Examining the Impact of List Size and False Memories on Retrieval-Induced Forgetting

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Abstract

When the successful practice and retrieval of a target memory suppresses its closely associated competitors, the cognitive phenomenon known as Retrieval-Induced Forgetting (RIF) has been indicated. RIF is observed in various memory systems and people in varying age groups are susceptible to its effects. One boundary condition that consistently resists RIF is known as integration, which refers to gathering competing memories into one structure to facilitate memory retrieval. Integration may occur with or without experimenter-supplied instructions. Despite serving as a reliable strategy to improve list recall, integration may lead to adverse effects such as false memories, which has been examined with various RIF studies that involve the use of semantically related word lists. Subjects often falsely recall specific lure words and it is believed to be due to integration. Thus, the first purpose of this study is to examine how the tendency to make associations (e.g., measure through false recall) impacts RIF effect size. Our second purpose refers to the absent research that has examined how and to what extent RIF and integration are impacted by varying list sizes. We hope to better understand forgetting (i.e. RIF) in relation to the effects of memories and begin developing the answer for if people who forget less are predisposed to produce more false memories.
Retrieval-Induced Forgetting (RIF) is a cognitive phenomenon that occurs when the practice and successful retrieval of an item in memory (e.g., orange) impedes the ability to recall closely associated items (e.g., banana) (Anderson et al., 1994). Evidently, the successful practice and retrieval of the desired memory suppresses those associated with it, inhibiting the accessibility of these related items over time. The suppression is great enough that subjects will exhibit higher recall of unassociated items than aforementioned closely associated items (Anderson et al., 1994). What is implied is that in order to remember a particular item, one must forget another.

Studies that wish to investigate RIF typically implement a paradigm similar to the exemplary work of Anderson et al. (1994). This paradigm begins with the study phase, where participants are presented lists of items of which they are instructed to be mindful for future retrieval (e.g., FRUIT—orange, FRUIT—banana, SLEEP—bed). In the retrieval-practice phase, participants complete retrieval practice for half of the items from half of the items formerly presented the study phase. This practice is in the form of completing word stems (e.g., FRUIT—o r __ __ __ __ for FRUIT—orange). Participants retrieve particular words from particular categories while not practicing the remaining words from the same practiced categories. Category-exemplar pairs are not practiced at all and serve as a baseline to compare to practiced and non-practice exemplars from practiced categories. Lastly, the final phase of a RIF experiment, the test phase, involves recall of all items initially presented in the study phase. RIF is indicated with higher recall of baseline items in comparison to unpracticed exemplars from practiced categories.

Interestingly, RIF is not a phenomenon exclusive to adulthood. The majority of RIF experiments have utilized sample sizes of young adults for participants. RIF in children was observed in the work of Aslan and Bäuml (2010), who examined RIF not only adults but second graders and kindergartners as well. It was found that RIF was significant in both the kindergartners and second grader groups, who had mean ages of 4.6 and 7.5, respectively. In a later study, Aslan and Bäuml (2012) found that RIF was also significant in older adults, ranging from 60 to 74 years of age.
RIF has been examined and observed in a variety of memory systems. For instance, Aslan and Bäuml (2011) examined different levels of working memory capacity (WMC) in relation to RIF. They found a higher recall for information retrieved during the retrieval-practice phase regardless of WMC, but also reported a positive correlation between WMC and RIF. In contrast, the work of Mall and Morey (2013) found a negative correlation between WMC and RIF, suggesting that a high WMC generally foretells less RIF. The work of Anderson et al. (1994) served as a standard for the RIF paradigm and is related not only to working memory, but also semantic long-term memory.

Lastly, Ciranni and Shimamura (1999) examined RIF in episodic long-term memory. It should be noted that participants in their experiment were not presented semantically related words, which deviates from each aforementioned experiment (Anderson et al., 1994; Aslan & Bäuml, 2010; Aslan & Bäuml, 2011; Aslan & Bäuml, 2012). Instead, participants were presented locations of uniquely-colored stimuli grouped according to three shapes (4 triangles, 4 circles, 4 crosses). Subjects then practiced half of the stimuli of half of the groups in the retrieval-practice phase, utilizing the location and shapes as cues, where word stems would have been utilized for semantically related words. Even when manipulating to examine episodic memory in place of semantic memory, subjects still exhibited RIF (Ciranni & Shimamura, 1999).

