ABSTRACT

DILLARD, S. GWYNN. The Sound Barrier: Two-Year-Old Children’s Use of Newly Acquired Words to Describe Preverbal Memories. (Under the direction of Lynne Baker-Ward.)

One of the proposed causes of childhood amnesia, the relative paucity of adults’ memories for events occurring before the age of four, is the inability to verbally access preverbal memories. Although recent findings by Simcock and Hayne (2002) are consistent with this possibility, other researchers (Peterson & Rideout, 1998; Bauer, Wenner, & Kroupina, 2002) report some verbal access to memories acquired before the onset of productive language. The present research used the paradigm of color naming to further examine whether 2-year-old children can use newly acquired words to describe their preverbal memories. The method extended previous work by directly examining the acquisition of verbal labels and providing contextual support for memory performance. Participants learned a task requiring selecting a specific color. Those without color labels were taught them through eight structured sessions of age-appropriate color learning activities. After two months, the children's memory for the event was assessed verbally, then with visual cues, and finally through re-enactment. There were no group differences in implicit memory for the event (Fisher's Exact Test, p=0.31); children who knew the target label at encoding (n=20, mean age at recall 31.2 months), who acquired the label only after the intervention (n=8, M = 31.3 months), and who lacked the label at both pretest and posttest (n=9, M= 29.1 months) performed comparably in the re-enactment condition. Although 12 of 20 children who knew their target color word at the time of encoding could verbally access the memory at the time of recall, only one of 8 children who did not know their target word at encoding but learned it before recall could access the verbal label. However, this child

incorrectly re-enacted the event. This research suggests that children cannot independently translate preverbal memories into words even with extensive task support. Therefore, language acquisition may indeed play an important role in the offset of childhood amnesia.

THE SOUND BARRIER: TWO-YEAR-OLD CHILDREN'S USE OF NEWLY ACQUIRED WORDS TO DESCRIBE PREVERBAL MEMORIES

by
S. GWYNN DILLARD

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APPROVED BY:

James Kalat, Ph.D

Daniel Bauer, Ph.D

Lynne Baker-Ward, Ph.D
Chair of Advisory Committee

BIOGRAPHY

Gwynn Dillard grew up in Greensboro, North Carolina. In 2000, she graduated with honors from the University of North Carolina, Chapel Hill with a B.S. in Biology. After working at a biotech company for several months, Gwynn spent one year in graduate school at the University of California, San Diego. There, she studied developmental biology including genetics and molecular biology. In 2002, she enrolled in a combined M.S. and Ph.D. program in developmental psychology at North Carolina State University in Raleigh. Gwynn's research for her master's program focused on the development of autobiographical memory in young children, and she earned her M.S. in developmental psychology in May 2004.

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TABLE OF CONTENTS

Page

LIST OF TABLES……………………………………………..……………………………….v

LIST OF FIGURES……………………………………..………………………………..vi

INTRODUCTION…………………………………………..……………………………..1

LITERATURE REVIEW
- Development of Autobiographical Memory…………………………………………....3
- Rationale for the Present Investigation……………………………………………….....8
- Hypotheses……...………………..……………………………………………………10

METHOD
- Participants…………………………...……………………………………………..11
- Materials………………………………..…………………………………………..13
- Procedure……………………..……………………………………………………..…14

RESULTS
- Preliminary Analysis……………………………….…….…………………………20
- Nonverbal Recall………………………………………………….………………..23
- Verbal Recall………..………………………………………….……………………..24

DISCUSSION
- Was the Color Assessment Valid?………………………….. …………………....….25
- Were there Pre-existing Group Differences?..…………..…………… ……………..….26
- Did Children Remember the Bubble Machine Event?………..…………..…………….28
- Did the Presence of a Verbal Label at Encoding Affect Retention?…….……….…......29
- Can Children Use Newly Acquired Verbal Labels to Describe Preverbal Memories?.…30
- Future Directions…………………………………………...……………………31

LIST OF REFERENCES………………………………………………………………...32

APPENDICES
- Appendix A. Informed Consent……………………………………………………….35
- Appendix B. Creamer Color Chart……………………………………………………....37
- Appendix C. Rainbow Pegboard…………………….………………………………...38
- Appendix D. Bubble Machine and Remote………...……………………………………39
- Appendix E. Participant Data Sheet…………………………………………………...…40
- Appendix F. Intervention Color Games…………….…………………………………42
- Appendix G. Visual Recall Aid……………………………………………………….45

LIST OF TABLES

Page

Table 1. Initial Group Characteristics……..………………………………………………..……20

Table 2. Number of Children in Each Initial Group by Childcare Center………………………21

Table 3. Proportion of children in initial group demonstrating correct verbal encoding……….22

Table 4. Group Characteristics……………………………………………………………….….22

Table 5. Number of Children in Each Group by Childcare Center……………………………..22

Table 6. Proportion of children demonstrating correct verbal encoding and recall in each condition by group……………………………………….25

LIST OF FIGURES

Page

Figure 1. Proportion of each group exhibiting correct recall by condition..........................23

The Sound Barrier: Two-Year-Old Children's Use of Newly Acquired Words to Describe Preverbal Memories

Infant amnesia is the inability of adults to remember autobiographical events from their infancy and early childhood. This absolute definition implies that one has no memories before a sudden offset of infantile amnesia, usually around the age of 2 (Peterson & Rideout, 1998). However, evidence suggests that the development of autobiographical memory, and hence the offset of infant amnesia, is a continuous process (Howe, 2000; Nelson & Fivush, in press). Moreover, some people actually have memories from before the age of 2 (Peterson, 2002). Thus, the more flexible term, childhood amnesia, is often used. Childhood amnesia is defined as the "relative paucity among adults of autobiographical memories for events that occurred before their 4th birthday" (Peterson, 2002, p. 373).

Over the years, innumerable explanations for infantile amnesia have been proposed. The first explanation came from Freud in the early 1900's. By asking his patients about their earliest memories, Freud concluded that early memories were still intact in adults, but repressed due to their emotionally charged content (Freud, 1905/1953). Modern research shows that early memories do not differ in emotional content from later memories (West & Bauer, 1999).

Although Freud's interpretation is no longer seen as tenable, there is no consensus regarding the reasons for the widely documented phenomenon of childhood amnesia. Several alternative but not mutually exclusive explanations are currently receiving attention. Mark Howe (2000, 2003) suggests that the development of the sense of self provides the necessary framework on which early memories can be attached. In his view, the development of the sense of self around 18 months of age provides the lower bound for the offset of infant amnesia. Others, such as Robyn Fivush and Elaine Reese, explain the development of autobiographical memory through social interactions (Fivush, Haden, & Reese, 1996; Reese, 2002b). In their views, children learn what to remember and how to remember through social interactions, particularly through conversations with their mothers. Another possibility is suggested by Peterson and Rideout (1998), who hypothesize that developing language skills may influence the offset of infant amnesia. These authors suggest that children who can talk about an event at the time of its occurrence can linguistically encode the event into their autobiographical memories.

Ultimately, however, infant amnesia surely depends on multiple interacting factors. Indeed a recent review by Nelson and Fivush indicates that the shift from childhood amnesia to autobiographical memory is gradual and depends on the development of basic memory abilities, language and narrative skills, adult socialization of memory talk, temporal understanding, and understanding of self and others (in press). While many researchers are beginning to take multifactoral approaches to the study of childhood amnesia, the present research will focus on the relationship between the acquisition of language and the development of autobiographical memory. This is a critical part of the puzzle of childhood amnesia that has yet to be thoroughly explored. As articulated by Simcock and Hayne (2002): "The inability to translate early, preverbal experiences into language may prevent these memories from becoming a part of autobiographical memory. Thus, language development may be the rate-limiting step in the offset of infant amnesia" (p.230). This leads to the question: Can young children use newly acquired words to describe preverbal memories? Specifically, the proposed research used the paradigm of color naming to further examine whether 2-year-olds could use newly acquired words to describe their preverbal memories. This study provided experimental control <u>and</u> contextual support for the children's memory, a design that is needed and missing in the current literature.

