The Rainbow Mnemonic Improves Recall in Preschool Children

Elena Ramlow (ramlow23@gmail.com)
Department of Psychology, Hillsdale College,
33 E. College Ave. Hillsdale, MI 49242

Jeri L. Little (jeri.little@csueastbay.edu)
Department of Psychology, California State University, East Bay
25800 Carlos Bee Blvd. Hayward, CA 94542

Abstract

Mnemonic devices aid recall. However, little research has explored their use with preschool-aged children. The present studies examined whether a new peg-type mnemonic technique (rainbow mnemonic) could be used to improve memory in preschool children. Item cards, which displayed a picture and its label, were studied alongside colored cards, and this condition was compared to a control condition in which children were left to their own devices to study the item cards. In Experiment 2, the rainbow mnemonic was also compared to a condition in which the children did not have access to the color cues during study or recall. The experiments revealed that the rainbow mnemonic could improve recall for preschool children as compared to control. This study demonstrates the effectiveness of a novel peg-type technique with preschool-aged children.

Keywords: mnemonic; peg-word; peg-type; memory; preschool; learning

Background

Mnemonic techniques such as the method of loci, the peg-word technique, and the keyword technique improve recall of to-be-remembered items. These techniques allow learners to form associations between pre-established knowledge and to-be-remembered information in a manner that makes the to-be-remembered information more memorable (Bellezza, 1981; Wood, 1967). The positive effects of mnemonic techniques on recall have been studied extensively, but limited research has been conducted on benefits that mnemonic techniques may provide to young children who have not yet begun the traditional K-12 education (DeLoache, Cassidy, & Brown, 1985), and even less research has established the benefit of a peg-type technique with children preschool aged or younger. The present study examines the effect of a peg-type mnemonic technique that we designed for the purposes of this study (the *rainbow mnemonic*) on the recall abilities of preschool children.

Peg-type Mnemonic Devices

A common type of mnemonic technique to remember items is the peg-type, which includes the peg-word technique and method of loci. These organizational mnemonics include cues that are extrinsic to the to-be-learned material, with the cues then functioning as reminders (Bellezza, 1981). For example, imagine you want to remember a shopping list (e.g., milk, eggs, chicken). The peg-word technique uses an established rhyme (e.g., *one is a bun, two is a shoe, three is a tree, etc.*), and learners form mental images with the items in the rhyme being attached to the information to remember (e.g., a bun soaking in milk). At the time of recall, the items in the rhyme serve as extrinsic cues that should remind the person of the information they wish to remember (Bellezza, 1981; Bugelski, Kidd, & Segmen, 1968; Morris & Reid, 1970; Wood, 1967).

Another well-known peg-type technique is the method of loci. In the method of loci, a series of well-known places are memorized in a strict order (e.g., one's home: enter through garage, then into the mud room, then into the kitchen). Learners then take the to-be-learned information and form interactive images containing items that represent the to-be-learned information in the well-known places (e.g., milk all over the floor of one's garage; Bellezza, 1981; Groninger, 1971; Ross & Lawrence, 1968).

Both the peg-word technique and the method of loci are beneficial for remembering a list of (usually) familiar items.

Mnemonic Application in Preschool Children

Although much research has been conducted on the use of mnemonic techniques on children (primarily in the 1970's and 1980's), generally little work has examined the potential benefits of using mnemonic devices with children younger than five years of age (DeLoache et al., 1985). When studied, mnemonics have focused on improving memory for objects and spatial relationships, not verbal materials such as a list of words. For example, DeLoache et al. (1985) found that 18 to 24 month-old children used rudimentary mnemonic skills to remember where a toy had been hidden (see also Watkins & Schadler, 1980). Flavell (1977) suggested that preschool-aged children are incapable of effectively using mnemonic strategies for verbal learning, but at least two studies have shown evidence to the contrary. Specifically, Kraft et al. (1990) showed that preschool children could learn a list of items more effectively with the method of loci than without, and Pressley, Samuel, Hershey, Bishop, and Dickinson (1981) showed that preschool children could learn English-Spanish word-pairs more effectively with a keyword mnemonic than without.

