory. Though all of the words within the list used in the present scored relatively high on these criteria, one could ensure that only the words that scored the highest were used in a future study procedure. One may wish to eliminate the distractor task entirely in order to improve participant performance. The lack of distractor

separating the study and test portions should allow participants to more readily recall the words studied. Following a methodology similar to that implemented in this study and making the changes mentioned above, hypotheses can be formulated using the two-mechanism approach and predict that part-set cueing inhibition will be present for both read and generated words; however, the inhibition seen for generated words will be amplified.

Further replications of the current study are also needed to determine if the results were an anomaly or a reoccurring theme. The present experiments yielded results that do not fit a relatively popular explanation for part-set cueing inhibition. In particular, one would expect that inhibition in the presence of cues would be amplified for words that were generated due to the lower interitem associations. The current study found that the amount of part-set cueing inhibition did not differ between read and generated words. It is possible that the present study's manipulation of generation was too weak. If this occurred, participants would not encode the generated and read words differently, which would explain the lack of difference in part-set cuing inhibition. The main effect for generation was present, however; it was a very small advantage. This may suggest that the manipulation was relatively weak. In order to increase the generation manipulation, one could increase the number of missing letters (possibly eliminate two or three letters as opposed to one) to elicit more effort on the part of the participant and possibly lead to a larger difference in part-set cuing inhibition.

Previous research in part-set cueing utilized word pairings during study phases of experiments as a method of examining effects of cues on recall performance (Mulligan, 2004; Slamecka & Graf, 1978). For example, participants may be presented with ANIMAL-HORSE, where HORSE will be the target word during the recall task. A future study could implement a similar design in which participants either study whole pairings,

as shown above, or fragmented pairings in which the second, or target, word is missing a letter. Because the target words are fragmented, participants would be required to come up with the correct missing letter in order to complete the word while studying. During the test condition, participants may receive entire pairs as cues. For example, a participant may receive the first, third fifth, etc., pairings as cues and be asked to recall the remaining items from the previously studied list. Previous studies have used this pairing design, however, this study would use entire pairings as cues rather than providing half of a pair as a cue and requiring the participant to recall the remaining half of the pair. Other research using this design has also left out a free recall condition, which would be present in this study (Muntean & Kimball, 2011). The pairings would elicit higher interitem associations among the words within a list, in which case cues would facilitate recall performance. One might wonder, however, how the presence of generated words would impact these associations and ultimately impact recall on a cued test.

Although the present studies were designed to answer the research question at a behavioral level, one could study these phenomena and memory in general at a neurological level utilizing imaging techniques, such as functional magnetic resonance imaging (fMRI). Some research has made attempts to better understand the neural underpinnings of both part-set cueing and generation effects, although not in the same study. For example, Crescentini, Shallice, Del Missier, and Macaluso (2010) asked participants to study two 16 pair word lists. In the high encoding condition, participants were allowed to practice the material, whereas in the low encoding condition participants were not. Participants were then tested either with or without part-set cues. The results of the fMRI indicated that part-set cueing effects were present only after low encoding, and this was seen in an increase in activity in the left frontopolar cortex and the right dorsolateral prefrontal cortex. Activity in these areas was not seen in those participants

who underwent the high encoding procedure. This study did not find part-set cueing effects for those participants in the high encoding condition. Further fMRI results indicated that varying encoding conditions yielded differing patterns of activation during retrieval, which suggested that different encoding processes have their own unique retrieval strategies.

In a recent study conducted by Rosner, Elman, and Shimamura (2013), the neurological basis of the generation effect was explored. Participants were shown word pairs that consisted of a cue word and a target word. For the generation condition, a letter was missing from the target word (QUARREL-F_GHT) and the participants were asked to complete the word with the proper letter. A separate set of participants viewed the same pairs, however; no letters were missing and the participant merely needed to read the words. All of the participants viewed these pairs while in a functional magnetic resonance imaging scanner. The neural images from the generated word condition revealed numerous areas activated during generation alone, including the inferior frontal gyrus, middle frontal gyrus, anterior cingulate cortex, precuneus, the intrapariteal sulcus, inferior temporal gyrus, and the lateral occipital cortex. The activation of these brain areas occurred in contrast to those activated when participants were unable to recall a given word. According to Rosner and colleagues, these areas are consistent with those related to refreshing or re-imagining items that had been recently presented. These findings outline the neural circuitry involved during generation tasks and help researchers better understand what mechanisms may be involved when participants are required to generate a word themselves as opposed to simply reading it.

