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Differences Between Directed Forgetting Methods Across Development: A Direct Comparison of the Item Cuing and Block Cuing Methods

(Under direction of DR. KATHERINE KIPP)

This experiment examined a direct comparison between the item and block cuing methods of directed forgetting research in a developmental framework. It has been hypothesized that these two methods tap into different cognitive processes, selective rehearsal and inhibition, respectively. First, third, fifth grade and college students were compared in a mixed method design. Each participant was presented with items in both the block and item cuing procedures and then recall and recognition for all items was assessed. Results showed that adults recalled significantly more to-be-remembered than to-be-forgotten words regardless of task. On the recognition test, all participants recognized more to-be-remembered (TBR) than to-be-forgotten (TBF) words on the item task and equal TBR and TBF words on the block task. Results are considered inconclusive as a fast speed of presentation may have influenced the data.

INDEX WORDS: Directed Forgetting, Recall, Age comparisons, Development, Inhibition, Selective Rehearsal

DIFFERENECS BETWEEN DIRECTED FORGETTING METHODS ACROSS DEVELOPMENT: A DIRECT COMPARISON OF THE ITEM AND BLOCK CUING METHODS

by

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DEDICATION

This paper is dedicated to my wonderful husband whose never-ending support made this work possible and my sweet son whose smile brightened even my darkest moments.

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So many people deserve acknowledgement for all of the support, guidance, and encouragement I received that this section could easily be longer than the paper itself. I will do my best to be brief, however.

To begin, I would like to think my advisor, Dr. Katherine Kipp. I am lucky to have someone so inspiring and so intimidating. Her tireless encouragement and patience are more than I deserve. I would also like to think my committee members, Dr. Richard Marsh and Dr. Janet Frick for their constructive comments and clever ideas; they have certainly given me plenty of new directions for future projects.

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Finally, to my husband and son: Your love is what keeps me sane. For that I will be eternally grateful.

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CHAPTER 1

INTRODUCTION

Cognitive inhibition refers to the process by which a person suppresses information that was previously activated in working memory. This process takes place after the information has become activated in working memory. It is thought that inhibition develops with age; in fact, children have been shown to perform more poorly than adults on a number of tasks that measure this process. Because children are not as able to inhibit items, they have more irrelevant information in working memory.

According to the limited resource model, each person has a limited amount of mental resources with which to perform cognitive operations (Case, Kurland & Goldberg, 1982). Cognitive performance changes as a person develops, not because the total amount of resources changes, but because a person becomes more efficient at using these resources. Children are inefficient at using their mental resources because even small tasks demand mental effort and consume much of their resources. They must devote more resources to things such as understanding task instructions or preventing irrelevant thoughts from disrupting their cognitive processes. This leaves less mental energy for storage. Because they have fewer resources to devote to these tasks, their performance suffers. As children mature, they develop better inhibition skills, which in turn affect their total processing abilities by allowing some of the resources that were once devoted to irrelevant information to now be devoted to processing

and storing relevant information. Therefore, inefficient inhibition has been hypothesized to contribute to developmental changes in processing abilities (Harshinfeger & Bjorklund, 1990).

Cognitive inhibition is a different process than simply forgetting or resisting interference. Inhibition differs from forgetting because the inhibited items are still present in long-term memory, only suppressed or less activated (Wilson & Kipp, 1998). It is possible to gain access to these items by reactivating them in working memory with tasks such as recognition tests. Inhibition differs from resistance to interference because resistance to interference occurs before the item has been encoded in working memory, whereas inhibition occurs when an item that is already activated in working memory is suppressed (Wilson & Kipp, 1998). According to Wilson and Kipp (1998), these two processes are often confused because they are closely related, develop over time, and are linked to frontal lobe development. These researchers propose, however, that it is possible to test which process is occurring by using recognition tests. For example, if resistance to interference is at work, the items never should have entered into long-term memory, thus scores on recognition tests should be low. If the process used was inhibition, however, scores on a recognition test should be high because the items are residing in memory and only need to be reactivated and brought back into working memory.

Directed Forgetting Tasks

A test used often in research on cognitive inhibition is directed forgetting (for a review, see Wilson & Kipp, 1998). In directed forgetting studies, researchers instruct participants to forget some items while remembering others. Researchers then test participants' memory for either the to-be-forgotten items (TBF) or the to-be-remembered items (TBR). There are two

main methods experimenters use when testing directed forgetting. One is item cuing. In item cuing, participants are shown stimuli one at a time. After each stimulus is presented, a cue is shown that informs participants whether they should remember the item for a later recall test or whether the item should be forgotten because it will not be tested later. The cues experimenters use vary across studies but can include the words "forget" or "remember," a string or "Fs" for forget or "Rs" for remember, and a red circle for forget and a green circle for remember (Wilson & Kipp, 1998). When testing children, some researchers use a story about a bee looking for a honey pot to help the children better understand when to forget and when to remember, and to make the task more interesting for children (e. g., Lehman & Bovasso, 1993; Lehman, Mckinley-Pace, Wilson, Slavsky, Woodson, 1997).