Kraft et al. (1990) found evidence for the effectiveness of the method of loci mnemonic with preschoolers ranging in age from 3 years 4 months to 5 years 5 months. In one condition (method of loci), participants were shown the gameboard to "Candyland," and the experimenter listed

words while pointing to locations on the gameboard and told participants to try to imagine the item interacting with the location in a specified way. Participants in this condition remembered more than did (a) participants who were told the item and the board location but not told how the two items should interact and (b) participants who were given the sentences about the interactions but did not see the board. Additionally, in their Experiment 2, participants who were trained on the method of loci technique were better able to transfer that mnemonic skill to another learning task than were participants who were not trained.

Like the peg-type mnemonics, the keyword mnemonic relies on interactive imagery. Both are useful for learning educational materials, but the keyword mnemonic differs from peg-type mnemonics in that it serves to improve the connection between familiar and unfamiliar information rather than improve memory for a list of familiar information. Specifically, in order to form a connection between familiar information (e.g., words in native language) and the less familiar to-be-learned information (e.g., words in foreign language), learners choose (or are given) a well-known word that sounds similar to the to-be-learned information to serve as a cue, and they then construct (or are given) an interactive image that combines the cue and the information they already know (Atkinson, 1975; Raugh & Atkinson, 1975). For example, to learn that *pato* is the Spanish word for duck, learners may imagine a duck in a pot; the image of the duck in the pot would then remind them of the similar sounding word, *pato.*

Pressley et al. (1981) examined young children's learning of English-Spanish translations using the keyword mnemonic. Experiments 2 and 3 examined children ranging in age from 2 years 10 months to 4 years 11 months. In their experiments, Pressley et al. (1981) compared a keyword mnemonic condition to a control condition. In both the keyword and control conditions, participants were explicitly told that the keyword referent (e.g., pot) sounded like the Spanish translation (e.g., *pato*) and they practiced recalling the keywords to the Spanish translations until they could remember all of the keywords. In the keyword condition, participants were told that the keywords would help them remember the Spanish items, whereas the participants in the control condition were told that the keywords would help them to know what the items sounded like. Following the study of keywords, participants in the keyword condition studied pictures containing the keyword referent (e.g., pot) interacting with the translation referent (e.g., duck) and were told that they should remember these pictures because they would help their memory later. In the control condition, participants saw line drawings of just the translation referent and were told to try to remember the English equivalent of the Spanish word. Results showed that the keyword procedure improved memory as compared to the control procedure. Pressley and MacFadyen (1983) showed additional evidence for the effectiveness of the keyword mnemonic for preschool children in a word-pair learning task.

Use of Color with Preschool Children and the Logic of the Rainbow Mnemonic

Our goal was to provide additional evidence that preschoolers can use mnemonic devices. To do so, we developed a peg-type technique based on color.

By the age of four, the majority of children are able to identify basic colors, including red, orange, yellow, green, blue, purple, pink, gray, and black (Johnson, 1977). The development of color recognition mostly takes place before 3.5 years (Johnson, 1977). Additionally, color seems to be involved in visual memories (e.g., Cochrane, 2019; although the exact nature of how color is perceived in mental imagery is uncertain; see Bramão, Faisca, Forkstam, Reis, Petersson, 2010). Given preschoolers' knowledge of colors (as suggested by research as well as suggested by the director of the preschool where we intended to conduct our study), we hypothesized that these preschool children could imagine items in various colors.

Assuming that the children are able to successfully imagine concrete and well-known items in the paired colors, those images could form the basis for their better memory later, consistent with other image-based mnemonics like the keyword technique. Pressley (1982) argued that children as young as four years old have the ability to generate elaborative imagery, but their ability to do so depends upon the nature of the materials: Concrete objects may be developmentally easier than verbal materials. For this reason, we presented the items as pictures (with words underneath), and we asked participants to provide a verbal descriptor. Additionally, we provided colored cards.

The Present Research

In an attempt to design a technique suitable for preschool aged children, we created a peg-type technique (i.e., *rainbow mnemonic*) in which colors of the rainbow (minus indigo, plus pink, gray, and black) were used as the "pegs," and participants were to imagine a to-be-remembered item (presented as a picture) in a certain color. In a pilot study (n = 23), the rainbow mnemonic appeared to promote recall for preschool children. Number of to-be-learned items and ideal session lengths were determined on the basis of this pilot testing and consultation with the preschool director. Although not part of the rainbow, we added pink, gray, and black so that we would have enough items to avoid ceiling effects. We did not include indigo because it is not a common color name in preschoolers' lexicon.

The question of interest was whether this new mnemonic would improve recall as compared to a control condition. Based on the research by Kraft et al. (1990) and Pressley et al. (1981) and research about preschooler's knowledge of color, we expected that it would.