RIF is reduced and possibly eliminated by the use of a boundary condition known as “integration”, which involves forming meaningful connections between competing memories (Anderson & McCulloch, 1999). Closely associated memories in competition are resistant to RIF when they are brought together into a lone interconnected structure, such as a semantic relationship, as they are more easily accessible for recall. Anderson and McCulloch (1999) found that RIF was weakened when they directed participants to form connections within the presented items. Anderson and McCulloch believe that creating an interrelated structure prevents competition and interference between memories, thus making them more accessible for recall. As a result, there is no RIF effect because item suppression only occurs due to items interfering or competing with the target memory to be practiced and retrieved. On the post-test questionnaires, many subjects reported having also made episodic associations (episodic integration) without experimenter-
supplied instructions, suggesting that the use of integration is apparently a natural, common process human use when encoding memories for subsequent retrieval (Anderson & McCulloch, 1999). Furthermore, Goodmon and Anderson (2011) discovered that semantic integration greatly reduced and seldom abolished RIF. Akin to Anderson and McCulloch (1999), participants also spontaneously made these semantic connections.

Integration as a boundary condition is not without cons in spite of its ability to facilitate memory retrieval. Specifically, integration may produce adverse effects such as false memories (Schlichting & Preston, 2015; Warren et al., 2014; Gershman et al., 2013; Hupbach, Gomez et al., 2007; Jones et al., 2012). Ironically, RIF often uses Deese-Roediger-McDermott (DRM) word lists to examine false memories (Stadler et al., 1999) in relation to memory retrieval. In a DRM procedure, participants are presented lists of words they are instructed to know for immediate subsequent recall. Each DRM list is semantically related and has a critical lure word that is integral to the paradigm. For instance, participants may be presented words such as nurse, hospital and sick but not the lure word ‘doctor’. During the test recall phase, participants will often falsely report the word ‘doctor’ and actually claim that the word was presented to them in an earlier stage of the paradigm (Roediger & McDermott, 1995). These false memories occur as participants form overly powerful associations with these semantically related items.

The use of integration, false memories and DRM lists within RIF studies are exemplified in the work of Bäuml and Kuhbandner (2003), which examined the associative strength of DRM list items in relation to integration and RIF. Bäuml and Kuhbandner (2003) presented their subjects DRM word lists (see Stadler et al., 1999) ranked from strongest to weakest in associative strength. Each DRM word list had a critical lure, which was not presented to subjects at any point throughout the study. However, these lures were often falsely recalled. For instance, when presented the words woman, husband and uncle, subjects would false recall the word ‘man’ (Bäuml & Kuhbandner, 2003). The aforementioned list of “woman, husband, uncle” is one with high associative strength, and theoretically should produce high rates of false recall. In turn, word lists with lower associative strength should have lower false recall rates. Bäuml and
Kuhbander (2003) actually found when the critical lure was included in the presented lists, RIF was not detected for high associativity word lists associated with high false recall but was detected for weak associativity word lists associated with low false recall. These results are believed to stem from spontaneous integration by the participating subjects (Bäuml & Kuhbander, 2003).

In conclusion, various studies confirm that directed and spontaneous integration has the ability weaken if not eliminate RIF. Therefore, we may assume that those who exhibit less RIF often use integration to facilitate recall. Spontaneous integration is more likely to occur when items from word lists are of higher associative strength or more semantically related. The RIF paradigm often uses DRM lists to examine false memories of words, which occurs due to associative processes such as integration, which has adverse effects such as false memories. After converging the available research, one major theoretical implication is the suggestion that those who forget less may be more prone to false memories.

A common trend among studies pertaining to RIF lies within their set sizes. For instance, the work of Anderson et al. (1994) was centered around one set size for the entire experiment, eight lists of six items for a total of 48 words. Anderson & McCulloch (1999)’s work employed a design including ten lists of six items for a total of 60 words. The work of Bäuml and Kuhbandner (2003) maintained a set size of 16 lists of 14 items for a total of 224 items. With this lack of variance among set sizes, it is unknown whether RIF is more or less pronounced between varying set sizes. Thus, we have two research questions: 1) How does an individual’s tendency to make associations impact RIF effect size, and 2) how does list size impact RIF and integration as a boundary condition?

**Methods**

**Participants:**

Participants in this study were enrolled in first, second- and third-year Psychology classes and received one bonus mark towards a first or second year psychology course. A sample size of $n = 230$ was obtained and the median age was 21 years. There were roughly 179 women in this study. The decision for this sample sized hinged upon previous studies that have investigated RIF and was expected to provide an
adequate effect size and power to determine any significant relationships (Anderson et al., 1994; Anderson & McCulloch, 1999, Nuñez et al., 2017).