Development of Autobiographical Memory

Since the present research examined the relationship between the acquisition of language and the development of autobiographical memory, let us begin by reviewing what is currently known about verbal ability and autobiographical memory skills in young children**.**

Children have the underlying neurological structures in place to support long-term recall around nine months of age (Bauer, 2002). Changes in the brain over the second year of life continue to improve long-term recall ability (Bauer, 2002). Specifically, the brain's frontal lobe has begun maturation at this point (Liston & Kagan, 2002). Dendrites in the hippocampus are also rapidly growing and differentiating in the first and second years of life (Liston & Kagan, 2002). Concurrently, language is acquired very rapidly in 1- and 2-year-old children. Although the cognitive ability of long-term recall occurs significantly earlier than children's ability to verbally describe the past (Bauer, 2002), children begin to talk about the past almost as soon as they begin to use language (Peterson, 2002; Reese, 2002a). This implies that language ability per se is not necessary for long-term recall, one form of memory.

Several studies have shown that 2-year olds, and even some children younger than this, have long-term verbal memories. For example, Peterson and Rideout (1998) conducted a study examining young children's memory for a trip to the emergency room. The children in this study were between 12 and 34 months of age when the emergency room visit occurred. These children were admitted to the emergency room for a minor traumatic injury, such as a wound requiring stitches or a fractured bone. The children were treated in the emergency room and then sent home. At the time of injury, children under age 2 did not have the narrative skills necessary to be able to verbally describe the event. These children could not verbalize any information about their injury in response to prompts from either an interviewer or a parent in the few days following the injury. Moreover, these children were unable to talk about any past information, such as information from the past day's activities. Children over the age of 2 were able to talk about the injury at the time of the event. Peterson and Rideout interviewed these young children to assess their recall of the traumatic event after delays of 6 months, 12 months, and either 18 or 24 months. They found that most of the children who were over age 2 at the time of the trauma, and thus had the verbal ability to describe their injury at the time of the event, remembered and were able to verbally recall the event for at least 2 years. Additionally, a few of the children under age 2, who could not narrativize at the time of the injury, were able to provide verbal accounts of the injury after delays of up to 18 months. However, children in this study may have had an opportunity to map language onto their memories by listening to adult discussions of the event. Moreover, repeatedly assessing the memory of the event in the same child provides several opportunities for language provided by others to be integrated with the memory of the event.

There is also evidence that young children can have long-term memory of experimentally controlled laboratory events, such as the making of a toy. Myers, Clifton, & Clarkson (1987) found that children who had experienced a repeated event between 6 and 40 weeks of age were able to demonstrate memory at the age of almost 3 years through their actions. Interestingly, one child in their study actually used words to describe his early experiences, indicating that this child could translate an early preverbal memory into words.

Patricia Bauer and colleagues have done several studies on children's ability to translate preverbal memories for laboratory events into words (Bauer & Wewerka, 1997; Bauer, Wenner & Kroupina, 2002). In Experiment 1 of the 2002 study, initial encoding occurred when the children were exposed to novel toy making sequences (e.g. making a gong by assembling x, y, z). These sequences were 3-steps long for 13-16 month old children and 4-steps long for 20-month old children. These events were always narrated so that children got the words at the time of encoding. This provided an opportunity for the child to verbally encode the event. Plus, although the level of general language production of the children was measured using the MacArthur Communicative Development Inventory at the time of encoding, specific words related to the toy-making sequence were not examined. After the first delay of 9-12 months, the children were assessed for spontaneous verbal recall. The children were given the props and the same verbal label given at the time of encoding, such as, “You can make a gong with that stuff.”

Bauer, Wenner, and Kroupina considered three types of verbalizations to be indicative of verbal memory: Naming or describing an event, talking about a target action in the event sequence while not actually performing it, and requesting or talking about an as yet unseen prop needed for the event. However, this method of coding makes no distinction between words children knew at the time of encoding and newly acquired words. Thus, if the children had exhibited verbal memory, they could have only used words they knew at the time of encoding. While there was no evidence of verbal memory at the first delay, children who were 20-months at encoding did show verbal memory at the second delay (children who were 13-16 months did not). The memory assessment at delay 2 occurred when the children were three years old, making the duration of the delay between assessment 1 and 2 different for the different age groups. The memory assessment measure presented at the second delay elicited verbal recall (as opposed to spontaneous verbal recall in delay 1). The children were given one prop at a time and asked to name the prop and what was done with the prop.

This method provides much more structure than the method used in the first delay memory assessments. Plus, the memory assessment at the first delay provided verbal reinstatement, giving the children another opportunity to map language onto the memory representation of the events or simply to the objects in the memory task before assessment at delay 2. In fact, verbal memory at delay 2 was predicted by productive vocabulary scores at the time of the first delay memory assessment. Although Bauer, Wenner, and Kroupina conclude that children can indeed later access their early memories under some highly contextualized conditions, one cannot be sure that children actually map new words to a preverbal memory or use words they had at the time of encoding or reinstatement. From a similar study done in 1997, Bauer concludes, “Language can later be superimposed on previously encoded preverbal memories” (Bauer & Wewerka, 1997, p.164). However, research by Simcock and Hayne (2002) comes to the opposing conclusion. Their study shows that children do not use words to describe an event that are not part of their productive vocabulary at the time of encoding.

Simcock and Hayne (2002) conducted an innovative experiment to determine whether children could translate preverbal event memories into language. First, they taught 27- to 39-months-old children how to perform a novel event. The event was interesting and fun for young children. The children learned how to operate a magic shrinking machine that was brought to their home. First, the children would pull a lever, which would turn on lights on the front of the machine. Next, the children would take a large toy from a case and place the toy into an opening on top of the machine. Then, they would turn a handle on the side of the machine, which resulted in a series of unique sounds. An identical but smaller toy could then be retrieved from a door on the front of the machine. Thus, the shrinking machine event consists of a series of five target actions. The over-all receptive and expressive language ability of the participating children was assessed at the time of the event and recall through the use of the Peabody Picture Vocabulary Test (Dunn & Dunn, 1997) and the Expressive Vocabulary Test (Williams, 1997)). Additionally, the children's productive ability for 23 target words related to the shrinking machine, such as *turn* and *ball*, was assessed through a parental checklist at both the time of the event and the time of recall.

Children's recall was assessed either six months or one year after the shrinking machine event. Recall was first assessed verbally. Researchers asked children open-ended questions about the event, and when the child failed to provide any more information, asked direct questions about the event. Next, the researchers assessed the children's non-verbal memory for the event through photograph recognition. They showed children a panel of four similar photographs, and asked the children to point to the correct picture. For example, the four photographs would be of four different teddy bears, and the child would be asked to identify the teddy bear actually used in the shrinking machine event. Lastly, the children's non-verbal memory was assessed through re-enactment. Simcock and Hayne would then bring the shrinking machine into the child's house, and see how many of the target actions the children could perform.

They found that children's non-verbal memory always was better than the child's verbal memory. Indeed, re-enactment evidence suggested that all children did have a memory of the event. Furthermore, the overall language skill of the children and specifically the number of target words in their productive vocabulary increased greatly over the delay between event encoding and recall. Most interestingly, the researchers noted, "there was not a single instance in which a child used words to describe the event that had not been part of his or her productive vocabulary at the time of encoding" (Simcock & Hayne, 2002, p. 230). The few target words that were produced at recall had been in the children's productive vocabulary at the time of encoding. This study suggests that language development alone does not make preverbal memories accessible to verbal recall. The authors speculate, "The inability to translate early, preverbal experiences into language may prevent these memories from becoming a part of autobiographical memory. Thus, language development may be the rate-limiting step in the offset of infant amnesia" (Simcock & Hayne, 2002, p. 230).