Experiment 1

In Experiment 1, participants completed two sessions which were separated by several days. During one session, they simply tried to remember a list of item cards (control). During

the other session, they were trained with the rainbow mnemonic.

Method

Participants Nineteen typically developing children (12 female) from a preschool in a small Midwestern town participated in this experiment. Children were mostly Caucasian, and ages ranged from 4.0 to 5.6 years (M = 4.6, SD = 0.50). The children's parents received a letter about the study and consented to their child's participation. This sample included all participants aged four and above in the preschool whose parents provided consent and who were willing to participate.

Design The study utilized a within-subjects design. The independent variable was mnemonic technique (mnemonic or control), and the dependent variable was number of words recalled.

Materials Eighteen to-be-learned words were selected for the purposes of this study. The to-be-learned words were divided into two lists such that each list contained an animal, natural item, toy, food item, transportation method, clothing item, kitchen item, furniture, and instrument item, based upon the updated and expanded category norms of Battig and Montague (Van Overschelde, J., Rawson, K., & Dunlosky, J., 2006). Words used for the lists were chosen from the top 15 words for their respective category and were easily represented in a simple drawing. Black and white line drawings were then selected for each word. The names of the items were printed on the cards (we did not expect the preschoolers to use this information, although some could). Each list was designed to be about equal in difficulty.

Figure 1: This figure shows the color cards and one set of item cards used in Experiments 1 and 2.

Laminated cards (5.5 by 8 in) in nine colors (i.e., red, orange, yellow, green, blue, purple, pink, gray, and black), as shown in Figure 1, were used to create the "pegs." For the to-be-learned items, 18 white laminated cards (5.5 by 4 in) with the aforementioned black and white line drawings and their corresponding word (printed in 60 pt. Calibri font) were constructed, also shown in Figure 1. The color cards had Velcro on the front, and the item cards had Velcro on the back so that the two cards could be attached during the experiment.

Procedure All participants completed two sessions on separate days, with one session for the rainbow game (mnemonic condition) and one for the word game (control condition). Conditions were counterbalanced across participants, and the different orders were randomly assigned.

Prior to beginning a session, participants were told that it was their turn to play a memory game, and they were taken into the preschool director's office. The participant and researcher sat on floor, and the researcher explained that they would be playing a memory game—either the rainbow game or the word game—depending on the condition.

For the rainbow game (mnemonic condition), the participant was shown the nine colored cards and asked if they knew what each color was. If the child was incorrect or did not know the color, the researcher would correct/inform the participant and seek confirmation that the participant understood. The researcher placed each card on the floor as the participant named the color. Next, the researcher went through each of the item cards, asking the participant to name each item. If the participant incorrectly identified the item or was unable to name the item, the researcher provided corrective feedback (e.g., this is a piano, like the instrument you sit and play at, right?). If the participant provided a synonym (e.g., jacket for coat, light for lamp), the researcher did not correct the participant and simply used the participant's word as the to-be-learned item. The researcher then velcroed each word card to a color saying, for example, "imagine a red dog," in the case that red was paired with dog, "imagine an orange leaf," in the case that orange was paired with leaf, and so on. The researcher told the participant that the color cards would still be there when the participant was asked to recall the words and that using them to remember the words would be helpful. The participant was then given an additional 45 s and was told to learn the words using the colors. If participant became distracted, their attention was redirected back to the task ("Let's keep learning our words").

For the word game (control condition), the participant was shown the nine item cards and asked to name each item, in the same manner as in the mnemonic condition. This was done twice in immediate succession. Presenting each participant with the item cards twice in the control condition controlled for exposure to the words and time spent teaching the words as compared to the mnemonic condition. Then, 45 s for additional study was given, and the researcher redirected distracted participants, as was done in the mnemonic condition.

Following the learning phase (in each condition), the researcher distracted the participant for 30 s with an unrestricted drawing task (i.e., a blank piece of paper and writing utensils were provided).

The researcher then asked the participant to recall the words they had just learned. In the mnemonic condition, the

colored cards were present; in the control condition, they were not. The correctly named items were recorded. As mentioned, if a participant named an item by a commonly used synonym (e.g., jacket instead of coat, light instead of lamp) during the learning phase, the researcher considered that word the correct answer in the test phase.