The other method frequently employed to test directed forgetting is block cuing. In block cuing, participants are shown a list of words. After the first half of the list is presented, participants are told either to remember the words or to forget the words in this first half of the list. After this, the second half of the list is presented. Most of the time participants are aware before the presentation of the lists that they will be given a remember or forget cue at some point during presentation. However, because they do not know whether the cue will be to remember or to forget, they should be studying each list assuming it will be tested.

After the items and the cues are presented, participants can be tested in a variety of ways. Participants may be tested on just the TBR items, just the TBF items, or both. Most often researchers give participants a surprise recall test of not only the items that the participants were instructed to remember, but also those that participants were told to forget. At times a

recognition test is used as well to see how many of the TBF items were actually encoded in memory but may not have been recalled during free recall. Implicit measures may also be used (e.g., MacLeod, 1989).

Distinguishing Between the Two Methods of Directed Forgetting

A debate in the directed forgetting literature is whether item cuing and block cuing procedures are measuring the same underlying processes. The two methods often yield different outcomes. When the item cuing method is used, directed forgetting effects are stronger. In other words, fewer TBF items than TBR items are recalled. This effect occurs on recognition tests as well, with participants recognizing more TBR items than TBF items. When the block cuing method is used, the directed forgetting effect is weaker on recall tests and is not shown at all on recognition tests. This presents an interesting question: Are these two methods testing the same underlying processes? Item cuing has been proposed to reflect selective rehearsal, whereas block cuing is thought to reflect inhibition (Harshinfeger & Pope, 1996; Wilson & Kipp, 1998). According to Harshinfeger and Pope (1996), in an item cued procedure, as each item is presented participants could wait for the cue before actually encoding that item in memory. Therefore, if a forget cue follows a specific item, participants may not be processing it at all, but instead choosing to rehearse only items that are followed by a remember cue. When selective rehearsal of the TBR words occurs, TBF words are not encoded in memory resulting in a pattern of low recall and recognition of TBF items (Harshinfeger & Pope, 1996; Wilson & Kipp, 1998). When block cuing is used, however, the strategy of waiting until the cue is presented to rehearse items is more difficult, if not impossible. As participants are presented

with the list of items, they do not know if they will be tested on those items. This should result in participants trying to encode all the items in memory. By the time they receive the forget cue at the end of the list, the items would have already been encoded and rehearsed. Harshinfeger and Pope (1996) believe that to "forget" these items, participants rely on inhibition to suppress the activation of these items. Thus, inhibition is proposed to be the cause of the directed forgetting effect in recall tests of words presented with the block cuing method. Inhibition should not stop participants from being able to recognize the TBF items on a recognition test, however. The TBF items are still in memory; after all, they are only suppressed. By re-presenting these inhibited items on the recognition test, they are released from inhibition and participants are able to recognize them (Harshinfeger & Pope, 1996; Wilson & Kipp, 1998). This explains why participants given the block cued procedure do not show a directed forgetting effect on recognition tests.

One study directly contrasted the two methods to explore this issue. MacLeod (1999) found a more pronounced directed forgetting effect with the item cuing method than the block method. In addition, although results on the recognition test revealed directed forgetting effects with the item cuing method, directed forgetting effects in recognition were not found when the block cuing method was used. Thus, as predicted by the hypothesis that item cuing is measuring selective rehearsal, participants were unable to recognize many TBF words. However, participants presented with the block cuing method recognized an equal number of TBF and TBR words. This supports the hypothesis that the two methods are measuring different processes, selective rehearsal and inhibition, respectively. It is, however, the only direct

evidence that these two methods are measuring different processes.

There is some evidence against the hypothesis that item cuing and list methods are measuring different things, however. Lehman, McKinley-Pace, Wilson, Slavsky, and Woodson (1997) proposed that both list and item cuing could be used to measure inhibition. The authors argued that if selective rehearsal is the only mechanism that accounts for directed forgetting effects in item methods then taking away the opportunity to selectively rehearse should completely stop the directed forgetting effect. They took away the opportunity to selectively rehearse by having participants count out loud starting immediately after the cue was presented until the next item was presented. This counting should stop any effects due to selective rehearsal because now neither the TBR nor the TBF words are being rehearsed. They found that although the participants without an opportunity to rehearse recalled fewer TBR items than control participants (those not required to count), they still exhibited a directed forgetting effect. Lehman et al. concluded that selective rehearsal could not be the only mechanism that leads to directed forgetting effects in the item cuing method. They believe that inhibition must also play a role in item cuing, but this may only occur when selective rehearsal is prevented.