**Design:**

The experiment had three phases: the study, retrieval practice phrase and test phases. After having been presented all of the items in the study phase, participants performed the retrieval-practice phase. The retrieval practice phase contained three types of stimuli: Rp+, Rp- and Nrp items. The Rp+ items were exemplars of a category that received retrieval practice (e.g., write “door” when presented with WINDOW — d o __ __), while the Rp- items (e.g., WINDOW — pane) were exemplars of the same category but received no practice. To ensure that participants recalled as many Rp+ items as possible, each exemplar was provided with two letter cues. The Nrp items consisted of exemplars of categories which received no retrieval practice for any of the list items and served as a baseline (e.g., DOCTOR – nurse). The practice and successful retrieval of Rp+ items should suppress the Rp- items to such an extent that participants will exhibit higher recall of Nrp items. The Rp+ (e.g., WINDOW – door), Rp- (WINDOW – pane) and Nrp conditions (e.g., CHAIR – table) were manipulated within subjects. Participants filled out a demographic questionnaire following the test phase.

**Measures:**

The experiment used DRM word lists (see Appendix A). Participants were read aloud DRM lists in two set sizes. Those in the first condition (e.g., the small set size group) were read aloud four separate DRM word lists, each of which consisted of six words. Thus, they were read a total of 24 items. Those in the second condition (e.g., the large set size group) were read aloud 12 separate DRM word lists, also containing six words per list, for a total of 72 items. The words from each list were ordered from strongest to weakest in associative strength.

**Procedure:**

Each participant received a consent form prior to beginning the study phase. Researchers then showed participants videos of research assistants reading aloud DRM word lists while wearing a different
hat for each category. The team of research assistants that contributed to the formation of the videos consisted of four people (two males, two females), each of which sported a different hat for each category of items read aloud in the videos. These hats were worn to distinguish each DRM list by ensuring that each individual reading lists significantly differed in appearance. Participants received one of two instructions prior to viewing the video. Half of the participants were instructed to use an integration strategy and the other group was received no specific integration instructions. These integration instructions were orally presented by the same student researcher each time. Participants then started the study phase by viewing their respective videos (i.e., 4 lists of 24 items or 12 lists of 72 items).

As this experiment was part of a joint study, a collaborating student researcher for another experiment required the same participants to perform a lineup task after viewing the videos in the study phase and taking a 20-minute break prior to carrying out the remaining phases of the current experiment. Participants knew of this procedure as a result of overviewing the consent form. The collaborating student researcher’s experiment investigated how well people are able to remember faces of people while concentrating on remembering another detail about them, namely the words they are saying. This experiment was irrelevant to retrieval-induced forgetting and served as a distractor task. Participants were instructed to complete this distractor task directly following the break, then to enter the succeeding phases of the present experiment. To aid participants in completing the experiment, the sheets for each phase were printed in distinct colors (e.g., white sheets for the lineup task, blue sheets for the retrieval practice cue phase and green sheets for the test phase).

The small set size group observed videos of research assistants reading six items from four out of 12 DRM list categories. Separately, the large set size group viewed research assistant-produced videos of each of the 12 DRM list categories. There were three possible versions of videos that the small set size group may have been presented. In the first version, research assistants read each item from the first four categories (i.e., WINDOW, SLEEP, SMELL and DOCTOR), following the order of the DRM list. Research assistants read each item from the next four categories (i.e., SWEET, CHAIR, SMOKE and
ROUGH) in the second version. The third and final version comprised research assistants reading each item from the final category (i.e., NEEDLE, ANGER, TRASH and SOFT). As there were 12 DRM lists utilized for this experiment, the large set size group were presented each item. Following the lineup task related to the aforementioned experiment succeeding a 20-minute break, participants entered the second phase of this experiment.

The retrieval practice cue phase was the second phase of the experiment. In this phase, participants received incomplete word stems (e.g., D O __ __) that were provided on a paper handout. They were instructed to complete these stems by writing the remaining letters to form a word they had seen in the preceding study phase. Participants retrieved half of the items from half of the categories (Anderson et al., 1994). For instance, the small set size group received word stems containing four categories of six items, and thus 24 words in the study phase. Therefore, they would practice two of these four categories (e.g., WINDOW, SLEEP, SMELL, DOCTOR) and three of the six items within categories to equal six words. The words that received directed retrieval practice were the Rp+ items (e.g., hospital), while the remainder of words from the same category that received no practice were Rp- items (e.g., nurse). The two remaining categories that received no retrieval practice were the Nrp items. In accordance with this formula, as a participant in the large set size group was presented 12 lists of words each with six items, their word stems consisted of six categories with three words each, consequently practicing 18 words. Counterbalancing was implemented to eliminate the possibility of order effects; thus, multiple versions of retrieval practice cues were formed. Participants in the small set size group practiced one of 12 small set retrieval-practice cue sets while participants in the large set size group were presented one of four large set 12-list retrieval-practice cue sets (see Appendix A).