Rationale for the Present Investigation

"A verbally accessible memory is the *sine qua non* of autobiographical memory" (Reese, 2002a, p.216). The onset of autobiographical memory implies the offset of infant amnesia. Thus, this research focused on children's emerging ability to verbally describe the past. This study examined whether or not young children could independently use newly acquired words to describe preverbal memories. As discussed above, there is still an active debate in the field about the answer to this question. The design of this study is strongly based on Simcock and Hayne's (2002) shrinking machine study. However, considerations from Bauer's work were included (Bauer & Wewerka, 1997; Bauer, Wenner & Kroupina, 2002).

Specifically, the proposed research used the paradigm of color naming to further examine whether 2-year-olds could use newly acquired words to describe their preverbal memories. Two-year-old children were chosen for the present study because two is the age of the beginning of the offset of childhood amnesia. This is the age at which much research (e.g. Bruce, Dolan, & Phillips-Grant, 2000) places the beginnings of autobiographical memory and coincides with a period of rapid language acquisition. Furthermore, research shows that two-year-olds just beginning preschool have limited color-term knowledge. This color-knowledge is greatly increased after only 4 months of attending preschool (Shatz, Behrend, Gelman, & Ebeling, 1996). Therefore, the learning of color words provided an ideal phenomenon in which to study the beginnings of verbal autobiographical memories.

In the present study, children were taught a fun and novel bubble machine event. In the event, children were presented with 6 different colors of bubble soap. Only one particular target colored bubble soap "magically" turned the bubble machine on when it was poured into the machine. Thus, remembering which color soap activated the machine was key to successfully completing the event. As established by color knowledge assessments, half of the participants knew the color term for the target color at the time of encoding (known-known group). The other half did not know the target color word at the time of encoding. Verbal and non-verbal memory was assessed after a two-month delay. During the delay, some children in the unknown target word condition did not learn their target color word (unknown-unknown group) whereas some children acquired the target color word (unknown-known group). Mainly, this occurred naturally through their time in preschool. However, there was also an intervention in which children were actively taught their color words. Memory assessment occurred in a manner reminiscent of the Simcock and Hayne study. However, the verbal memory assessment provided significantly more contextual support and adult scaffolding for children's memories than the Simcock and Hayne study.

Simcock and Hayne assessed children's verbal memory for a novel event through the use of open-ended questions, then more direct questions, and finally they brought in a photograph of the shrinking machine and asked if they could remember any more information. However, Hudson (1993) states that verbal means are not effective for reinstating memories in young children. Bauer (personal communication, April 26, 2003) believes that photographs are also ineffective for reinstating memories in two year-olds. However, physical cues, such as location and people, can reinstate memories in the young. Bauer suggests that children can translate memories into words with the help of context and adult scaffolding (Bauer & Wewerka, 1997). Therefore, the present study conducted the verbal memory assessment in a way that maximized contextual cues and adult scaffolding. The children were shown the same bubble machine, in the same place, by the same experimenter during the verbal recall assessment. One very specific, structured question was posed to the participating children: What color bubble soap makes this bubble machine blow bubbles? Furthermore, as the parents and teachers of the participants in this study had no knowledge of the target color for each child, there was no way that children could map language onto their preverbal memory of the bubble machine event during conversations with adults. This study thus provided both experimental control and contextual support for the children's memory, a design that was needed and missing in the current literature.

Hypotheses

First, it was expected that children in all groups would exhibit non-verbal recall for the bubble machine event. However, children who knew the target color word at the time of encoding were expected to exhibit slightly higher frequency of non-verbal recall. This prediction was based on recent evidence from another Simcock and Hayne study (2003) utilizing the shrinking machine event that demonstrated a positive correlation between knowing target words for an event at the time of encoding and non-verbal recall of that event

Furthermore, it was expected that children in the known-known target word group—that is, the children who had already acquired the color labels at the time that the initial bubble machine event transpired-- would indeed demonstrate verbal recall and that their verbal recall would be considerably better than that of the unknown-known and unknown-unknown groups.

Lastly, this study examined whether children in the unknown-known target word group--those who acquired the relevant color labels after the event and hence presumably did not have access to the labels at encoding--would exhibit verbal recall. Based on Bauer's research, I predicted that children in the unknown-known group would exhibit verbal memory because of the strong contextual support and adult scaffolding provided. This would show that children could indeed independently translate preverbal memories into words. It would show that early preverbal memories are verbally accessible later in life. However, the alternative outcome--that children in the unknown-known target word condition would <u>not</u> be able to exhibit verbal memory--would be consistent with findings by Simcock and Hayne (2002). This finding would suggest that children cannot independently translate preverbal memories into words and thus language acquisition may indeed play an important role in the offset of childhood amnesia.

Method

Participants

Prior to approaching the child care centers from which participants were recruited, approval from the institution's Internal Review Board was obtained (Approval Number IRB00000330, September, 9, 2003). Fifty-eight two-year-old participants were initially recruited through five cooperating daycare centers in the triangle area. Researchers met with the centers' directors to discuss the purposes and procedures involved in this project. With the consent of each director, parents were sent letters describing the research along with an informed consent document (see Appendix A). Only those children whose parents returned the signed consent form indicating their willingness for their child to be included in the study met with the researchers.

In addition, verbal assent was obtained from the participating children. The researcher approached the potential participant in his or her classroom in the presence of the teacher. The researcher said: "Hello, [child's name]. My name is [researcher's name]. I'm a student at NC State. I'm glad I could visit your class today. I want to play a color game with you. Your [mom/dad/parents] and teacher have said that it's OK for you to play with me in the [location of bubble event --e. g., media room.]. But I need to know that it's OK with you, too. Will you play with me? [If child assents.] Thanks so much!" If the child showed signs of distress or expressed a desire to leave, the child was returned to his/her classroom. Additionally, as a part of this study, weekly curriculum activities were provided to the class as a whole. These activities were made available to the entire class.

Thirty-seven of the initial 58 children completed the study. Of the 21 children who were not included, 10 moved or were absent on the days of the bubble event, four refused to participate in the event, four did not speak English as a first language, one child saw another child participate in the bubble event with a different target color thus contaminating his memory of the event, one child was unable to learn how to operate the bubble machine, and one child wet his pants during the bubble event and thus was unable to complete the session.

The average age of the 37 participants at the time of the initial bubble event was 28.8 months (*SD* 3.24, Range 23.0 to 34.6 months). 22 of the participants were female; the remaining 15 were male. Although the participants' parents were not directly questioned about their family backgrounds and socioeconomic status, all children attended childcare centers in the same suburban community serving predominantly middle-income families. All children in the two-year-old classes were invited to participate in the study, without regard to gender or racial or ethnic background. However, as noted above, data from children who did not speak English as a first language were excluded from analyses as the knowledge of another language may interfere with English verbal encoding and recall. However, these children still took part in the bubble machine events.

Additionally, children had to pass a color-blind screening to be included in this research because failing to perceive the color stimuli in the to-be-remembered bubble event necessarily prevents a memory that can be described in the expected way. All participants showed normal results on the simple, age-appropriate color-blind screening procedure described below.

Materials

The MacArthur Communicative Development Inventory (CDI) is a standard measure of linguistic sophistication used for toddlers. The CDI is commercially available through Paul H. Brooks Publishing Co. (Baltimore, MD). It is the assessment used by both Bauer (Bauer, Wenner, & Kroupina, 2002) and Simcock and Hayne (2003). The CDI is a checklist of vocabulary words, such as “toy,” “shoe,” and “nose.” Parents were asked to indicate whether their child understands or understands and uses these words. The form took parents about 15 minutes to fill out. Most unfortunately, the “Words & Gestures” form was used in this study instead of the intended “Words & Sentences” form. The “Words and Gestures” form is appropriate for 8-16 month old children. Thus, as all of the children in the present study were at least 24 months of age, the CDI form only showed ceiling effects. The “Words & Sentences” form is designed for children 16-30 months old and would have provided appropriate information.

The Creamer Color chart (see Appendix B) is a pseudoisochromatic plate with two geometric symbols (circle and star). It was used to detect red-green color blindness, which is the most common type of color blindness (Mayo Clinic Staff, 2003).