These two studies mentioned above examine the neural correlates for part-set cueing and the generation effect as separate entities. Future studies might employ methods in which part-set cueing and generation effects are combined in order to

determine whether similar or varying brain activity patterns are seen. The current study could be replicated with the addition of fMRI to analyze both the effects of part-set cueing and generation at the behavioral level, as well as to determine what brain areas are active during the read versus generate portions and what areas are active in recalling these items. Participants would be placed in an fMRI scanner, and then view the word lists via PowerPoint. The neuroimaging would highlight the areas in use while participants attempt to encode the information as it is presented. The fMRI could then detail the brain areas in use while attempting to retrieve these items in a later recall task. Half of the participants from each encoding group (read versus generated) would then engage in an uncued recall task, in which they are simply asked to recall as many words from the previous list as they can. The other half of the participants would be placed in a cued test condition, in which part-set cues are present and participants are asked to recall the remaining words from the previously studied list. One may predict, based on the studies previously discussed, that the read and generated groups would display different neural activity patterns during encoding and retrieval. This finding would be due to separate encoding strategies being tied with different retrieval strategies.

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Figure 1

Figure 1 displays mean proportions recalled as a function of presentation type and test group type. The top figure displays means for Experiment 1 unconditionalized data, while the bottom figure displays means for Experiment 1 conditionalized data.
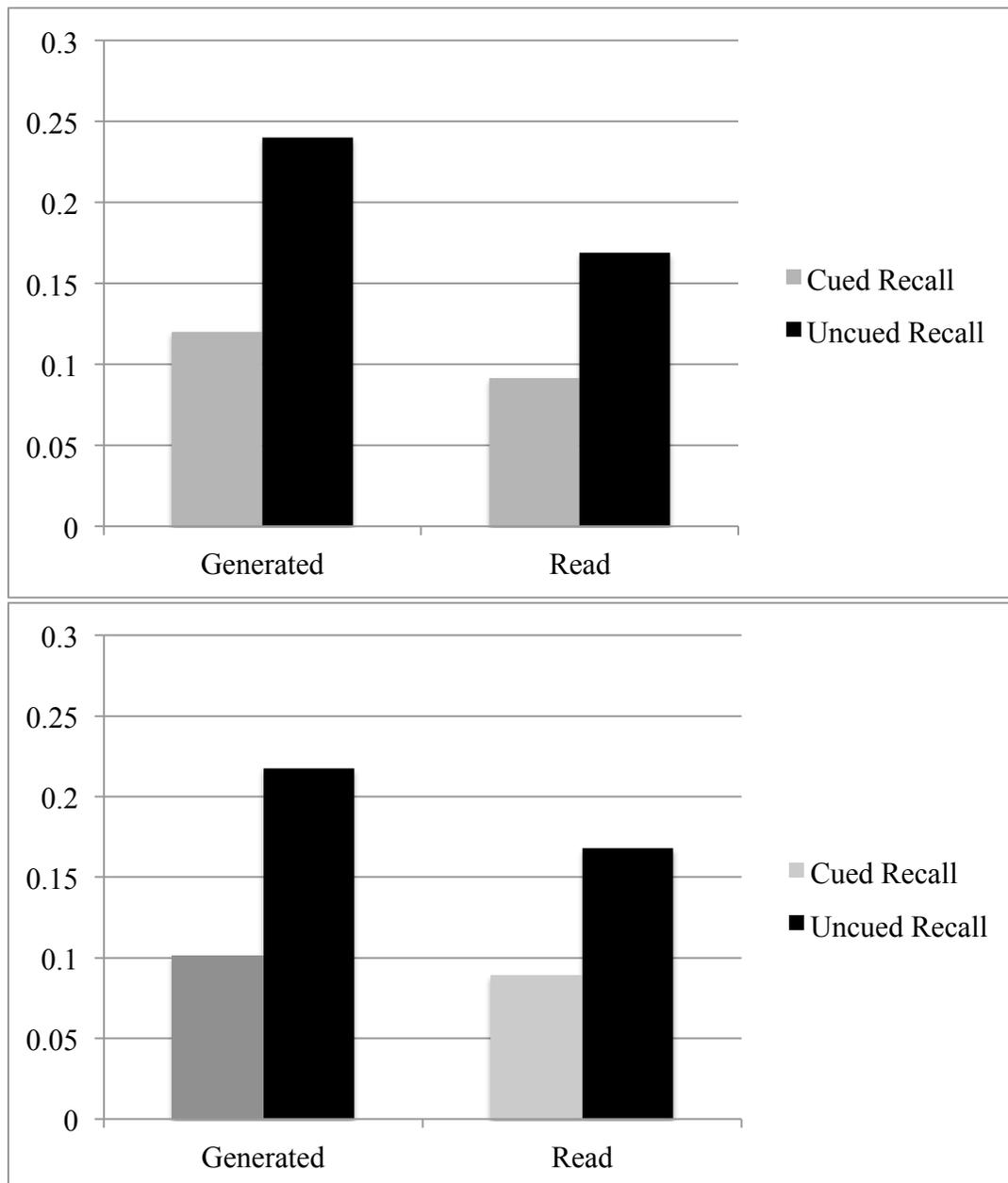
Figure 2