During the final test phase, participants were instructed to recall all items that were presented to them in the study. Therefore, the small and large set size groups were asked to recall 24 and 72 words, respectively. Participants were presented a test sheet that varied only in length of blanks to fill, depending on which group they were apart of throughout the study. Each test sheet consisted of instructions to recall
as many words as possible, with the first item from each category provided despite the absence of category itself (e.g., “Please write down all the words you can remember for the word list beginning with DOOR.”), with lines for participants to write their answers. Just below the instructions were pictures of the research assistant(s) that read the corresponding set of words to facilitate recall. The number of items successfully recalled, as well as falsely recalled lures, were measured.

**Hypotheses:**

To begin, we expect to find RIF in both set sizes. We also predict higher rates of recall in the small set size. In the small set size group, we hypothesized that RIF would be weaker in the group given specific integration instructions and that integration instructions should increase the number of items recalled. However, having more items in the larger set size group should increase the difficulty of integration. Consequently, the larger set size group should produce more RIF for both the integration and no-integration groups. Also, we anticipated that participants who make more false recalls will have less RIF effects compared to participants who make less false recalls.

**Results**

Two statistical analysis techniques were employed in order to analyze the data collected from this experiment. First, we conducted a mixed factorial 2 (Integration: yes vs no instructions) x 2 (Stimulus Set Size: small number of items, large number of items or small set size, large set size) x 2 (Set; Rp - minus Nrp) ANOVA. integration and set size served as our between-subjects factors while the set was our within-subjects factor. The dependent variable was the RIF effect. Our second statistical analysis technique was correlational analysis to measure the relationship between false recall rates and effect size of RIF.

We hypothesized an RIF effect and were proven correct, evidenced by a statistically significant main effect of Set, $F(1, 226) = 9.133$, \(MSE = .015, p = .003\). In particular, Rp- items (i.e., .03) were recalled less than Nrp items (i.e., .04) Additionally, we predicted lower correct recall rates for the large set size condition in comparison to the small set size. Our ANOVA of Stimulus Set Size confirmed our
predictions, $F(1, 226) = 32.001, MSE = .023, p < .001$. Specifically, the mean recall rate was lower for large set sizes (i.e., 09%) compared to small set sizes (i.e., 17%).

In the small set size group, we hypothesized that the RIF effect would be weaker in the group given specific integration instructions and that integration instructions should increase the number of items recalled. The RIF effect for the small set size integration participants was .03, while the RIF effect size for the small set size no integration group was .07. As more items in the large set size group should increase the difficulty of integration, we predicted the large set size group producing more RIF for both integration and no-integration groups. For the large set size group that received no integration instructions, the RIF effect was .01. for the large set size integration group, their RIF effect was .03. Albeit contradictory to our hypotheses, none of these differences in RIF effect sizes were proven statistically significant, $F(1, 226) = 3.281, MSE = .023, p = .052$.

Our condition of set (RIF effect) did not interact with stimulus set size, $F(1, 226) = 1.956, MSE = .029, p = .163$. Similarly, our condition of set did not interact with integration, $F(1, 226) = .312, MSE = .005, p = .577$. Lastly, there was no interaction between our three conditions, set, stimulus size and integration, $F(1, 226) = 1.246, MSE = .018, p = .266$. Correlational analysis was conducted to assess the strength of the relationship between RIF effect size and false recall rates. However, this analysis lacked power and therefore could not be included in the current study results.

**Discussion**

As we observed statistically significant differences in Rp- and Nrp for both set sizes, the current study adds to the myriad of evidence that the ability to recall memories is suppressed after practicing and successfully retrieving closely associated items in memory. Based on the results of the statistical analysis, it appears that RIF can occur in varying list sizes and that larger set sizes may increase the RIF effect size. We supposed that participants in the small set size group would have lower recall simply for the fact that they would have a significantly less items they would be asked to recall. Thus, their working memories would be under much less taxation than their large set size counterparts. In the small set size group, we
predicted the RIF effect to be weaker in the group provided integration instructions and that integration instructions should increase the number of items recalled. For the large set size, we predicted more RIF for both integration and no-integration groups because we believed that more items one must integrate should decrease the difficulty of integration.

It is surprising but understandable that we failed to find a statistically significant main effect of integration, although it was close with a significance of .052. The larger RIF effect size in the small set size suggests that the integrative effects were observed predominantly in the small set size condition as opposed to the large set size condition. These results are apparently counterintuitive, but theoretically plausible when considering earlier research on RIF and WMC. As previously stated in the introduction, Aslan and Bäuml (2011) found that RIF was positively correlated with RIF. On the other hand, Mall and Morey (2013) found that RIF was negatively correlated with RIF. The conflicting nature of these results suggest that perhaps our participants in the large set size group possessed greater variance in WMC than their small set size counterparts. However, it appears that WMC alone is unable to explain these results. Marsh et al., (2013) found that RIF may be eliminated by the presence of auditory distraction and strengthened when retrieval practice takes place in silence. This finding is especially important in relation to the nature of data collection for the present experiment. Data collection for the large set size was conducted in a large auditorium with more noise due to the increased number of students. The majority of the data collection for the small set size group took place in smaller rooms that contained less students and consequently less noise. Therefore, a possibility of increased variance in conjunction with auditory distraction within the large set size group maybe begin to explain the larger RIF effect size within the small set size group as well as the lack of interaction between any of our variables. As RIF effect between varying set sizes has yet to be studied, this is the first of many experiments that investigate the effect of list size on the propensity of retrieval-induced forgetting. These results may not be replicated as more studies center around this phenomenon.
Conclusions