The Rainbow Colorboard Peg Board by Learning Resources® (see Appendix C) has one peg of each of the 6 experimental colors: red, orange, yellow, green, blue, purple. The colors are focal colors. The pegs were used in the color knowledge assessment.

The bubble machine is the Bubble Pro Party Machine™ (see Appendix D), commercially available through Adams Apple Distributing, Glenview, IL. In order to prevent color confusion in this study, all parts of the bubble machine were spraypainted black. The bubble machine was plugged into a transceiver module that is operable by remote control. Thus, the bubble machine could be turned on and off by a small remote control. The transceiver and remote control, Catalog #: 980-0201, are commercially available through Radio Shack.

Procedure

The participants in this study were involved in five steps: (1) pretest, (2) to-be-remembered bubble machine event, (3) intervention, (4) post-test and (5) memory assessment. One undergraduate assistant was assigned to each of the five childcare centers. The same undergradute administered the pretest, intervention, and post-test in each childcare center. Two researchers administered the bubble machine event and the memory assessment. The primary researcher administered the aforementioned events in four of the five childcare centers. A secondary reseracher adminstered the bubble machine and memory assessment in the remaining center. Importantly, each child interacted with the same researcher for the bubble machine event and memory assessment. This provided strong contextual support for the children's recall.

The pretest and bubble machine event were administered in one 10-minute session in the children's childcare centers. One day later, the bubble machine event was repeated in the same location. The intervention took place once a week for 8 weeks in the classrooms at times designated by the cooperating teachers. The post-test and memory assessment required only about 15 minutes and were conducted in the childcare centers.

The pretest consisited of 3 parts: MacArthur Communicative Development Inventory, colorblind screening, and the color knowledge assessment. Parents of participants were sent a letter asking them to fill out the enclosed CDI at their leisure. Reminders were sent on two occassions to parents who neglected to return the form. Colorblind screening was done using the Creamer Color chart. The children were asked to point to the shapes they saw. All children passed the test and were able to point to both the circle and the star.

Next, the color knowledge of each participant was assessed in three different ways for the six basic colors used in this experiment. The colors were red, orange, yellow, blue, green, and purple. These are the same colors used by Shatz et. al. (1996) in their research of color-term knowledge in 2-year-olds. Their research showed that most 2-year-olds did not know all six of these colors, but that a few months of preschool instruction significantly increased their color-term knowledge. Moreover, the shades of these six colors used in this study were the most typical example of the color category, refered to as focal colors. In other words, the red was truly red, not orangy-red or magenta. The best example of the colors used in this experiment was determined by a consensus from the primary researcher and 5 research assistants. Developmental studies show that children are better at knowing and naming focal colors than non-focal colors (Pitchford & Mullen, 2003). Furthermore, although children learn focal colors before non-focal colors, the order in which they learn these colors is idiosyncratic (Bornstein, 1985). Each of the six experimental colors were classified as “known” or “unknown” for each participant. Colors that were “known” were correctly named and identified by the participant and the participant’s teacher confirmed that the child knew these colors. Colors that were “unknown” were either incorrectly named, incorrectly identified, both incorrectly named and incorrectly identified, or indicated to be unknown by the participant’s teacher.

A target color was randomly selected for each child from one of their “unknown” colors to be used in the to-be-remembered bubble event for half the participants; the remaining children had a "known" color selected as their target color.

The children's color knowledge was assessed in two ways using the Rainbow Colorboard Peg Board. First, the participants color word production was assessed. The pegboard was set just out of reach of the child. The participant was given one peg at a time. The order of presentation of colors was randomly determined for each participant. The participant was asked, “What color is this?” If no answer was given, prompting continued until an answer was given. Prompts included, “You know what color that is. What color is that?” The child's response was recorded by the experimenter on the child’s data sheet (see Appendix E). Next, the participant's color identification skills were then assessed using the same pegboard. All of the colored pegs were placed in a pile within easy reach of the child. The participant was asked to pass the reseracher the (specified color, e.g. red) peg. The colors were asked for in random order. The peg was returned to the pile after it was selected by the child, so that the child could have chosen any of the 6 colors in response to each request. The researcher recorded the child’s answer. Lastly, each child’s teacher was asked to confirm the results based on their knowledge of the child’s use of color terms. This procedure allowed color knowledge to be assessed in three different ways: child’s understanding, child’s production, and teacher’s opinion. This method was adapted from a similar task done with crayons and construction paper used by Soja (1994) in her research on 2-year-olds acquistion of color words.

The next step of this experiment was the to-be-remembered event, which was learning how to operate a special bubble machine. This special bubble machine turned on only when a child added the target colored bubble soap. This occured because the researcher surreptitiously used a remote control hidden in his/her pocket to turn on the bubble machine.

Each child participated in the same unique event in two identical sessions separated by one day. This mimiced the encoding conditions used by Simcock and Hayne (2002). Additionally, to provide further contextual support, the researcher wore the same colored clothing for each bubble machine event. The researcher always wore a black shirt and khaki pants. The neutral color clothing was selected to prevent interference of other colors with the target color.

The experimenter asked the child to play a fun bubble game with her in a quiet corner of the child's classroom (or other appropriate area designated by the childcare center). In this area, the bubble machine was sitting beside six identical containers of bubble soap that were red, orange, yellow, blue, green, and purple. The shades of the bottles of bubble soap were focal colors, and matched the shades of the pegs used in the color-knowledge assessment. The child was told, "I have a magic bubble machine. It only works when you add bubble soap that is this color (pointed to the target color for the participating child, being careful not to actually name the color so that the child would not be able to use the researcher's verbal color label in their mnemonic event representation). When you add this bubble soap, the machine blows bubbles! (Demonstrated by pouring a small amount of the specified colored bubble soap into the bubble machine, and surreptitiously turning the machine on via a remote control hidden in the experimenter's pocket.) It doesn't work when you use the other colors of bubble soap! (Demonstrated by pouring in two non-target color soaps). Now you try!" The researcher then mixed up the colored bubble soaps and urged the participant to pick a color. The bubble machine was turned on only for the target color. The bubbles were mixed up after each successful attempt by the child, and the process was repeated until the child successfully chose the target color five times. The event was repeated the next day.

At the end of the second encoding session, the colored bubble soap was returned to a box, out of view from the participant. The child was then asked, “What color bubble soap made the bubble machine turn on?” His/her response was recorded. This measured initial verbal encoding. This was an important step for estimating error in this experimental design.

The intervention phase of this experiment was designed to enhance color learning in the participants. In the eight weeks following the bubble machine event, an undergraduate research assistant volunteered in each participating preschool class for one hour a week. The research assistant led the entire class (including children who did and did not know their target colors) in one of eight age-appropriate color learning activities during their weekly visit (See Appendix F). Thus, each class participated in each of the color games in random order. Most color activities lasted approximately 15 minutes. The color lessons were both age appropriate and engaging for the children. Most color lessons were obtained from local craft and school supply stores.

After the intervention period, the children participated in a post-test. This was identical to the color-knowledge assessment described above. This distinguished participants who still knew their target color (known-known, n=20), who successfully learned the word for their target color (unknown-known, n=8), and those who did not learn the word for their target color (unknown-unknown, n=9). All children who knew their target color word at the time of the pre-test still knew their target color at the post-test.

Lastly, the children's memory for the bubble machine event was assessed. The assessment first examined verbal memory, then non-verbal memory through the use of color recognition, and lastly through re-enactment. This pattern of memory assessment was identical to the pattern used by Simcock & Hayne (2002). The researcher said to the participants, “Hi (participant’s name). Remember me? My name is (researcher’s name) and I came to play bubbles with you a few months ago. I brought my bubble machine again today, would you like to come play with it?” If the child ascented, the researcher escorted the child to the same quiet corner or designated area of classroom that the initial event took place in. Verbal memory was assessed first by showing the child the bubble machine, but having the bubble soap in a box so that the child could not see it. The researcher then asked the child, “Remember this bubble machine only works when a certain color bubble soap is used. What color should we use to make it turn on?” If the child answered, the researcher moved on. If not, the researcher continued prompting. The researcher recorded the child’s answer on his/her original data sheet. The child was then provided with a visual aid: a color chart with each of the six experimental colors on it (Appendix G). The child was asked to point to the color of bubble soap the machine needed to work. The child’s response was recorded. Finally, the child was asked to re-enact the bubble machine event. The child was provided with the colored bubble soaps used in the initial to-be-remembered event. He or she was asked to pick a color of bubble soap from among the six choices, randomly arrayed in front of him/her. The child’s first choice was recorded.

The data in this study were coded in an easy-to-understand way. For each of the three memory assessment conditions (verbal, visual, and re-enactment), each participant either demonstrated memory (yes=1) or did not demonstrate memory (no=0). Only correct responses were coded as demonstrating memory. In other words, the child had to say the correct color word, point to the correct color square, or pick the correctly colored bubble soap on the first try. Incorrect responses, such as saying the wrong color word, pointing to the wrong color square, or picking the wrong colored bubble soap, did not demonstrate memory. There were three groups of participants: those who knew the target word at the time of encoding and recall (known-known), those who did not know the target word at the time of encoding but had learned it by the time of recall (unknown-known) and those who did not know the target color word at the time of encoding or recall (unknown-unknown).

Results

Preliminary Analyses

Initially, children were divided into two groups: those who knew their target color (known) and those who did not know their target color (unknown). The use of a *t*-test indicated that these groups did not significantly differ in age (t= -0.89, p=.38) and the use of a chi-squared analysis indicated that these groups did not differ in the proportion of CDIs returned by parents (X= .11 , p= .29). However, there were significantly more girls in the known group than in the unknown group (X= 4.36, p= .04) (See Table 1).

Table 1.
Initial group characteristics.

Initial Group	*N (Males, Females)*	*Age in Months (Mean, SD)*	*Proportion of CDI's returned*
Known	20 (5M, 15F)*	29.3 (3.6)	0.75
Unknown	17 (10M, 7F)*	28.4 (2.7)	0.59

*Chi- squared differences: p < .05

Although the *n* is too small in each cell for a formal analysis, examining Table 2 suggests that there was no effect of preschool on initial group status. Similar proportions of children initially knowing and not knowing their target color came from each childcare center.

Table 2.
Number of children in each initial group by childcare center.

Childcare Center	*A*	*B*	*C*	*D*	*E*	*Totals*
Known	5	6	6	3	0	20
Unknown	7	4	2	2	2	17
Total	12	10	8	5	2	37

Children in the initial known group were expected to verbally encode their target color during the bubble machine event. Immediately after the second presentation of the bubble machine and with the bubble soap placed in a box out of sight, participants were asked, "What color bubble soap turned the bubble machine on?" Children that were able to verbally label their target color exhibited correct verbal encoding. Children that said another color, "I don't know", or did not respond at all after several prompts did not exhibit correct verbal encoding. Seventeen of the 20 children in this group did exhibit correct verbal encoding. Children in the initial unknown group were not expected to exhibit initial verbal encoding of their target color. Surprisingly, 1 of these 17 children did show correct verbal encoding (see Table 3). However, this appears to be a random error as this child could not correctly identify or produce this target color during the color assessment and the child's teacher indicated that the child did not yet know any of her colors. Research indicates that children will often answer the question "What color?" with any word they know is a category of color even though they do not have full understanding of the word and cannot correctly map the color word to the actual color (Soja, 1994). This further supports the classification of this as an error and the assignment of this child to the initial unknown group.

Table 3.
Proportion of children in initial group demonstrating correct verbal encoding.

Initial Group	*Proportion of Correct Verbal Encoding*
Known	.85
Unknown	.125

Eight of the 17 children in the initial unknown group were able to learn the color label for their target color during the intervention period. Thus, the initial unknown group was split into those children who did acquire their target color label and those who did not learn their color label, forming the unknown-known group and the unknown-unknown group, respectively. The unknown-known group and the unknown-unknown group were approaching significant age differences (t= -1.89, p= .08), but showed no significant differences in gender (Fisher's Exact Test, p= .64) or in proportion of CDIs returned (Fisher's Exact Test, p= .33). Additionally, examining table 5 suggests that the childcare center had no effect on whether or not children acquired their target color.

Table 4.
Group characteristics.

Group	*N (Males, Females)*	*Mean Age in Months (SD)*	*Proportion of CDI's Returned*
Known-Known	20 (5M, 15F)	29.3 (3.6)	0.75
Unknown-Known	9 (6M, 3F)	29.6 (2.8)	0.75
Unknown-Unknown	8 (4M, 4F)	27.3 (2.3)	0.44

Table 5.
Number of children in each group by childcare center.

Childcare Center	*A*	*B*	*C*	*D*	*E*	*Totals*
Known-Known	5	6	6	3	0	20
Unknown-Known	5	2	1	0	0	8
Unknown-Unknown	2	2	1	2	2	9
Total	12	10	8	5	2	37

Non-Verbal Recall

As illustrated in figure 1, the known-known and unknown-known groups of children demonstrated implicit non-verbal memory for the correct target significantly above the level of chance. The standard error bars were calculated using 1/6 as the null hypothesis value in the re-enactment and visual condition since the children were choosing the correct target colored bubble soap from a set of 6 different colored bottles in the re-enactment condition and were choosing the correct colored square from a set of 6 different colored squares in the visual condition. Thus, the level of chance was also set at 1/6. The known-known group performed significantly above chance in the re-enactment condition (z= 5.9, p < .0001) and the visual condition (z= 4.70, p < .0001). The unknown-known group also performed significantly better than chance in the re-enactment condition (z= 2.58, p=.01), but not in the visual condition (z=0.68, p=.50). The unknown-unknown group did not perform significantly above chance in either the re-enactment condition (z=1.37, p=.17) or the visual condition (z=1.37, p=.17).

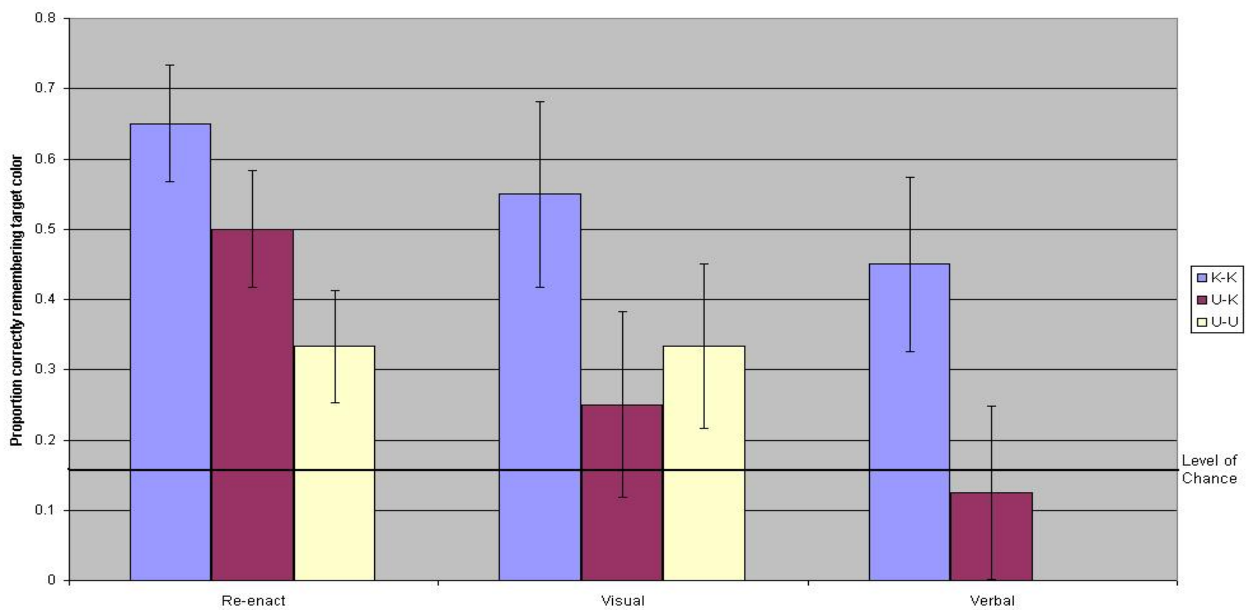

Figure 1. *Proportion of each group exhibiting correct recall of target color in re-enactment condition, visual aid condition, and verbal condition.*

Interestingly, the known-known group did not exhibit statistically significantly better nonverbal memory for the target color than the other groups as hypothesized. In fact, there were significant differences between the recall of the three groups in neither the re-enactment condition (Fisher's Exact test, p=.31) nor the visual recall condition (Fisher's Exact test, p=.33). No significant differences were detected in the recall of children in between the re-enactment condition and the visual condition within the known-known group (McNemar's Test, p=.16), within the unknown-known (McNemar's Test, p=.32), or within the unknown-unknown group (McNemar's Test, p=1).