Each session lasted about seven minutes, and each participant had two sessions, with sessions occurring between seven and fourteen days apart. The long delay between sessions reduced the likelihood that participants would remember details of their earlier experience. The order of the conditions (mnemonic vs. control) and which set of items was used for each condition was counterbalanced across participants.

Results and Discussion

Number of correctly recalled items were scored for each participant for each condition without regard to order. As mentioned, if the participant provided a synonym during the study phase and then on the test (e.g., jacket for coat), the researcher did not correct the participant and simply used the participant's word as the to-be-learned item. A paired-samples *t* test revealed that participants recalled more words in the mnemonic condition (M = 4.9, SE = 0.6) than in the control condition (M = 4.0, SE = 0.5), $t(18) = 2.96$, $p = 0.01$, $d = 0.69$.

In Experiment 1, we showed that the rainbow mnemonic could improve recall, as compared to a control condition in which the children were left to their own devices to learn the words.

In Experiment 2, we aimed to replicate the present result and examine whether participants could use the mnemonic technique even if the pegs were not physically present during learning or during the test (*mental mnemonic* condition). We added this exploratory condition for a practical reason: examinations of peg-type mnemonics in older children and adults typically involve holding the pegs in memory during learning and recall.

Experiment 2

Experiment 2 utilized the mnemonic and control conditions used in Experiment 1 in addition to a new mental mnemonic condition. All participants participated in all three conditions.

Method

Participants Thirty-one typically developing children (17 female) from a preschool in a small Midwestern town participated in this experiment. The age range of participants was 4.0 to 5.1 (M = 4.4, SD = 0.36), and they were primarily Caucasian. The children's parents received a letter about the study and consented to their child's participation. This sample included all participants aged four and above in the preschool whose parents provided consent and who were willing to participate. None of these children had participated in Experiment 1.

Design The study utilized a within-subjects design. The independent variable was mnemonic technique and had three levels (i.e., mnemonic, mental mnemonic, or control), and the dependent variable was number of words recalled.

Materials The materials were the same as those used in Experiment 1, except that nine additional item cards (one additional set) were created for Experiment 2 for counterbalancing purposes. These used the same requirements as those used in Experiment 1.

Procedure In the present experiment, all participants took part in three sessions on separate days—one for each of the three conditions. The procedure was the same as that used in Experiment 1, except for the addition of mental mnemonic condition, which is explained below. The three sessions took place a minimum of three days apart. Again, condition and item set were counterbalanced across conditions, and participants were randomly assigned to a specific counterbalancing condition.

The mental mnemonic condition was the same as the mnemonic condition used in Experiment 1 with the following exceptions. Without being shown colors, the participant was asked if they knew the colors of the rainbow. The researcher then verbally went over the colors of the rainbow with the participant, telling them to imagine the rainbow in their head. The researcher asked the participant to imagine that this rainbow also had the color pink in it, that there was a large gray cloud by their rainbow, and that a big black bird flying by. She told the participants that they would use all these colors in their head to help them remember words. Then, the researcher presented the participant with the item cards in the same manner as in the mnemonic condition. The first time she presented the item cards, the researcher asked participants to name all of the pictures on the cards. For the second exposure, the researcher reminded the participant of the imaginary rainbow, and then placed each item card on the ground saying, for example, "imagine a red dog" if red were paired with dog, and so on.

After going through the words twice (as was the case in the other two conditions), the participant was told to try to learn the words using the colors in their head and was given 45 s to do so. The participant then engaged in the distractor drawing task for 30 s, and was then asked to recall the items without the color cards present. The mental mnemonic condition—like the other two conditions—took about 7 minutes.

Results and Discussion

One participant was excluded from analysis due to complications during the session.

Number of correctly recalled items were scored for each participant for each condition. Again, if the participant provided a synonym during the study phase and then on the test (e.g., jacket for coat), the researcher did not correct the participant and simply used the participant's word as the to-be-learned item. A repeated-measures ANOVA failed to show that performance was affected by condition, $F(2,58) =$

1.22, p = .30. Participants recalled numerically more words in the mnemonic condition (M = 4.3, SE = 0.4) than in the control condition (M = 3.7, SE = 0.4). Performance for the mental mnemonic condition (M = 4.1, SE = 0.4) was also numerically higher than performance in the control condition.

Because the mnemonic and control conditions were identical across the two experiments, we combined the data for those two conditions across experiments. As shown in Figure 2, when collapsing across Experiments 1 and 2 (for the two conditions that were the same in the two experiments), participants (N = 49) recalled statistically more items in the mnemonic condition (M = 4.6, SE = 0.3) than in the control condition (M = 3.8, SE = 0.3), $t(48)$ = 2.83, p = 0.01, d = 0.40.