Developmental Trajectories of Inhibition and Selective Rehearsal

A problem in the directed forgetting literature is a lack of consistency in results across studies and across laboratories. Some researchers use the two methods indiscriminately and then interpret the results according to cognitive inhibition without considering which method was used. Another problem is that there are not many studies that directly compare the two methods. This forces researchers to look across the literature to experiments done in other

laboratories, with different participants to compare the methods. On the rare occasion that methods are compared in one experiment (e. g., Macleod, 1999), they are compared in a between subjects design, making firm conclusions about the differences between methods more difficult to make. These problems are especially prevalent in literature examining directed forgetting in children. Problems such as these make it difficult to determine the developmental trajectory of performance in directed forgetting tasks.

For example, most researchers using the item cuing method have found that children are effective at selectively rehearsing. Foster and Gavelek (1983), for instance examined the length of time children paused as they studied words in an item cued directed forgetting task. They found that children presented with the item cuing method paused longer on TBR items than TBF items, suggesting that they were selectively rehearsing TBR items and not rehearsing TBF items. These results suggest that even children in first grade show a directed forgetting effect with the item cuing method.

On the other hand, researchers that examine directed forgetting in children using the block cuing method have found a different developmental pattern of performance than was found with the item cuing method. Harshinfeger and Pope (1996) found that the directed forgetting effect did not occur in children before fifth grade and that even the fifth grade students did not show as pronounced an effect as the adults. This offers support to the idea that the block cuing method is measuring something different from the item cuing method.

It is possible to compare the results of these two experiments and hypothesize that the two methods do measure different processes and that these processes develop at different

rates. In order to compare the methods, however, it is necessary to compare them within one experiment, within one lab, and within one group of participants. The current study addresses the problems mentioned before by comparing the two methods within subjects and across age groups to allow a more precise comparison of the two methods. Examining these methods within participants and across different age groups, would provide a more valid determination of whether the directed forgetting effects of these methods follow a different developmental pattern. These results would provide an additional line of evidence for the distinction of the processes underlying the two methods. In addition, the within participant comparison with both methods would illuminate any developmental differences in the ages at which children can inhibit or selectively encode and rehearse.

Specific hypotheses

Block Method

According to Harshinfeger and Pope (1996), the block cuing method measures retrieval inhibition. These researchers argue that retrieval inhibition begins to develop by fifth grade but is not fully mature until adulthood. If this hypothesis is correct, first and third graders should not be able to effectively inhibit the TBF words leading to equal recall of TBR and TBF words (see Table 1). Children in fifth grade, however, should begin to show a difference in recall of the words, with fewer TBF words than TBR words being

recalled. There may still be a small difference in performance compared to adults because even by fifth grade inhibition is not fully developed.

If inhibition accounts for directed forgetting effects in this task, the recognition test should show a different pattern of results (see Table 2). Children in first and third grade should recognize the same numbers of TBR as TBF words because they would not have inhibited the TBF words. In contrast to the recall test, fifth graders' and adults' recognition patterns may follow the same patterns as the younger children, with equal recognition of TBR and TBF words. Fifth graders and adults will follow this pattern because the previously inhibited TBF words would have been released from inhibition and recognized. Therefore, the directed forgetting effect should not be present for the recognition test at any age level.

Item cuing method

A different pattern of results is predicted for the item cuing method (see Table 1). According to Harshinfeger and Pope (1996), the item cuing method measures the ability to selectively rehearse. Because this ability develops much earlier than inhibition, children as young as first grade may show directed forgetting effects with this method (Foster & Gavelek, 1983). It is therefore predicted that all age groups will show the directed forgetting effect, recalling more TBR than TBF words.

During the recognition test, the same pattern should be observed (see Table 2). Because the TBF words were not rehearsed, they were not stored as well in memory. Participants would be less able to recognize those words on the recognition task. Thus,

once again, all age groups may show directed forgetting effects, recognizing more TBR words than TBF words.

CHAPTER 2

METHODS

Participants

Fifty-seven children from an elementary school in northern Georgia were selected to participate in this study. Three age groups were tested: 19 first graders, 19 third, and 19 fifth graders. Nineteen college-aged adults from a state university in Northern Georgia were also included. See Table 3 for a list of age and gender information. These age groups were selected because cognitive inhibition has been proposed to begin to develop by the fifth grade and selective rehearsal has been proposed to be developed by the first grade (Harshinfeger & Pope, 1996; Foster & Gavelek, 1983). Including children from first, third, and fifth grade should allow for the examination of these developmental differences between the two mechanisms. Adults were included as a control group of mature inhibitors.

Children were recruited by soliciting participation from schools in the north Georgia area. Schools were located by searching the Internet and phone books for all schools located near the University of Georgia. After several schools were identified, calls were made to the principals of these schools. A brief explanation was given to the principals about the purpose of the research and what would be required of the principal and faculty at the school.