The objectives of our study were to: 1) determine the impact of memory set size (e.g., small vs large set size) on integration and RIF effect size and 2) to examine whether increased false memories (i.e., DRM lure retrievals) are associated with increased proclivity to integrate list items. By manipulating the set sizes between participants, the extent of the differences in RIF could be examined. Second, manipulating the integration instructions provided the opportunity to measure the differences in both set sizes when instructed, or not instructed, to attempt to make connections with the semantically related items from the DRM lists. Third, determining the correlation between RIF effect size and falsely recalled lures serves as an attempt to determine if less forgetting predicts more false memories. To date, no existing study has examined RIF with multiple set sizes nor investigated if people who forget less have a higher propensity for false memories. Although some predictions were incorrect, our results may lead to further investigation in future studies.

Limitations

It must be noted that there were extraneous variables that may have negatively impacted the results of this experiment. The data collection was conducted on different days over the course of several months, in various university classrooms following the permission of instructors who let their students know of this roughly three lectures prior to our arrival. Our research participants, first, second- and third-year students enrolled in Psychology courses, watched the same designated videos together (e.g., small set size group, DRM lists five to eight, without integration for one particular class). The classes selected for data collection of the larger set size were in auditoriums rather than regular-sized classrooms and therefore had more participants. As these were larger rooms with more students, there was an increased number of disruptions. For instance, a student in the large set size group was caught attempting to write the words presented to them in the study phase to facilitate their recall, as they figured they would be required to be able to recall these words in the future. If this student is confronted by a student researcher or research assistant and instructed to cease writing, this may disrupt other participants attempting to watch the video
and their attention will now be away from the video and on the participant being confronted. By not paying undivided attention to the video in the study phase, we are now unable to infer if the results of a participant are due to RIF or simply not being able to pay undivided attention throughout the study phase.

In other instances, various participants attempted to complete the experiment in an order not instructed by the student researchers, such as completing the test phase prior to the lineup task. Our student researchers and research assistants were instructed to monitor participants to ensure these errors would not occur and to correctly guide participants in the right direction if necessary. However, confronting these participants may have disrupted the attention of other participants attempting to complete the experiment. Some participant reverted to completing the experiment in the fashion that they chose to after being confronted as well. Thus, once again, we are unable to infer if the results of the participant were due to RIF and not factors unreleased to the participant.

A participating student may have also experienced sleep loss and sleep deprivation at the time of data collection. Fatigue levels of participants were not measured. The word lists may overload a participant’s working memory depending on their capacity, but this overload may be expedited and amplified with sleep deprivation and therefore cognitive fatigue. The implications are significant particularly for the large set size group as they were asked to recall a relatively large amount of items in comparison to their small set size counterparts. If a student is sleep deprived prior to beginning this experiment, then potentially distracted by extraneous variables at various points throughout the study, then it is a possible explanation for the unexpected results from the large set size group.

Another limitation is that our data collection did not involve significant details in regards to integration. Participants of both groups that did not receive integration instructions were not asked if they attempted to form connections within the DRM lists in the study phase. As previously stated, participants have shown a tendency to make these connections without experimenter-supplied instructions (Anderson & McCulloch, 1999). By not inquiring about integration in these no-integration conditions, we are unsure if some students contributed to our surprising results because they were successfully integrating items
without experimenter-supplied instructions. Conversely, we did not confirm that students who received integration instructions actually followed through with them. As previously stated, our participants may have been fatigued and unable to maintain focus on the instructions. In the large set size condition, this inattentiveness may have been exacerbated and led to many participants attempting to form connections then ceasing at some point in the study phase.

Our sample size was from a population of university students, which may not have been reflective of the general population. It is possible but not confirmed that working memory capacity is positively correlated with education, and these young adults enrolled in university may have produced results that would differ from those not enrolled. Thus, our results have limited generalizability. Another limitation of this study is that there were only two set sizes. Perhaps a medium set size (i.e., 8 lists of 6 items for a total of 48 words), or simply additional levels of list sizes (i.e., 10 items for one list, 6 for another) would help us better understand how varying list sizes impact RIF related factors.