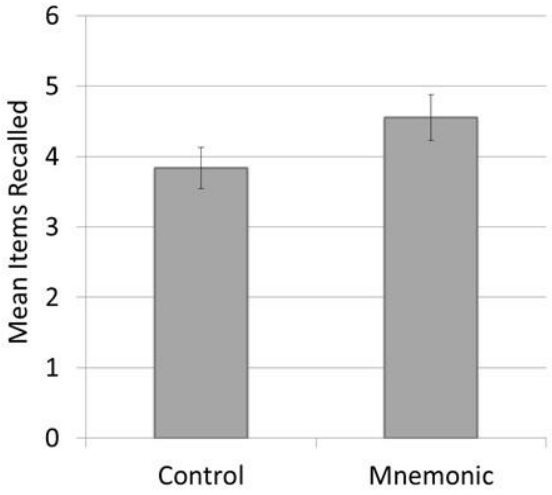

Figure 2: Mean number of items correctly recalled in the control and mnemonic conditions across Experiments 1 and 2. Error bars represent +/- 1 SE.

The present experiment was conducted in order to (a) replicate the finding that preschool children could use the rainbow mnemonic to memorize a list of items and (b) examine whether a physical presentation of the pegs (during learning and recall) was necessary for the mnemonic benefit.

The present results showed a trend towards the mnemonic condition helping performance as compared to having no mnemonic (i.e., control), but the advantage was not reliable in the present study. This may have been an artifact of increased variance from adding a new list of items and introducing a third session, or the significant result in the first experiment may have been a Type 1 error. It seems more likely that the null result in the second experiment was a Type 2 error because the collapsed results showed a reasonable effect with a large sample (n = 50, within-subject) preschoolers.

General Discussion

Mnemonic techniques are known to help memory, but little research has investigated their use with preschool-aged children, and even less work has explored the use of such techniques to improve verbal learning. The present paper introduced a peg-type technique (i.e., the rainbow mnemonic) that could be used effectively by preschool children. This study is one of the first to show a benefit of a peg-type technique in children five years old or younger and one of a small number of studies to show a benefit of mnemonic techniques for verbal learning in preschool-aged children.

Both Experiment 1 and a combined analysis of Experiments 1 and 2 showed that the rainbow mnemonic technique improved memory as compared to a control condition. Importantly, this benefit occurred without providing images that explicitly combined the cue/peg and the to-be-remembered word (e.g., a picture of a red dog). That is, the color cards (e.g., red) and item cards (e.g., dog) were presented separately, and participants had to combine the information. This is important because Pressley et al. (1981) suggested that a possible explanation of their finding better recall in the keyword condition than in the control condition was the provision of an interactive image in the keyword condition but not in the control condition (see also Pressley & Levin, 1978). They argued that young children may be unable to create their own interactive images (see Wolff & Levin, 1972). It should be noted that Kraft et al. (1990) also showed a benefit of the method of loci without the provision of interactive images.

It was our belief that children could and would create images that combined the pictures and colors, and the better performance in the mnemonic condition than in the control condition is consistent with this belief. However, semantic processing more generally (e.g., Craik & Tulving, 1975) may have been responsible for the benefit we observed. For example, participants did sometimes object to the items (e.g., "a red dog?" followed by giggles or telling the researcher that dogs are not red), and such responses may have been evidence of non-imagery-based processing, albeit semantic processing that promotes learning. Why the rainbow technique works is a question for future research.

It also may be of interest whether participants' age influenced their ability to successfully use the rainbow technique. Collapsing across the two experiments, there was no evidence for a relationship between mnemonic benefit (i.e., benefit of mnemonic condition over control) and age, $r(48)$ = 0.03, p = .81. This null result may be the result of restricted range, as the range of ages of the participants in our study was only a bit over 12 months.

Another consideration is that these participants attended preschool. Preschool children may be better able to use mnemonic strategies than would children of the same age who do not attend an educational program. The homogeneity of our sample (mostly Caucasian, small town) is also worth consideration.