After the principal agreed to volunteer his school for testing, letters were sent home to the parents of children in first, third and fifth grade classrooms. The specific classes that were

used were selected by the principal. Two first grade classes, two third grade classes, and two fifth grade classes participated.

Children whose parents returned signed permission slips were allowed to participate in the study. Once permission slips were returned, a list of all eligible students in each class was compiled. There was no set procedure for choosing the order that the grades and classes within the grades were tested. Instead, children were tested whenever they were available.

Materials

The stimuli consisted of two lists of 20 words. The words were unrelated within and across tasks and were equated for the word length (List A $\underline{M}$ = 4.5, List B $\underline{M}$ = 4.8) and word frequency (List A $\underline{M}$ = 67.6, List B $\underline{M}$ = 67.9). For the recognition tests, two lists of 40 words were generated, which contained the 20 words from the study list and 20 foil words. These foils were also matched for length (List A foils $\underline{M}$ = 4.7, List B foils $\underline{M}$ = 4.7) and frequency (List A foils $\underline{M}$ = 64.8, List B foils, $\underline{M}$ = 69.9). Frequencies were calculated based on work done by Thordike and Lorge (1944). For a complete lists of words used, see Tables 4 through 7.

The Matching Familiar Figures Test was used as a buffer-clearing task between presentation of the stimuli and recall (Kagan, 1965). A 100-piece Spiderman puzzle was used as a distraction between tasks.

Procedure

The tasks were counterbalanced with half of the participants in each grade level

completing the item method first and half completing the block method first. Lists were also counterbalanced with half of the children receiving List A for the block cued task and List B for the item cued task, and the other half receiving List B for the block cued task and List A for the item cued task. Children also participated in a picture-naming task during the experimental session that was part of another project. This picture-naming task was counterbalanced with the directed forgetting tasks with half of the children receiving the picture-naming task first and half receiving the directed forgetting task first.

Children were tested individually. They were told that they would be participating in several memory games that would see how many words they could remember. All children were given an opportunity to decline to participate before the experiment began, as well as permission to stop the study at any time. An attempt was made to have children feel as comfortable as possible with the experimenters. In order to achieve this, experimenters talked to them about their families, their plans for the summer, and other topics that would allow the children to relax. Once introductions were completed, the tests were started.

The total time for the experiment was approximately 40 minutes. This included the time it took to escort the child to and from the testing room, the getting acquainted conversations, the tests themselves, and time at the end for the children to select a pencil for participating. Below is a discussion of the specific procedures that were used. Although these are discussed in approximately chronological order, it is important to keep in mind that the tasks were not always presented in this order, but were counterbalanced, as discussed before.

Block Method

During the block method, the first half of the list was read to the participant. After each word was read, participants repeated the word one time to check for accuracy. After the first 10 words were presented participants were told that the first list had been just for practice and that they should forget those words and only remember the next set of words. The participants were then asked what they were supposed to do with the list they had just heard. This question was included to check that the instructions to forget were understood. After participants were clear on the instructions, they were presented with the second half of the list.

After both lists were presented, the Matching Familiar Figures Test was administered for 30 seconds as a buffer-clearing task. Recall was then tested for the words on both halves of the list. Participants were told to recall orally as many words as they could from the list, even those words from the list that they were told to forget. They were told that they could recall these words in any order they wished and had as long as they needed to recall the words. Responses were written down by the experimenter as well as audio taped.

After the children indicated that they had remembered all of the words that they could, participants completed the recognition test, which consisted of the 20 stimulus words and 20 new words. This list of 40 words was read aloud to the participants. They indicated if they had heard the word on the previous lists by saying yes or no.

Distraction

Between the block and item tasks participants worked with the researchers on completing a 100 piece Spiderman puzzle for 5 minutes. The purpose of this was to clear the

participants' memory of the previously presented words as well as to provide a distinction between the two memory tasks. After 5 minutes of working on the puzzle, the second task was administered.

Item Method

Participants were told that they would hear a series of words one at a time and as each word was presented they would be shown either a red or a green card. Participants were instructed that they should remember only the words they hear that are paired with a green card and they should forget all the words that are paired with a red card. After these instructions were given, participants were asked to indicate what they were supposed to do when read a word with a green card and with a red card. When it was clear that participants understood the instructions, they were read one word at a time. Remember and forget cues were presented in a random order. As the word was read, the experimenter held up a green or red card. After participants heard the word and saw the card, they repeated the word for accuracy and said "forget" or "remember" depending on which card they saw.

After all 20 words were presented, the Matching Familiar Figures Test was given. Next participants were asked to recall as many of the words as they could remember, even those that had been paired with a red card and that they had been instructed to forget. After this was completed, participants took a recognition test for this task that contained the 20 original words as well as 20 new foils. This task was administered in the same manner as the recognition test for the block cued items.

Deception

Deception was used in the first task in order to keep participants from expecting to be asked to remember the TBF words during the second task. After the first task was administered participants were told that the researcher made a mistake. They were told that the words that they had been told to forget (the first list in the block method or the red cards in the item method) were actually words that they were supposed to have remembered. They were asked to recall all words, even those that they had been told to forget under the guise that they would be helping the researcher. Debriefing questions during pilot research on adults showed that adults were deceived by the researcher's "mistake" and did not try to remember the TBF words during the second task. Children were not asked directly about this during the debriefing but did show varying degrees of concern about the researcher's "mistake" which indicated that the children did believe the deception.

Presentation Rate

Stimuli were not presented at a constant rate of presentation as is done in most studies of this nature (Wilson & Kipp, 1998). Instead as soon as participants correctly repeated the word back to the experimenter, and, in the block method, stated whether the word was to be remembered or forgotten, the experimenter read the next word. This set up a presentation rate of approximately 1 to 2 seconds per word. The presentation rate for most studies of this type is approximately 4 seconds per word (Wilson & Kipp, 1998; Harshinfeger & Pope, 1996; Lehman et. al, 1993). The fast presentation rate used in this study most likely did not allow participants much time, if any, to rehearse the words as they were read. This methodological

flaw may account for the floor effects in the children's recall. The speed of presentation, its relation to the results, and floor effects are detailed further in the discussion.

Data Coding Procedure

Recall and recognition were coded by counting the total number of each type of word recalled or recognized. In other words, all TBR items, TBF items, and items that were not in either category were counted and recorded separately. After all words were counted and recorded, a proportion was calculated that compared the number of each type of word recalled to the total number of words recalled. Analyses were then performed on both the raw number of words and the proportion of each type of word recalled.

CHAPTER 3

RESULTS

Preliminary Analyses

Before beginning analysis of effects of the interest, the data were examined for any confounding effects. No significant main effects or interactions were found for gender of participants, order of tasks, list used, or experimenter.

Recall

Results showed a pattern of very low recall across all participants. The children's recall was especially low at every grade level, showing consistent floor effects regardless of task. Adults performed slightly better, but still had low recall. See table 8 for the means and standard deviations of the recall scores.

Number of words recalled were examined in a 4 (grade level: first, third, fifth, and college) X 2 (task: block or item) X 2 (word type: TBR or TBF) mixed model analysis of variance, with grade level as a between subjects factor. The analysis yielded a significant main effect for grade level, F (3, 72) = 15.48, $p < .0001$, indicating that college aged adults recalled more words than all other age groups, regardless of word type or task. There were no differences in recall between any of the other age groups. The analyses also yielded a significant main effect for word type, F (1, 72) = 8.69, $p < .01$, indicating that more TBR words (M = 2.06) than TBF words (M = 1.60) were recalled, regardless of the task or the participant's

grade level. The main effects were modified by a significant grade level by word type interaction, F (3, 72) = 7.64, p < .0001. Adults recalled more TBR than TBF words regardless of task, t (18) = 4.47, p < .0001, whereas the other age groups recalled equal numbers of each word type. There were no other significant main effects or interactions.

These analyses suggest that the initial hypothesis that the item and block methods would have different developmental patterns was not supported. Children of all grade levels recalled equal numbers of TBR and TBF items, regardless of task, suggesting that they do not produce a directed forgetting effect until after fifth grade. The results for adults did fit the hypothesized pattern as they showed a directed forgetting effect on both tasks.

Proportion of word type recalled

Due to concern about floor effects in the recall test, the recall data were converted from raw scores to proportions of TBR or TBF words recalled. This was accomplished by dividing the number of TBR or TBF words recalled by the total number of words recalled. The resulting pattern did not differ very much from the pattern of raw scores. See Table 9 for a list of means and standard deviations of the proportions of words recalled.

The resulting proportions were examined in a 4 (grade level: first, third, fifth, or college) X 2 (task: block or item) analysis of variance, with grade as a between subjects factor. The analysis yielded a main effect of grade level, F(3, 72) = 5.04, p < .01. First grade children recalled a greater proportion of TBF than TBR words, third and fifth grade children recalled an equal proportion of TBR and TBF words, and college students

recalled a greater proportion of TBR than TBF words. No other main effects or interactions were significant.

These results are very similar to those found with the raw score, suggesting that the floor effects were not as problematic as originally thought. The patterns of the proportions continue to show no directed forgetting effects for the children, and a pronounced directed forgetting effect for the adults. This suggests that the mechanisms underlying the directed forgetting effect in both tasks may not be developed until after fifth grade.

Recognition

Scores on the recognition test were also low. Results were similar for all participants, regardless of age, but differed across tasks. See table 10 for a list of the means and standard deviations of the recognition scores.