Figure 2 displays mean proportions recalled as a function of presentation type and test group type. The top figure displays means for Experiment 2 unconditionalized data, while the bottom figure displays means for Experiment 2 conditionalized data.
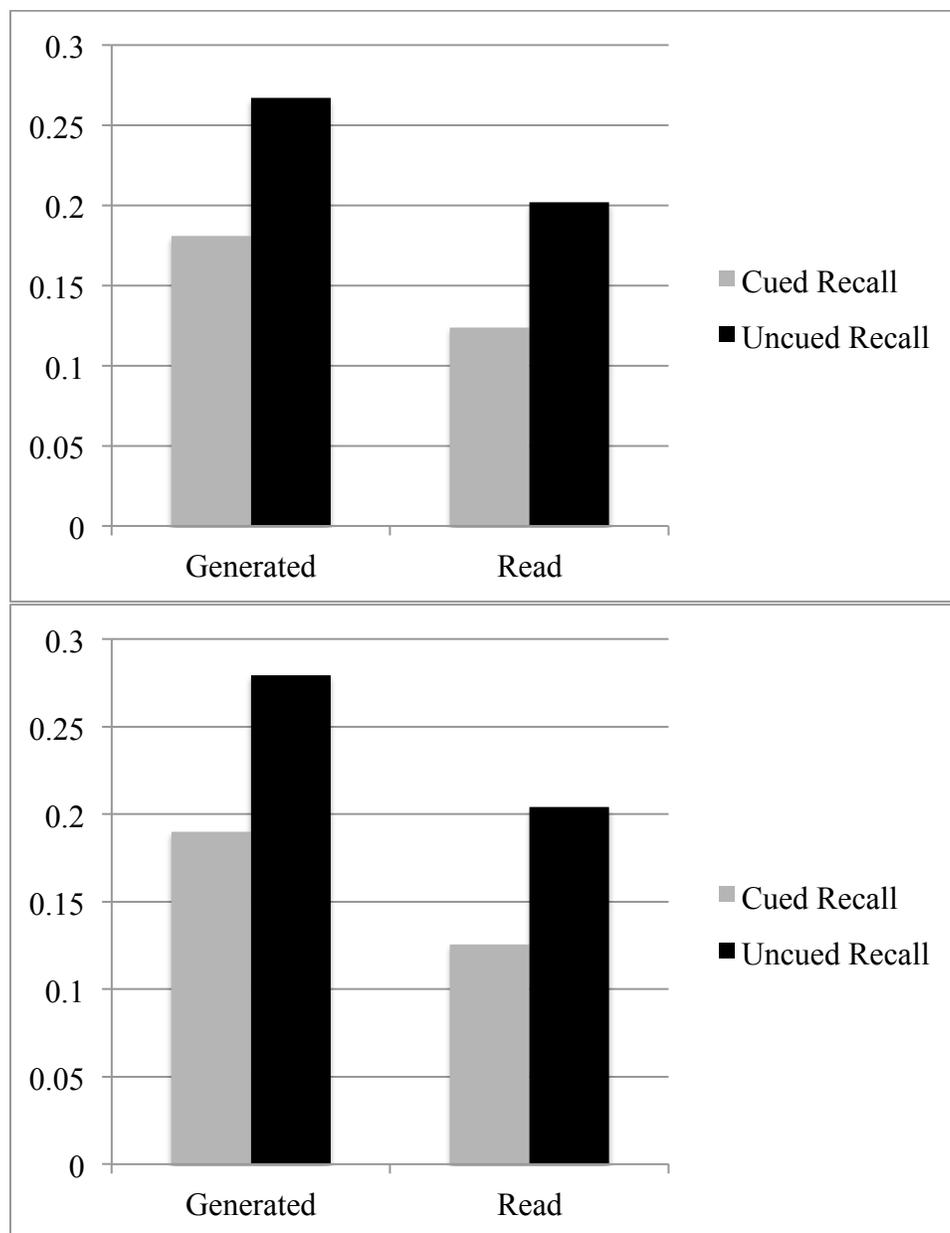
Appendix A