Limitations and Other Considerations

Our sample size was limited by the number of students in our preschool population, and this may have limited our ability to detect the benefit of the mnemonic condition in Experiment

2. However, the effect in Experiment 1 may also be due to a Type 1 error. Although we obtained a reliable benefit of the mnemonic condition compared to the control condition in the combined analysis of Experiments 1 and 2, future research is warranted to establish whether the rainbow mnemonic is a reliable technique to improve preschooler's memory.

Furthermore, we did not show evidence that children could use the rainbow mnemonic when the colored cards were not physically present during study and recall in Experiment 2. We added this condition because in practice, most pegword techniques are used after the learner memorizes the pegs. In hindsight, we may have overestimated children's ability to remember the order of the colors in a rainbow. In fact, many children and even older individuals struggle to remember the order of colors in a rainbow and use a mnemonic for this purpose (e.g., ROY G. BIV, Richard of York Gave Battle In Vain). Additionally, our participants also had to remember pink, black, and white, which created a larger mental load. Unfortunately, although we asked participants whether they knew these colors during the learning phase, we did not record information pertaining to that knowledge. This knowledge may be an important predictor of the effectiveness of the mental mnemonic condition.

Although the present research shows that preschool children can use a mnemonic technique when those recall cues (i.e., colors) are present at both study and test, the present studies do not address whether participants would be able to recall the items if the cues were only present during study but not on the test. Our prediction, based on performance from the mental mnemonic condition in Experiment 2 is that they would not be able to do so, but this would likely be easier than the mental mnemonic condition in Experiment 2 because in the mental mnemonic condition the cues were not present during study or test. As mentioned, one boundary condition in whether mnemonic techniques work with young children is the extent to which pictorial support is given during study (Pressley, 1982).

Our study also does not address whether preschool aged children would ever spontaneously use the rainbow technique. Many have argued that it is unlikely because spontaneous strategy use tends to develop at a later age (see e.g., Flavell, 1970; Pressley & Dennis-Rounds, 1980) and may be a consequence of introduction to formal education (Morrison, Smith, & Dow-Ehrensberger, 1995). Flavell, Friedrichs, and Hoyt (1985) argued that children do not spontaneously engage in mnemonic strategies because they do not know how to use them or even when they are needed. However, Kraft et al. (1990) found evidence that previous experience with the method of loci technique led to better performance on a subsequent task (with a new gameboard) as compared to a control condition. This benefit was larger still when participants were reminded of the previous task.

It is also possible that such techniques could be developed over time, resulting in spontaneous use. A longitudinal study could examine the effects that teaching preschool children mnemonic devices have on their strategy use in the future. Furthermore, longitudinal research could examine whether early exposure to mnemonic devices could lead to greater cognitive abilities or influence processing later in life. Grammer, Coffman, and Ornstein (2013), for example, found that children who had first grade teachers that employed a mnemonic style of teaching exhibited more sophisticated strategy use by the spring. The instruction, based on metacognition, improved the students' own cognitive reasoning skills and allowed them to apply this knowledge to other activities. Additionally, this advantage persisted when they were measured in the second and fourth grades. Whether for short-term use or as a learned strategy for spontaneous use, the present research clearly has potential educational implications.

Concluding Remarks

In conclusion, there is little research on the ability of preschool children to use mnemonic techniques for verbal materials. The present work provides initial evidence of a new peg-type technique that could be well suited to this age group. Research showing effective mnemonic use in preschoolers raises the question of whether children could begin learning these techniques earlier, and whether there would be downstream effects that could improve their metacognitive strategies later.

Acknowledgments

We thank Sonja Bindus and the families at Mary Randall Preschool for their participation.

References

Atkinson, R. C. (1975). Mnemotechnics in second-language learning. *American Psychologist, 30,* 821-828. doi: 10.1037/h0077029

Bellezza, F. (1981). Mnemonic devices. *Review of Educational Research, 51,* 247-275. doi: 10.3102/00346543051002247

Bramão I. Faisca L. Forkstam C. Reis A. Petersson K. M. (2010). Cortical brain regions associated with color processing: An FMRI study. *Open Neuroimaging Journal,* 4, 164–173

Bugelski, B. R., Kidd, E., & Segmen, J. (1968). Image as a mediator in one-trial paired-associate learning. *Journal of Experimental Psychology, 76,* 69-73. doi: 10.1037/h0025280

Craik, F. I. M., & Tulving, E. (1975). Depth of processing and the retention of words in episodic memory. *Journal of Experimental Psychology: General, 104,* 268-294. doi: 10.1037/0096-3445.104.3.268

Cochrane, B. (2019). *Imagery is like perception: three perceptual effects produced with color imagery* (Doctoral dissertation).