Recognition scores were examined in a 4 (grade level: first, third, fifth, or college) X 2 (task: block or item) X 2 (word type: TBR or TBF) analysis of variance, with grade as a between subjects factor. Analyses yielded a main effect for task, $F(1, 72) = 4.21$, $p < .05$, indicating that more words were correctly recognized during the item task ($M = 8.04$) than during the block task ($M = 7.73$), regardless of grade level or word type.

This main effect was modified by a significant task by word type interaction, $F(1, 72) = 4.91$, $p < .05$. A closer examination of this effect revealed that in the item task participants recognized significantly more TBR items ($M = 8.30$) than TBF items ($M = 7.38$), $t(75) = 2.74$, $p < .01$, while in the block task they recognized equal amounts of TBR ($M = 7.66$) and TBF ($M = 7.80$) words. In addition, results indicate that participants recognized more TBR words in

the item task than in the block task, $t(75) = 3.41$, $p < .01$. No other main effects or interactions were significant.

These results support the hypothesis that the two methods are examining different underlying processes. As was predicted, participants recognized equal numbers of TBR and TBF words after the block cuing procedure, suggesting that the TBF words were encoded in memory but were inhibited during recall. On the other hand, the participants recognized more TBR items than TBF items after the item task suggesting that in this task the TBF items were not encoded in memory as well as the TBR items.

CHAPTER 4

DISCUSSION

The results obtained in this study paint an interesting and complex picture. The original hypothesis, which suggested that the patterns of development change in recall and recognition performance would be different in item and block cued tasks, was not supported. There were no interactions between word type and task. Rather, the pattern across tasks was the same on the recall test, with college aged adults recalling more TBR items and all other age groups recalling equal amounts of TBR and TBF items. This is contrary to what was expected if the tasks measured different processes. If the item task measured selective rehearsal, for instance, the results should have shown all age groups recalling more TBR than TBF items because selective rehearsal is thought to be developed by first grade. Instead, children in both tasks recalled equal numbers of TBR and TBF items. This suggests that the underlying mechanisms that lead to a directed forgetting effect in the item and block task are developing at the same rate, which may be considered evidence that the same mechanism, inhibition, is underlying both tasks.

Examining proportions of TBR and TBF words recalled provided a more precise analysis. Adults showed mature inhibitory ability, recalling a higher proportion of TBR items than TBF items. Third and fifth graders recalled an equal proportion of the two word types and first graders actually showed a preference for TBF items by recalling a significantly higher proportion

of those words than TBR words. These results are consistent with the inhibition theory of directed forgetting which states that inhibitory abilities are continuing to develop across the elementary school years and provide more evidence that inhibition underlies both methods (Wilson & Kipp, 1998).

The patterns of performance on the recognition tasks suggest a different conclusion, however. When inhibition is the causal mechanism in directed forgetting participants typically recognize equal numbers of TBR and TBF words (Bjork, 1989, Harshinfeger & Pope, 1996; Wilson & Kipp, 1998). This pattern was found in the block task, suggesting that that inhibition is responsible for the directed forgetting effect in recall on this task. This pattern suggests that during the recognition task the words were released from inhibition, resulting in equal recognition of TBF and TBR words. In the item task, however, participants continued to show a directed forgetting effect, recognizing more TBR than TBF items regardless of grade level. These results suggest that the TBF items were not encoded as well as the TBR items, and that selective rehearsal is responsible for directed forgetting effects in the item task.

The results, therefore, are contradictory. Whereas the recall test points to inhibition as the underlying mechanism for both tasks, the recognition test suggests that these two tasks are measuring different processes. There are several interpretations of these results. First, the two methods may measure different processes, despite the similar course of development of the recall task. Perhaps inhibition and selective rehearsal follow similar patterns of developmental change, not maturing fully until after fifth grade. This would explain the results from the recognition test. This interpretation calls into question

literature suggesting that selective rehearsal is fully developed by first grade (Foster & Gavelek, 1983).

Another interpretation of these results focuses on the methodological error mentioned in the method section. A close look at the results for the recall test shows consistent floor effects for the children in all conditions. Whereas most experimenters conducting directed forgetting experiments use a three or four second rate of presentation, I presented words at the rate of approximately one to two words per second. This fast speed may be the cause of the floor effects that are so apparent in the data for the younger children. Even the adults' recall is low compared to other studies, which typically show adults recalling more words (Wilson & Kipp, 1998). The speed of presentation may have prevented adequate rehearsal of the items, preventing most words from being encoded in memory. This would also explain the rather low recognition scores, in which even adults were unable to recognize more than half of the presented words.

To address this methodological error, a proportional recall analysis was conducted. The results of this analysis were similar to that of the raw data. There was a consistent inhibition pattern across both tasks. In addition, previous researchers examining adults have found that the directed forgetting effect continues to occur despite fast presentation speeds (Davis & Okada, 1971). This would seem to imply that the floor effects are not to blame for the contradictory results of the recall and recognition data.

The fast presentation speed offers another interpretation, however. By presenting the

items so quickly, the participants may have been unable to rehearse during presentation. Taking away this rehearsal opportunity would explain the floor effects for the children and the low recall and recognition scores for the adults. The question then becomes, what would reducing rehearsal during these tasks do to the pattern of results across tasks and word types? The answer to this may be found Lehman et al.'s (1997) work mentioned earlier in this paper. Lehman et al. used an item cued procedure to examine the directed forgetting effect in third and forth grade children and adults. In their procedure, they prevented participants from rehearsing by having them count aloud after each cue was presented. They argued that doing so would prevent selective rehearsal, and therefore, any directed forgetting that occurred must be due to inhibition. They found directed forgetting effects for all age groups, and concluded that inhibition must play a role in the item cued procedure. Lehman et al. made two conclusions relevant to the current study. First, they took their results as evidence that directed forgetting in the item task relies, at least in part, on inhibition. Second, they noted that there was no difference between the performance of the adults and children when rehearsal was eliminated, and proposed that inhibition must therefore be developed by third grade.

If the methodological error of fast presentation speed inadvertently created conditions similar to those in Lehman's study, results from the current experiment should mirror Lehman's results, at least in the item cued task. However, the results from the current study do not fit with the Lehman et al. study. Recall performance was not equal across age groups in the current study. In contrast to Lehman's experiment, adults in this study showed a directed forgetting effect whereas children did not. Thus, these results do not support Lehman's conclusion that

inhibition is fully developed by third grade. It could be that the methodology used by Lehman et al. was sufficiently different from the methodology employed here. Perhaps the counting required in the Lehman study was more taxing and allowed less rehearsal than the fast presentation speed of the current study. This is unlikely, however, as it is obvious by the low levels of recall of the TBR words that rehearsal in the current study was compromised. Critically, it is impossible to be sure that Lehman et al. actually measured inhibition in their study because they did not include a recognition test. Without a recognition test, it is not known if participants actually encoded the TBF items in memory. It could be that although participants were unable to selectively rehearse because of the counting task, they were still able to selectively encode the TBR items. In the current study, a recognition test was conducted. The results from that test are consistent with the theory that even with the reduced time for selective rehearsal, participants were still able to selectively encode the TBR items.

Unfortunately, the results obtained in this study are difficult to interpret because of the floor effects, lack of time for rehearsal, and inconsistencies with previous research. The central hypotheses of this study, namely whether the block and item cued measures of directed forgetting have different developmental patterns and whether these two tasks are therefore measuring different underlying mechanisms, remain unanswered. In order to better address these questions, a study is needed in which presentation speed is kept constant and consistent with the previous literature in this area. To address this concern, I am currently conducting a second study with similar methodology to the one discussed here. The only new feature in this study is a constant presentation speed of one word every four seconds. By providing participants with

time to effectively rehearse the words in both tasks, I hope to more effectively address the questions raised in this study.

In addition, the methodological error that occurred in this experiment and the inconsistencies with the findings of Lehman et al. present an interesting new area of future research. Research should be conducted that attempts to replicate Lehman's findings as the results presented here are contradictory to what Lehman found. Similar methodology should be used, with counting used to prevent rehearsal, so that a more direct comparison can be made. It would also be interesting to include both tasks so that differences between the tasks could be compared. A recognition test should be also be included so that firmer conclusions can be made about possible inhibition in the item cued task.

Until more experiments are conducted that directly compare the two methods, the debate about the causal mechanisms for both tasks will continue. Research is needed to continue to differentiate the two methods which will allow future researchers to be cognizant of the underlying mechanisms they are actually testing when using these procedures.

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APPENDICES

Table 1

Predicted results on recall test for block and item cuing methods

	Block Cuing	Item Cuing
First grade	TBF=TBR	TBF<TBR
Third grade	TBF=TBR	TBF<TBR
Fifth grade	TBF<TBR	TBF<TBR
College	TBF<TBR	TBF<TBR

Table 2

Predicted results on recognition test for block and item cuing methods

	Block Cuing	Item Cuing
First grade	TBF=TBR	TBF<TBR
Third grade	TBF=TBR	TBF<TBR
Fifth grade	TBF=TBR	TBF<TBR
College	TBF=TBR	TBF<TBR

Table 3

Mean age, age range, and gender of participants

	Age	Age range	Males	Females
First grade	7. 36 (.37)	6.83 - 8.33	8	11
Third grade	9.39 (.45)	8.83 - 10.33	7	12
Fifth grade	11.56 (.61)	10.75 - 12.67	5	14
College	19.67 (1.08)	18.00 - 21.00	3	16