Verbal Recall

Only the children in the known-known group exhibited explicit verbal memory at a statistically significant level (z=3.75, p=.0002). In fact, 12 of the 20 children who knew their target color word at the time of encoding could verbally access the memory at the time of recall. The known-known group demonstrated significantly better recall in the verbal condition than the unknown-known and unknown-unknown groups (Fisher's Exact Test, p= .02). Only one of 8 children who did not know their target word at encoding but learned it before recall could access the verbal label. This is statistically insignificant (z=0, p=.50). Moreover, this child was incorrect in his re-enactment choice, further supporting the conclusion that his verbal recall was due to chance. Further, it is important to note that this child did not show initial verbal encoding. In the case of verbal recall, chance cannot simply be set to 1/6 as the children were choosing the color label from their entire repertoire of color labels. Thus, chance was set to be the level of unexpected initial verbal encoding. In the known-known group, 17 of the 20 (.85) children showed correct verbal encoding as expected, thus .15 was used as the level of chance. In the unknown-known group, 1 of 8 (.125) children unexpectedly demonstrated correct verbal encoding. Thus, for this group, .125 was used as the level of chance. None of the children in the unknown-unknown group exhibited initial verbal encoding or verbal recall after the delay.

Table 6.
Proportion of children demonstrating correct verbal encoding and recall in each condition by group.

Group	*N*	*Initial Verbal Encoding*	*Re-enactment Recall*	*Visual Recall*	*Verbal Recall*
Unknown-Unknown	9	0	.33 (.124)	.33 (.124)	0 (N/A)
Unknown-Known	8	.125	.50 (.132)	.25 (.132)	.125 (.117)
Known-Known	20	.85	.25 (.083)	.55 (.083)	.45 (.080)

Discussion

Overall, the results of this study indicate that two-year-old children cannot independently translate their preverbal memories into newly acquired words even in the presence of strong contextual support and adult scaffolding. However, before exploring the implications of the findings, it is important to examine the limitations as well as possible threats to the validity of this study.

Was the Color Assessment Valid?

The information from the color knowledge assessment was the basis of initial and final group assignment. As the validity of this study hinges on the validity of the assessment, great care was taken in designing this measure. To increase the validity of the assessment, multiple measures were used to determine color knowledge. First, the child's ability to recognize and identify colors was assessed non-verbally by having the participant pick out a colored peg corresponding to the verbal label given by the researcher. Next, the child's ability to produce the color word was assessed by having the child say the color label for each colored peg. Finally, the child's teacher was asked to confirm the results of the color assessment. A color was only classified as "known" when all three measures were in agreement. For 14 of the 17 children in the initial unknown group, all three measures were in agreement. Two children in this group correctly identified their target color, but could not produce the target color word and their teachers indicated that the children did not know these colors. Moreover, neither of these children demonstrated initial verbal encoding, further suggesting they did not truly understand the verbal label for their target color. One final child in the initial unknown group correctly stated the target color word, but was unable to correctly identify the color and the child's teacher indicated that the child did not know the color. Again, this child did not show correct verbal encoding suggesting the child did not truly understand the verbal label for his target color. For a child to move from the unknown to known group, the same stringent criterion of convergent data from all three measures had to be met.

Although I am highly confident in the accuracy of group assignments, steps were taken to be able to statistically account for possible errors. Measuring the rate of correct initial verbal encoding allowed for an estimate of this error. Children in the known group were able to produce the correct verbal label at encoding as predicted in 17 of 20 cases, giving an error rate of 0.15. Children in the unknown group were unexpectedly able to correctly produce the correct verbal label at encoding in 1 of 17 cases, giving an error rate of .125. These error rates were indeed overcome in the present research, indicating that the results were both statistically significant and valid.

Were there Pre-Existing Group Differences?

The participants in this study were initially grouped into those who knew their target color and those who had yet to learn their target color. As discussed above, we can assume that children have been assigned to the correct group. However, the question remains if there are other differences between these groups that may be able to explain the difference seen in recall.

All children participating in this study attended comparable childcare centers serving the same middle income, suburban community. Although a formal statistical analysis was inappropriate due to the small number of participants falling into each cell, Table 2 suggests that similar proportions of children knowing and not knowing their target color came from each center. Thus, it appears that the childcare center a child attended did not correlate with his/her color knowledge or memory abilities.

Preliminary analyses also indicated that the initial known and unknown groups did not significantly differ in age or in the proportion of CDIs returned. The data from the CDIs would have been quite useful in examining initial group differences in overall language ability. However, the only language used in this study were color words, and these were adequately assessed through the color knowledge assessment procedure. Perhaps the information about which parents took the time to return the CDI is a rough indication of family structure or organization. In the initial grouping, there was no significant difference in the proportion of CDIs returned, suggesting that family structure cannot explain the initial differences in the children's color knowledge. However, this is strictly speculation. More information would need to be collected to contemplate the effects of family structure on children's color knowledge.

There was, however, a difference in the gender composition of the initial groupings. Significantly more girls knew their target colors than boys. This may be linked to gender differences in overall vocabulary in toddlers. It has been documented that girls talk a bit earlier than boys, have larger vocabularies, and produce utterances that are slightly longer on average than do boys of the same age (Huttenlocher et. al, 1991). Yet, an equal number of boys and girls were able to learn their target color during the intervention phase, suggesting that gender does not affect the learning of color words. Overall, there does not appear to be any significant initial group differences that could explain the findings of this study.

The intent of the intervention phase of this study was to teach all of the children in the initial unknown group their target color. However, the intervention was effective for only eight of the 17 children. So, were there group differences between the children who did learn their target color over the 8-week intervention period (unknown-known) and those who did not (unknown-unknown)? Although only approaching significance, it appears that the children who learned their target color word were older than the children who did not. This suggests a role for maturation and/or life experience in word acquisition. The children in the unknown-known and unknown-unknown groups did not differ in gender composition or on the proportion of CDIs returned. However, the small n of these groups limits the power to detect these differences. Although only 44% of parents of children in the unknown-unknown group returned CDIs and 75% of parents of children in the unknown-known group returned CDIs, this difference was not statistically significant. However, it suggests that the influence of family structure on vocabulary acquisition should be explored in future research.

Did Children Remember the Bubble Machine Event?

The paradigm used in this study required that children have an accurate preverbal memory in order to have the chance to translate this memory into newly learned words. Thus, it is crucial to the validity of this experiment to establish that children did indeed have an accurate non-verbal memory of the bubble machine event.

Children in the unknown-unknown group did not evidence memory for the bubble machine event in any condition. Perhaps their lack of forming and retaining the event memory is due to their younger age. As the children did not remember the event, their lack of verbal recall may be due to their lack of memory for the event.

Children in the known-known group clearly showed they remembered the event in all recall conditions. The children in this group were able to tell the researcher the correct target color, point to the correct target color, and they could choose the correct target color when the bubble machine event was reenacted.