DeLoache, J., Cassidy, D., & Brown, A. (1985). Precursors of mnemonic strategies in very young children's memory. *Child Development, 56,* 125-137. doi:10.2307/1130180

Flavell (1970). Developmental studies of mediated memory. *Advances in Child Development and Behavior*, *5*, 181-211. doi: 10.1016/S0065-2407(08)60467-X

Flavell, J. H., Friedrichs, A. G., & Hoyt, J. D. (1970). Developmental changes in memorization processes. *Cognitive Psychology*, *1*, 324-340. doi: 10.1016/0010-0285(70)90019-8

Grammer, J., Coffman, J., & Ornstein, P. (2013). The effect of teachers' memory-relevant language on children's strategy use and knowledge. *Child Development, 84*, doi: 1989-2002. 10.1111/cdev.12100

Groninger, L. D. (1971). Mnemonic imagery and forgetting. *Psychonomic Science, 23*, 161-163. doi: 10.3758/BF03336056

Johnson, E.G. (1977). The development of color knowledge in preschool children. *Child Development, 48,* 308-311. doi: 10.2307/1128918

Kraft, R. N., Eisenberg, K., Myren, L., Ney, M., Poritsky, J., & Potter, S. (1990, April). Teaching preschool children to generate and apply mnemonic strategies. Paper presented at the Annual Meeting of the American Educational Research Association.

Morris, P. E. & Reid, R. L. (1970). The repeated use of mnemonic imagery. *Psychonomic Science, 20*, 337-338. doi: 10.3758/BF03335677

Morrison, F., Smith, L., & Dow-Ehrensberger, M. (1995). Education and cognitive development: A natural experiment. *Developmental Psychology, 31*, 789-799. doi:10.1037/0012-1649.31.5.789

Pressley, M. (1982). Elaboration and memory development. *Child Development, 53*(2) 296-309. doi: 10.2307/1128972

Pressley, M. & Dennis-Rounds, J. (1980). Transfer of a mnemonic keyword strategy at two age levels. *Journal of Educational Psychology, 72*, 575-582. doi: 10.1037/0022-0663.72.4.575

Pressley, M., & Levin, J. R. (1978). Developmental constraints associated with children's use of the keyword method of foreign language vocabulary learning. *Journal of Experimental Child Psychology*, *26*, 359-372. doi: 10.1016/0022-0965(78)90014-0

Pressley, M., & MacFadyen, J. (1983). The development of mnemonic mediator usage at testing. *Child Development*, *54*, 474-479.

Pressley, M., Samuel, J., Hershey, M. M., Bishop, S. L., & Dickinson, D. (1981). Use of mnemonic technique to teach young children foreign language vocabulary. *Contemporary Educational Psychology, 6*, 110-116. doi: 10.1016/0361-476X(81)90039-4

Raugh, M. R., & Atkinson, R. C. (1975). A Mnemonic Method for Learning a Second-Language Vocabulary. *Journal of Educational Psychology, 67*, 1-16. doi: 10.1037/h0078665

Ross, J. & Lawrence, K. A. (1968). Some observations on memory artifice. *Psychonomic Science, 13*, 107-108. doi: 10.3758/BF03342433

Rupiper, M. L. (1999). Developmental changes in verbal and imaginal mnemonic techniques for serial recall. *Student Work, 297*.

Shapiro, A. M. & Waters, D. L. (2005). An investigation of the cognitive processes underlying the keyword method of foreign vocabulary learning. *Language Teaching Research, 9*, 129-146. doi: 10.1191/1362168805lr151oa

Van Overschelde, J., Rawson, K., & Dunlosky, J. (2006). Category norms: An updated and expanded version of the Battig and Montague (1969) norms. *Journal of Memory and Language, 54*(4), 289-335. doi: 10.1016/j.jml.2003.10.003

Watkins, B., & Schadler, M. (1980). The development of strategy use in a spatial task. *The Journal of genetic psychology*, *137*(1st Half), 109-117. https://doi.org/10.1080/00221325.1980.10532805

Wolff, P. & Levin, J.R. (1972). The role of overt activity in children's imagery production. *Child Development, 43*, 537-547. doi: 10.2307/1127554

Wood, G. (1967). Mnemonic systems in recall. *Journal of Educational Psychology, 58*(6), 1-27. doi: 10.1037/h0021519