Lastly, despite the significance of mentioning WMC we did not measure the WMC of each participating student. It would have been beneficial to have subjects complete a working memory task prior to participating in our experiment. The completion of this task would have provided us with a quantifiable measure of the participating subject’s WMC and, in turn, we would have been able to correlate with RIF, integration and false recall rates.
References


Words were presented in the following order, ranked from strongest to weakest in associativity strength.

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Appendix B

Retrieval-practice cue sheets for small set size group

Twenty minutes ago, you watched videos of a male and a female reading 4 lists of words each. Now we want you to try to remember some of those words. For each word you need to remember, you will be given a few letters that start the word to give you a hint. Your job is to finish the word.

The first list was read by the man wearing the hat in this picture. Finish the words he read on that list.

DO ___
PA ___
LE ___ ___

The second list was read by the woman wearing the hat in this picture. Finish the words she read on that list.

BE __
AW ___ ___
DR ___ ___

Twenty minutes ago, you watched videos of a male and a female reading 4 lists of words each. Now we want you to try to remember some of those words. For each word you need to remember, you will be given a few letters that start the word to give you a hint. Your job is to finish the word.
The third list was read by the man wearing the hat in this picture. Finish the words he read on that list.

- NO __ __
- SN __ __ __
- HE __ __

The fourth list was read by the woman wearing the hat in this picture. Finish the words she read on that list.

- NU __ __ __
- LA __ __ __ __
- HE __ __ __ __

Twenty minutes ago, you watched videos of a male and a female reading 4 lists of words each. Now we want you to try to remember some of those words. For each word you need to remember, you will be given a few letters that start the word to give you a hint. Your job is to finish the word.

The first list was read by the man wearing the hat in this picture. Finish the words he read on that list.
The second list was read by the woman wearing the hat in this picture. Finish the words she read on that list.

The third list was read by the man wearing the hat in this picture. Finish the words he read on that list.

Twenty minutes ago, you watched videos of a male and a female reading 4 lists of words each. Now we want you to try to remember some of those words. For each word you need to remember, you will be given a few letters that start the word to give you a hint. Your job is to finish the word.
Twenty minutes ago, you watched videos of a male and a female reading 4 lists of words each. Now we want you to try to remember some of those words. For each word you need to remember, you will be given a few letters that start the word to give you a hint. Your job is to finish the word.

The first list was read by the man wearing the hat in this picture. Finish the words he read on that list.

```
C I __________
B L __ __
P O __________
```

The fourth list was read by the woman wearing the hat in this picture. Finish the words she read on that list.

```
S M __ __ __
R O __
S A __ P A __ __
```

The first list was read by the man wearing the hat in this picture. Finish the words he read on that list.
The second list was read by the woman wearing the hat in this picture. Finish the words she read on that list.

M A __
L A __
T E __ __ __

Twenty minutes ago, you watched videos of a male and a female reading 4 lists of words each. Now we want you to try to remember some of those words. For each word you need to remember, you will be given a few letters that start the word to give you a hint. Your job is to finish the word.

The third list was read by the man wearing the hat in this picture. Finish the words he read on that list.

T H __ __ __
E Y __
S H __ __ __
The fourth list was read by the woman wearing the hat in this picture. Finish the words she read on that list.

H A __ __
P I __ __ __ __
L O __ __

Twenty minutes ago, you watched videos of a male and a female reading 4 lists of words each. Now we want you to try to remember some of those words. For each word you need to remember, you will be given a few letters that start the word to give you a hint. Your job is to finish the word.

The first list was read by the man wearing the hat in this picture. Finish the words he read on that list.

G A __ __ __ __
C A __
S E __ __ __ __
The second list was read by woman wearing the hat in this picture. Finish the words she read on that list.

\[
\begin{align*}
G& \ _\ _\ _ \\
S& \ _\ _\ _ \\
S& \ I \ _\ _ \\
\end{align*}
\]

Twenty minutes ago, you watched videos of a male and a female reading 4 lists of words each. Now we want you to try to remember some of those words. For each word you need to remember, you will be given a few letters that start the word to give you a hint. Your job is to finish the word.

The third list was read by the man wearing the hat in this picture. Finish the words he read on that list.

\[
\begin{align*}
R& \ E \ _\ _ \\
T& \ I \ _\ _\ _ \\
W& \ A \ _\ _ \\
\end{align*}
\]
Twenty minutes ago, you watched videos of a male and a female reading 4 lists of words each. Now we want you to try to remember some of those words. For each word you need to remember, you will be given a few letters that start the word to give you a hint. Your job is to finish the word.

The first list was read by the man wearing the hat in this picture. Finish the words he read on that list.

B R __ __ __ __
A R __ __
S E __

The fourth list was read by the woman wearing the hat in this picture. Finish the words she read on that list.