However, the group of utmost importance to answering the key questions in this study, the unknown-known group, did display significant memory for the event during the re-enactment condition. It is clear that these children could remember the event because they could choose the correct target color in the reenactment of the bubble machine event. Thus, it is fair to assume that these children did have a correct memory of the event. Therefore, these children’s lack of verbal recall cannot be explained by their lack of memory for the bubble machine event.

Did the Presence of a Verbal Label at Encoding Affect Retention?

Clearly there was an effect of knowing the verbal label at the time of encoding as these children demonstrated delayed recall of the event in the reenactment condition, the verbal condition, and the verbal condition whereas children that did not have the verbal label at encoding only showed delayed recall in the reenactment condition.

However, there were no statistically significant differences between the recall performance of children having the verbal label at encoding and those that did not have the verbal label at encoding in the reenactment and visual conditions. This is most likely due to the low power of this study resulting from the low number of participants. Indeed, the pattern of data observed in Figure 1 supports the hypothesis that children having the verbal label at the time of encoding would be more likely to remember the event. However, the study would need to be replicated with significantly more participants in order to test this hypothesis.

Can Children Use Newly Acquired Verbal Labels to Describe Preverbal Memories?

In this study, children cannot use newly acquired verbal labels to describe preverbal memories as evidenced by data from the unknown-known group. These children did not know their target color labels at the time of encoding. The children did know their target color label at the time of recall as evidenced by the convergence of data from three measures of color knowledge. It is clear that children did have memory for the bubble event, but were still unable to use their newly acquired color labels to describe this memory. However, a strong caution is in order. There were only eight children in the unknown-known group making the statistical power to reject the null, that verbal response was due to chance, low. Yet, similar results in the current literature lend support for the present finding. In fact, this finding replicates that of Simcock and Hayne (2002), who also found that young children could not use newly learned words to describe an event encoded into memory before these words were part of the child's productive vocabulary. Moreover, this study shows that added contextual support could not overcome this deficit. Even in the same place, with the same researcher wearing the same outfit, seeing and touching the same bubble machine, the children could not translate preverbal memories into new words. Structuring the memory recall to minimize demands on the young children also did not have an influence on children's ability to use new words to describe a preverbal experience. In this experiment, the researcher gave children a description of the to-be-remembered event and asked the child to provide one word that was key to the event. Yet, even in this simple, discrete structure, children could not use newly acquired words to describe their preverbal memory. These findings imply that children cannot independently map new words onto preverbal memories. As a verbally accessible memory is the result of autobiographical memory, preverbal memories may not enter into autobiographical memory unless the child is given a chance to map language onto the memory at a later point in time, once new words have been acquired. Perhaps at this very young age, children need adults to map their newly understood language onto their past mnemonic representations. Conversations with adults could do this for the child, but only after the child has learned the meaning of the words that an adult uses. In fact, Nelson and Fivush suggest that social interaction with adults is an important part of the development of autobiographical memory (in press). Perhaps the importance of these adult conversations lies in the opportunities they provide children to associate verbal labels understood by the child, but provided by the adult, with the child's preverbal memories. This could help explain why adults have a paucity of memories from their early childhood. Indeed, the results from this study indicate that having language at the time of encoding of a memory is necessary for the later independent verbal recall of that memory. Thus, language development may be necessary, although not sufficient, for the ontogeny of autobiographical memory.

Future Directions

While this study answers a few questions about children's use of new words to describe preverbal memories, it also leads to several new questions. Under what conditions can a child map language onto a preverbal memory? Do adult conversations really provide opportunities for young children to associate new language with a preverbal memory? Can older children independently map new vocabulary words onto preverbal memories without the assistance of adults? The latter question could be answered using the same paradigm as the present study with different stimuli. For instance, instead of using color labels as the new words, perhaps more difficult colors (gold, silver, bronze) or even shapes (diamond, hexagon) could be used in a follow-up study.

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Appendix A. Informed Consent

North Carolina State University
INFORMED CONSENT FORM for RESEARCH

Can young children use newly aquired words to describe preverbal memories?

Gwynn Dillard, Graduate Student — Lynne Baker-Ward, Ph.D.

We are asking you to participate in a research study. The purpose of this study is to investigate the development of verbal memory in toddlers.

INFORMATION

If you agree to participate in this study, you will be asked to fill out a standard vocabulary assessment for your toddler. This takes about 15 minutes. **Your child will be asked to** point to two shapes in a screen for red-green color blindness, play a color game to assess your child's color knowledge, and play with a special bubble machine that only blows bubbles when a certain color bubble soap is used. The child will be asked to remember the bubble machine even two-months later. We are interested in whether or not children can use color names learned after the event to tell us about the earlier experienced.

RISKS

If your child becomes distressed while playing color games or with the bubble machine, he/she will be reassured and returned to his/her classroom.

BENEFITS

Your child will learn colors through fun games. Additionally, the data from this study can potentially provide information that will answer questions about the offset of infantile amnesia and the development of children's memory.

CONFIDENTIALITY

The information in the study records will be kept strictly confidential. Data will be stored securely and only identified by an anonymous identification number. No reference will be made in oral or written reports which could link you to the study.

CONTACT

If you have questions at any time about the study or the procedures, you may contact the researcher, Gwynn Dillard**, at** Dept. of Psychology, Campus Box 7801, Raleigh, NC 27695-7801**, or** (919)247-4749**. If you feel you have not been treated according to the descriptions in this form, or your rights as a participant in research have been violated during the course of this project, you may contact Dr. Matthew Zingraff, Chair of the NCSU IRB for the Use of Human Subjects in Research Committee, Box 7514, NCSU Campus (919/513-1834) or Mr. Matthew Ronning, Assistant Vice Chancellor, Research Administration, Box 7514, NCSU Campus (919/513-2148)**

PARTICIPATION

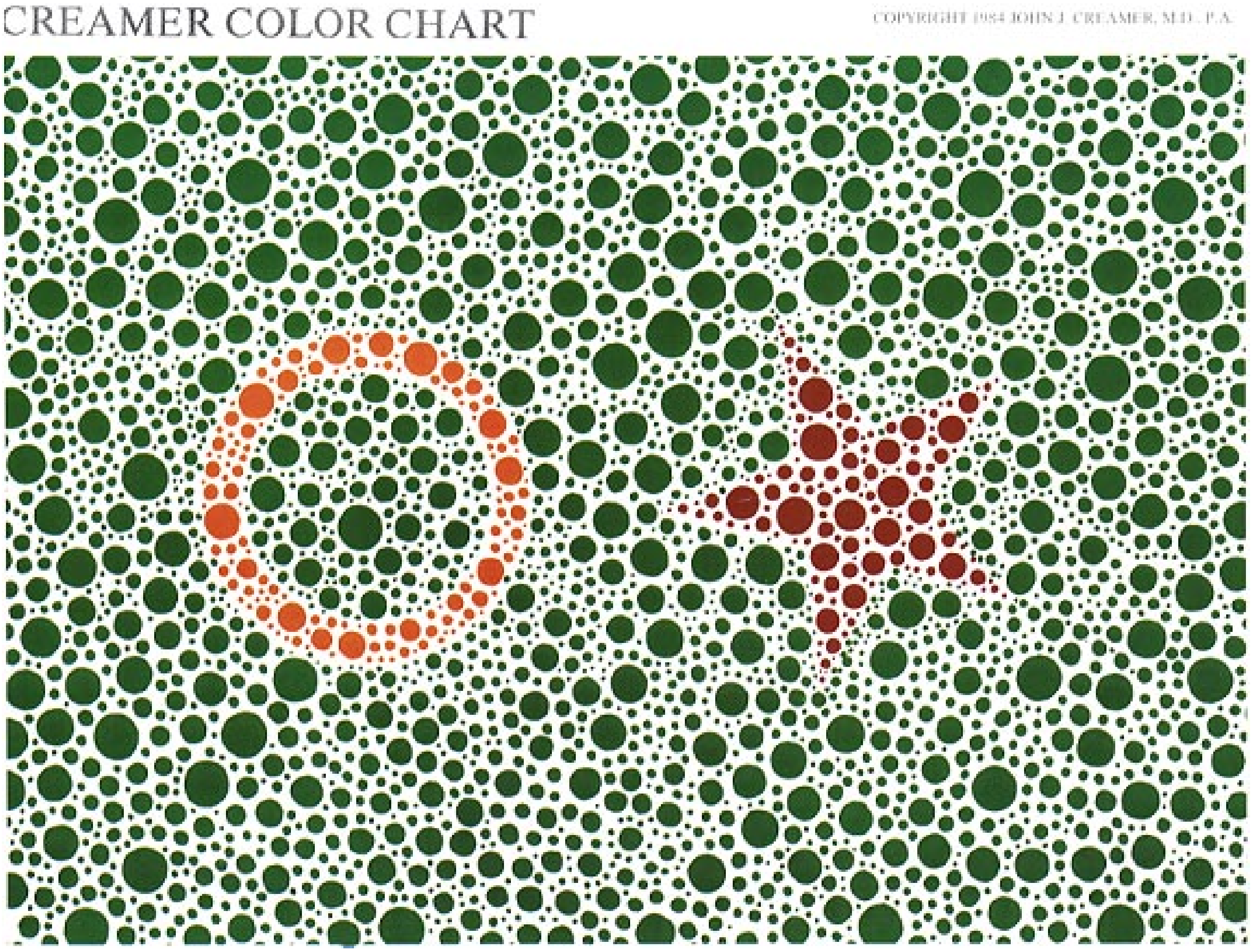
Your participation in this study is voluntary; you may decline to participate without penalty. If you decide to participate, you may withdraw from the study at any time without penalty and without loss of benefits to which you are otherwise entitled. If you withdraw from the study before data collection is completed your data will be returned to you or destroyed at your request.