Experiment 1 Word Lists

List 1
1. Concept (con_ept)
2. Chance (ch_nce)
3. Demon (d_mon)
4. Mileage (m_leage)
5. Errand (er_and)
6. Tidbit (tidbit_)
7. Humor (hum_r)
8. Feline (fel_ne)
9. Effort (_ffort)
10. Episode (_pisode)
11. Quality (quali_ty)
12. Ability (_bility)
13. Justice (just_ce)
14. Boredom (_oredom)
15. Conquest (co_quest)
16. Anxiety (an_iety)
17. Venom (ven_m)
18. Belief (b_lief)
19. Spirit (sp_rit)
20. Moral (m_ral)
21. Power (p_wer)
22. Buffoon (b_ffoon)
23. Gender (g_nder)
24. Evidence (evidenc_)
25. Truth (tr_th)
26. Tribute (t_ibute)
27. Illusion (il_usion)
28. Length (_ength)
29. Heaven (heav_n)
30. Research (resea_ch)
31. Justice (just_ce)
32. Impact (imp_ct)
List 2
1. Context (cont_xt)
2. Moment (mome_t)
3. Charm (c_arm)
4. Agility (ag_lity)
5. Genius (g_nius)
6. Misery (m_sery)
7. Chaos (chao_)
8. Sonata (sonat_)
9. Deceit (_eceit)
10. Edition (ed_tion)
11. Welfare (w_lfare)

12. Thought (tho_ght)
13. Fantasy (fant_sy)
14. Hearing (h_aring)
15. Velocity (v_locity)
16. Madness (madne_s)
17. Owner (own_r)
18. Amount (amoun_)
19. Upkeep (_pkeep)
20. Folly (fo_ly)
21. Month (m_nth)
22. Dweller (dwell_r)
23. Answer (an_wer)
24. Nonsense (non_ense)
25. Adage (adag_)
26. History (_istory
27. Semester (semest_r)
28. Menace (m_nace)
29. Encore (_ncore)
30. Jealousy (jeal_usy)
31. Series (_eries)
32. Impulse (impuls_)

List 3

1. Fallacy (fal_acy)
2. Theory (_heory)
3. Shock (shoc_)
4. Alimony (alim_ny)
5. Safety (s_fety)
6. Speech (sp_ech)
7. Dream (dre_m)
8. Author (auth_r)
9. Malice (m_lice)
10. Miracle (mira_le)
11. Opinion (opinio_)
12. Essence (es_ence)
13. Dynasty (dyna_ty)
14. Chapter (chapt_r)
15. Vocation (vo_ation)
16. Science (sc_ence)
17. Pride (prid_)
18. Equity (eq_ity)
19. Advice (_dvice)
20. Honor (h_nor)
21. Quest (q_est)
22. Silence (silen_e)
23. Excuse (excu_e)
24. Quantity (qua_tity)
25. Greed (gre_d)
26. Mastery (mas_ery)
27. Pressure (p_essure)

28. Pledge (pl_dge)
29. Health (heal_h)
30. Strength (stre_gth)
31. Speech (sp_ech)
32. Boredom (_oredom)

List 4

1. Figment (figm_nt)
2. Method (me_hod)
3. Dream (dre_m)
4. Fortune (_ortune)
5. Oxygen (ox_gen)
6. Nephew (nep_ew)
7. Opium (opiu_)
8. Volume (vol_me)
9. Virtue (virtu_)
10. Perjury (perjur_)
11. Economy (_conomy)
12. Outcome (outcom_)
13. Gravity (gra_ity)
14. Freedom (free_om)
15. Mischief (mis_hief)
16. Preview (prev_ew)
17. Glory (gl_ry)
18. Origin (or_gin)
19. Memory (_emory)
20. Event (ev_nt)
21. Chasm (ch_sm)
22. Product (p_oduct)
23. Custom (cus_om)
24. Attitude (_ttitude)
25. Maker (mak_r)
26. Trouble (tr_uble)
27. Contents (con_ents)
28. Patent (pat_nt)
29. Hatred (hatr_d)
30. Homicide (h_micide)
31. Misery (m_sery)
32. Madness (madne_s)

Appendix B

Experiment 2 Word Lists

List 1

    33. Concept (con_ept)
    34. Chance (ch_nce)
    35. Demon (d_mon)
    36. Mileage (m_leage)
    37. Errand (er_and)
    38. Tidbit (tidbit_)
    39. Humor (hum_r)
    40. Feline (fel_ne)
    41. Effort (_ffort)
    42. Episode (_pisode)
    43. Quality (quali_ty)
    44. Ability (_bility)
    45. Justice (just_ce)
    46. Boredom (_oredom)
    47. Conquest (co_quest)
    48. Anxiety (an_iety)
    49. Venom (ven_m)
    50. Belief (b_lief)
    51. Spirit (sp_rit)
    52. Moral (m_ral)
    53. Power (p_wer)
    54. Buffoon (b_ffoon)
    55. Gender (g_nder)
    56. Evidence (evidenc_)

List 2

    33. Context (cont_xt)
    34. Moment (mome_t)
    35. Charm (c_arm)
    36. Agility (ag_lity)
    37. Genius (g_nius)
    38. Misery (m_sery)
    39. Chaos (chao_)
    40. Sonata (sonat_)
    41. Deceit (_eceit)
    42. Edition (ed_tion)
    43. Welfare (w_lfare)
    44. Thought (tho_ght)
    45. Fantasy (fant_sy)
    46. Hearing (h_aring)
    47. Velocity (v_locity)
    48. Madness (madne_s)
    49. Owner (own_r)
    50. Amount (amoun_)
    51. Upkeep (_pkeep)
    52. Folly (fo_ly)

53. Month (m_nth)
54. Dweller (dwell_r)
55. Answer (an_wer)
56. Nonsense (non_ense)

List 3

33. Fallacy (fal_acy)
34. Theory (_heory)
35. Shock (shoc_)
36. Alimony (alim_ny)
37. Safety (s_fety)
38. Speech (sp_ech)
39. Dream (dre_m)
40. Author (auth_r)
41. Malice (m_lice)
42. Miracle (mira_le)
43. Opinion (opinio_)
44. Essence (es_ence)
45. Dynasty (dyna_ty)
46. Chapter (chapt_r)
47. Vocation (vo_ation)
48. Science (sc_ence)
49. Pride (prid_)
50. Equity (eq_ity)
51. Advice (_dvice)
52. Honor (h_nor)
53. Quest (q_est)
54. Silence (silen_e)
55. Excuse (excu_e)
56. Quantity (qua_tity)

List 4

33. Figment (figm_nt)
34. Method (me_hod)
35. Dream (dre_m)
36. Fortune (_ortune)
37. Oxygen (ox_gen)
38. Nephew (nep_ew)
39. Opium (opiu_)
40. Volume (vol_me)
41. Virtue (virtu_)
42. Perjury (perjur_)
43. Economy (_conomy)
44. Outcome (outcom_)
45. Gravity (gra_ity)
46. Freedom (free_om)
47. Mischief (mis_hief)
48. Preview (prev_ew)
49. Glory (gl_ry)
50. Origin (or_gin)
51. Memory (_emory)

52. Event (ev_nt)
53. Chasm (ch_sm)
54. Product (p_oduct)
55. Custom (cus_om)
56. Attitude (_ttitude)

Appendix C

Sample Uncued Test Sheet

Please recall as many words as you can and you may write anywhere on the paper.

Appendix D

Sample Cued Test Sheet

Please recall as many words as you can and you may write anywhere on the paper. 12 of the words have been given back as cues to assist in your memory.

mileage
justice
humor
episode
chance
belief
evidence
conquest
errand
spirit
boredom
quality

Appendix E

Instruction Sheet

Thank you for your participation. In this experiment, you will complete four separate study-test trials. On each trial, you will be shown a series of words. These words will either be complete, or missing one letter. You will need to read each word **out loud** as it is shown, and complete the word with the correct missing letter. Your task is to memorize these words for a later test.

For the digit task, please read the numbers **out loud** as they are shown.

After the slideshow is complete, please move to the correct desk to complete the test portion of the experiment. (Point to desks where test sheets are placed) You will have 90 seconds to recall as many words as possible. Please work for the entire 90 seconds. After the test phase is complete, you will return to the monitor for the next slideshow presentation.

If you have any questions, please ask them now.