S I __
M E __ __ __ __
H O __ __ __ __

The first list was read by the man wearing the hat in this picture. Finish the words he read on that list.

B R __ __ __ __
A R __ __
S E __
C A __ __ __  
B I __ __ __  
T A __ __ __

The second list was read by the woman wearing the hat in this picture. Finish the words she read on that list.

S I __  
S E __ __  
D E __ __

Twenty minutes ago, you watched videos of a male and a female reading 4 lists of words each. Now we want you to try to remember some of those words. For each word you need to remember, you will be given a few letters that start the word to give you a hint. Your job is to finish the word.

The third list was read by the man wearing the hat in this picture. Finish the words he read on that list.
Twenty minutes ago, you watched videos of a male and a female reading 4 lists of words each. Now we want you to try to remember some of those words. For each word you need to remember, you will be given a few letters that start the word to give you a hint. Your job is to finish the word.

The first list was read by the man wearing the hat in this picture. Finish the words he read on that list.

P U ___
B I ___ ___ ___
A S ___ ___

The fourth list was read by the woman wearing the hat in this picture. Finish the words she read on that list.

B U ___ ___
T O ___ ___
J A ___ ___ ___

The first list was read by the man wearing the hat in this picture. Finish the words he read on that list.
The second list was read by the woman wearing the hat in this picture. Finish the words she read on that list.

Twenty minutes ago, you watched videos of a male and a female reading 4 lists of words each. Now we want you to try to remember some of those words. For each word you need to remember, you will be given a few letters that start the word to give you a hint. Your job is to finish the word.

The third list was read by the man wearing the hat in this picture. Finish the words he read on that list.
The fourth list was read by the woman wearing the hat in this picture. Finish the words she read on that list.

\[
\begin{align*}
L & \quad I \quad \_ \_ \_ \\
P & \quad L \quad \_ \_ \_ \\
C & \quad O \quad \_ \_ \_ \_ \_ \\
\end{align*}
\]

Appendix C

Retrieval-practice cue sheets for large set size group

Twenty minutes ago, you watched videos of a male and a female reading 12 lists of words each. Now we want you to try to remember some of those words. For each word you need to remember, you will be given a few letters that start the word to give you a hint. Your job is to finish the word.

The first list was read by the man wearing the hat in this picture. Finish the words he read on that list.

\[
\begin{align*}
W & \quad A \quad \_ \_ \_ \\
R & \quad E \quad \_ \_ \_ \_ \_ \\
B & \quad A \quad \_ \\
\end{align*}
\]
The second list was read by the woman wearing the hat in this picture. Finish the words she read on that list.

BE __
AW __ __
DR __ __

The third list was read by the man wearing the hat in this picture. Finish the words he read on that list.

NO __
SN __ __
HE __ 
The fourth list was read by the woman wearing the hat in this picture. Finish the words she read on that list.

N U __ __ __
L A __ __ __ __
H E __ __ __

The fifth list was read by the man wearing the hat in this picture. Finish the words he read on that list.

S O __ __
S U __ __ __
G O __ __
The sixth list was read by the woman wearing the hat in this picture. Finish the words she read on that list.

```
T A __ __ __
L E __ __
C O __ __ __
```

Twenty minutes ago, you watched videos of a male and a female reading 12 lists of words each. Now we want you to try to remember some of those words. For each word you need to remember, you will be given a few letters that start the word to give you a hint. Your job is to finish the word.

The seventh list was read by the man wearing the hat in this picture. Finish the words he read on that list.

```
C I __ __ __ __ __ __ __
B L __ __ __
P O __ __ __ __ __ __ __
```

The eighth list was read by the woman wearing the hat in this picture. Finish the words she read on that list.
The ninth list was read by the man wearing the hat in this picture. Finish the words he read on that list.

T H ___ ___ ___
E Y ___
S H ___ ___

The tenth list was read by the woman wearing the hat in this picture. Finish the words she read on that list.

S M ___ ___ ___
R O ___
S A ___ P A ___ ___
The eleventh list was read by the man wearing the hat in this picture. Finish the words he read on that list.

G A __ __ __ __
C A __
S E __ __ __ __

The twelfth list was read by the woman wearing the hat in this picture. Finish the words she read on that list.

M A __
L A __ __
T E __ __ __
Twenty minutes ago, you watched videos of a male and a female reading 12 lists of words each. Now we want you to try to remember some of those words. For each word you need to remember, you will be given a few letters that start the word to give you a hint. Your job is to finish the word.

The first list was read by the man wearing the hat in this picture. Finish the words he read on that list.

HA ___
P I ___ ___
LO ___

The second list was read by the woman wearing the hat in this picture. Finish the words she read on that list.

GL ___
SH ___ ___
SI ___
The third list was read by the man wearing the hat in this picture. Finish the words he read on that list.