CONSENT

"I have read and understand the above information. I have received a copy of this form. I agree to allow my child to participate in this study with the understanding that I may withdraw at any time."
Child's name____Child's Date of Birth _________________

Parent's signature____ Date __________________

Appendix B. Creamer Color Chart



The Creamer Color chart is 8.5” by 11” and printed with special inks of equal color value. The above is only an illustration of the actual product and is not printed in special ink or suitable for actual testing. The chart was ordered from Richmond products, http://www.richmondproducts.com/Color%20Blindness%20Quick.htm.

Appendix C. Rainbow Peg Board

This rainbow pegboard by Learning Resources features easy-to-hold pegs that fit into spaces on a multihued 6" x 14" wooden board.

Appendix D. Bubble Machine and Remote

The bubble machine used in this study has been spray painted so that all parts are black.

The transceiver allows you to control an appliance plugged into the module with a touch of a button on a keychain sized wireless remote.

Appendix E. Participant Data Sheet

Name ________________________________ Birthdate ___/___/_____ Gender M F

Preschool _____________________________ Class _________________________

MacArthur Score __________________ Passed colorblind screening Y N

Color Pretest (Date ___/___/_____, Particiapnt's Age in Months _____)

COLOR	**PRODUCTION** (record response)	**IDENTIFICATION** (record response)	**KNOWN** (check)	**UNKNOWN** (check)
Red				
Orange				
Yellow				
Green				
Blue				
Purple				

Target color* ___________________ *Known or Unknown

To-be-remembered event: Date ___/___/_____, Researcher ___________________

Verbal Recall at Encoding: ____

Color Posttest (Date ___/___/_____, Particiapnt's Age in Months _____)

COLOR	**PRODUCTION** (record response)	**IDENTIFICATION** (record response)	**KNOWN** (check)	**UNKNOWN** (check)
Red				
Orange				
Yellow				
Green				
Blue				
Purple				

Target color known?   Y   N

Memory assessment (Date ___/___/_____, Researcher______________)

Verbal	
Visual Aid	
Re-enactment	

Appendix F. Color Games

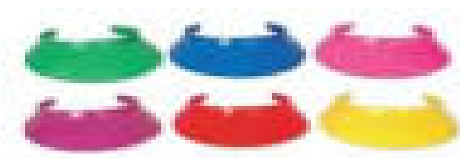
1. Bean Bag Hop

Materials: 6 bean bags (red, orange, yellow, purple, green, blue).

Directions: 1. Line up the beanbags on the floor about 2 feet apart.
2. Have children hop over each beanbag while calling out the color.

2. Color Catch

Materials: 24 colored plastic visors (4 each of red, orange, yellow, purple, green, blue), 1 small plastic ball



Directions:

1. Give each child a colored visor. Sit the children in a circle.
2. Help children identify the color visor they are wearing by giving directions like "All greens stand up" and "All reds clap your hands."
3. Give the ball to one child and give her a specific direction based on the color visor she is wearing such as "Orange, roll the ball to someone wearing a red visor" and then "Red, roll the ball to someone wearing a blue visor", etc.
4. Play until everyone has a turn or two, and then switch the visors around so the children have different colors and play again.

(Adapted from Colors: Preschool/Kindergarten: The Mailbox Theme Series by Jayne Gammons & Michele Menzel, Eds., Greensboro, NC: The Education Center, Inc., TEC31722000).

3. Simon Says

Materials: 72 felt squares (12 each of red, orange, yellow, purple, green, blue)

Directions:
1. Bring out each color of felt squares and have the children say the name of the color and then place the squares of that color on the floor.
2. When all the squares are out, give directions such as “Simon says hop on yellow” and “Simon says put your hand on red” etc.
3. For clean up, “Simon says bring me a red square” until all the colors are picked up.

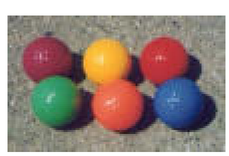
4. Dancing Color Circle

Materials: 16 pieces of colored construction paper (2 each of red, orange, yellow, purple, green, blue)

Directions: Note: This game is similar to musical chairs.
1. Arrange the colors in random order in a circle on the floor.
2. Play CD of children’s music while the children dance around the circle.
3. When the music stops, have each child stand on the one color they are on.
4. Go around the circle and have each child label the color they are on.

5. Golf Game

Materials: 6 colored plastic golf balls and 6 colored Styrofoam cups (1 each of red, orange, yellow, purple, green, blue), 6 mini plastic golf clubs



Directions:
1. Have children hit (or roll if hitting is too difficult) each golf ball into its matching color cup while labeling that color.

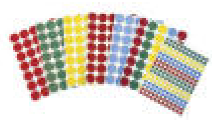
6. Magical Pumpkin Patch

Materials: 24 spray-painted mini pumpkins (4 each of red, orange, yellow, purple, green, blue)

Directions:
1. Scatter colored pumpkins over a small area outside.
2. Have children find all of the red pumpkins, then go through each of the remaining 5 colors.
3. Repeat.

7. Hokey Pokey

Materials: Round stickers in red, orange, yellow, purple, blue, and green.



Directions:
1. Place one sticker on each child's hands and feet of differing colors.
2. Help children label the stickers as they put them on.
3. Sing a modified version of the hokey pokey: "You put your red dot in, you put your red dot out, you put your red dot in and you shake it all about. You do the hokey pokey and you turn yourself around. That's what it's all about!" Repeat for each color.
4. Help the children to move the stickers around and/or get new stickers. Repeat.

8. Fish Game

Materials: Crayons (red, orange, yellow, purple, green, blue), outlines of fish on plain white paper, completed rainbow fish as a model

Directions:
1. Put the rainbow fish on the table and ask the children if they want to make their own rainbow fish.
2. Give each child a crayon and tell them what color the crayon is. Ask the child to repeat it.
3. Have the children use all 6 colors one at a time.
4. Review the names of all colors when the fish drawings are complete.

Appendix G. Visual Aid

Note: This is a replication. The original paper used in the research was constructed using the same markers that were used to color the bubble soap bottles used in the to-be-remembered event. Each color was represented in a 2.5”x 3” solid rectangle on an 8.5” x 11” white background in the order depicted below.