Table 4

List A, with word length and frequency according to Thorndike and Lorge (1944)

	Frequency	Word Length	TBR or TBF
Baby	100	4	TBR
Bank	100	4	TBF
Bear	100	4	TBR
Bread	50	5	TBF
Brother	100	7	TBF
Cake	50	4	TBR
Candle	43	6	TBR
Ear	100	3	TBF
Egg	100	3	TBR
Hour	100	4	TBF
Jar	43	3	TBF
Map	50	3	TBF
Moon	100	4	TBR
Nose	100	4	TBR
Pencil	40	6	TBF
Pillow	33	6	TBR
Puppet	6	6	TBR
Soap	37	4	TBF
Sword	50	5	TBR
Wheel	50	5	TBF
	$\underline{M}$ = 67.60	$\underline{M}$ = 4.5	

Table 5

List B, with word length and frequency according to Thorndike and Lorge (1944)

	Frequency	Word Length	TBR or TBF
Blanket	30	7	TBR
Box	100	3	TBF
Butter	100	6	TBR
Church	100	6	TBF
Dress	100	5	TBF
Elbow	26	5	TBF
Fence	50	5	TBR
Fire	100	4	TBR
Hat	100	3	TBF
House	100	5	TBF
Lion	50	4	TBR
Magnet	9	6	TBF
Milk	100	4	TBF
Mother	100	6	TBR
Owl	35	3	TBR
Scale	50	5	TBR
Spider	100	6	TBF
Swing	50	5	TBF
Wall	100	4	TBR
Weed	34	4	TBR
	$\underline{M}$ = 67.9	$\underline{M}$ = 4.8	

Table 6

List A Foils, with word length and frequency according to Thorndike and Lorge (1944)

	Frequency	Word Length
Arm	100	3
Doll	46	4
Earth	100	5
Fish	100	4
Floor	100	5
Fox	25	3
Goat	50	4
Kitchen	100	7
Moss	22	4
Nail	50	4
Penny	38	5
Piano	26	5
Plate	50	5
Quarter	100	7
Stew	11	4
Stove	40	5
Train	100	5
Uncle	100	5
Vine	38	4
Woman	100	5
	$\underline{M}$ = 64.8	$\underline{M}$ = 4.7

Table 7

List B Foils, with word length and frequency according to Thorndike and Lorge (1944)

	Frequency	Word Length
Ant	38	3
Back	100	4
Board	100	5
Branch	100	6
Bridge	100	6
Cherry	35	6
City	100	4
Clock	50	5
College	100	7
Dish	50	4
Door	100	4
Fan	38	3
Fern	13	4
Frog	25	4
Glue	15	4
Guard	100	5
Hill	100	4
Ice	100	3
Mountain	100	8
Mouse	34	5
	M = 69.9	M = 4.7

Table 8

Mean Recall Score as a Function Of Grade Level, Task, and Word Type

Grade		Block Cued	Item Cued
First			
	TBF	1.47 (1.02)	1.63 (1.07)
	TBR	1.00 (1.33)	1.16 (1.02)
Third			
	TBF	1.37 (1.17)	1.47 (0.91)
	TBR	1.63 (1.07)	1.68 (1.25)
Fifth			
	TBF	2.00 (1.29)	0.90 (0.88)
	TBR	1.84 (1.34)	2.00 (1.56)
College			
	TBF	2.16 (1.78)	1.79 (1.08)
	TBR	3.63 (2.16)	3.47 (1.71)

Table 9

Mean Proportion of Each Word Type Recalled as a Function Of Grade Level, Task, and Word

Grade		Block Cued	Item Cued
First			
	TBF	.64 (.35)	.54 (.32)
	TBR	.31 (.32)	.41 (.31)
Third			
	TBF	.44 (.29)	.46 (.32)
	TBR	.56 (.29)	.49 (.32)
Fifth			
	TBF	.51 (.30)	.27 (.30)
	TBR	.49 (.30)	.57 (.37)
College			
	TBF	.32 (.21)	.32 (.18)
	TBR	.68 (.21)	.67 (.18)

Table 10

Mean Recognition Score as a Function of Grade Level, Task, And Word Type

Grade		Block Cued	Item Cued
First			
	TBF	7.47 (2.27)	7.68 (2.43)
	TBR	7.11 (2.35)	7.79 (1.72)
Third			
	TBF	7.68 (1.38)	8.21 (1.13)
	TBR	7.79 (1.78)	8.47 (1.35)
Fifth			
	TBF	8.05 (1.47)	7.68 (1.49)
	TBR	7.68 (1.50)	8.05 (1.31)
College			
	TBF	8.00 (1.29)	7.53 (1.31)
	TBR	7.53 (1.31)	8.90 (1.24)