B R __ __ __
A R __ __
S E __

The fourth list was read by the woman wearing the hat in this picture. Finish the words she read on that list.

R E __ __
T I __ __ __
W A __ __
The fifth list was read by the man wearing the hat in this picture. Finish the words he read on that list.

SI __ __
ME __ __ __ __ __
HO __ __ __ __ __

C A __ __ __
B I __ __ __ __
T A __ __ __

The sixth list was read by the woman wearing the hat in this picture. Finish the words she read on that list.
Twenty minutes ago, you watched videos of a male and a female reading 12 lists of words each. Now we want you to try to remember some of those words. For each word you need to remember, you will be given a few letters that start the word to give you a hint. Your job is to finish the word.

The seventh list was read by the man wearing the hat in this picture. Finish the words he read on that list.

The eighth list was read by the woman wearing the hat in this picture. Finish the words she read on that list.
The ninth list was read by the man wearing the hat in this picture. Finish the words he read on that list.

B U ___
T O ___
J A ___

The tenth list was read by the woman wearing the hat in this picture. Finish the words she read on that list.

P I __
S E ___ ___
P O ___ ___
The eleventh list was read by the man wearing the hat in this picture. Finish the words he read on that list.

FE ___
RA ___
FU ___

The twelfth list was read by the woman wearing the hat in this picture. Finish the words she read on that list.

WA ___
RE ___
BA ___
Appendix D

Test sheets for small set size group

1. Please write down all the words you can remember for the word list beginning with **DOOR**. When Mike read the list, he was wearing this hat:

   ![Hat Image]

   L I ___ ___
P L ___ ___
C O ___ ___
2. Please write down all the words you can remember for the word list beginning with **BED**. When Alyssa read the list, she was wearing this hat:

![Alyssa with a hat](image1)

3. Please write down all the words you can remember for the word list beginning with **NOSE**. When Ben read the list, he was wearing this hat:

![Ben with a hat](image2)

4. Please write down all the words you can remember for the word list beginning with **NURSE**. When Mackenzie read the list, she was wearing this hat:
1. Please write down all the words you can remember for the word list beginning with **SOUR**. When Mike read the list, he was wearing this hat:

```
_________________  ________________  ________________
_________________  ________________  ________________
```

2. Please write down all the words you can remember for the word list beginning with **TABLE**. When Alyssa read the list, she was wearing this hat:
3. Please write down all the words you can remember for the word list beginning with **CIGARETTE**. When Ben read the list, he was wearing this hat:

![Hat Image](image)

4. Please write down all the words you can remember for the word list beginning with **SMOOTH**. When Mackenzie read the list, she was wearing this hat:

![Hat Image](image)
1. Please write down all the words you can remember for the word list beginning with **THREAD**. When Mike read the list, he was wearing this hat:

![Hat Image]

2. Please write down all the words you can remember for the word list beginning with **MAD**. When Alyssa read the list, she was wearing this hat:

![Hat Image]

3. Please write down all the words you can remember for the word list beginning with
GARAGE. When Ben read the list, he was wearing this hat:

4. Please write down all the words you can remember for the word list beginning with HARD. When Mackenzie read the list, she was wearing this hat:

Appendix E
Test sheets for large set size group

1. Please write down all the words you can remember for the word list beginning with
DOOR. When Mike read the list, he was wearing this hat:

2. Please write down all the words you can remember for the word list beginning with BED. When Alyssa read the list, she was wearing this hat:

3. Please write down all the words you can remember for the word list beginning with NOSE. When Ben read the list, he was wearing this hat:
4. Please write down all the words you can remember for the word list beginning with NURSE. When Mackenzie read the list, she was wearing this hat:

5. Please write down all the words you can remember for the word list beginning with SOUR. When Mike read the list, he was wearing this hat:
6. Please write down all the words you can remember for the word list beginning with **TABLE**. When Alyssa read the list, she was wearing this hat:

   ____________  ____________  ____________

   ____________  ____________  ____________

7. Please write down all the words you can remember for the word list beginning with **CIGARETTE**. When Ben read the list, he was wearing this hat:
8. Please write down all the words you can remember for the word list beginning with SMOOTH. When Mackenzie read the list, she was wearing this hat:

9. Please write down all the words you can remember for the word list beginning with THREAD. When Mike read the list, he was wearing this hat:
10. Please write down all the words you can remember for the word list beginning with MAD. When Alyssa read the list, she was wearing this hat:

______________  ______________  ______________
______________  ______________  ______________

11. Please write down all the words you can remember for the word list beginning with GARAGE. When Ben read the list, he was wearing this hat:

______________  ______________  ______________
______________  ______________  ______________
12. Please write down all the words you can remember for the word list beginning with **HARD**. When Mackenzie read the list, she was wearing this hat: