ABSTRACT

Title of Thesis: CONTRIBUTIONS OF AGENCY VS. NON-AGENCY TO
                      SEQUENTIAL MEMORY IN 3-YEAR OLDS

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       Two studies explored the effect of agency on memory in 3-year-old children

when learning a sequence in a picture-book format. Previous research has shown that

with both adults and older children, the inclusion of agency in free verbal recall is a

central theme. However, very young children are often thought to have poor memory

for social events because of their verbal limitations. By using a form of deferred

imitation, Study 1 explored social episodic memory in a non-verbal sequential

reconstruction task. Children who saw an agent in the picture sequence reconstructed

more steps than those that did not see an agent present in the picture-books. Study 2

expanded upon these results by investigating the extent to which agency is necessary

in order to improve memory, and what properties of the Study 1 increased

performance. In this study, participants who were presented with an agent in only the

first and last picture of the sequence did not reconstruct more steps than those that did

not see an agent present. Taken together, agency may increase memory for a

sequence but only if ample amounts of agentive cues are present throughout.

CONTRIBUTIONS OF AGENCY VS. NON-AGENCY TO SEQUENTIAL

MEMORY IN 3-YEAR OLDS

by

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Chapter 1: Introduction

Our memories make up a vital part of who we are. They provide a framework upon which we base current and future behaviors, and allow us to build individual identities based on experiences. In adults, social events appear more salient and remembered more readily than nonsocial events (Bower & Rinck, 1999). However, the study of social episodic memory has been largely ignored in infant and early childhood populations, possibly due to the verbal nature of many social memory studies.

This paper focuses on the development of memory for social events. Furthermore, it explores the factors that create frameworks for robust early memories such as agency and goal-directed activities. By studying these factors early in life, it is hoped that we will gain a better understanding of how we remember events in our social world.

Memory & Agency in Adulthood

As Patricia Bauer once stated, "Who we are is who we were and what we did" (2007). In other words, our memories are the essence of our identity and remembering socially relevant events is essential to normal functioning. Studies on adult memory recollections demonstrate that there is a tendency to remember events including an agent (a living, acting being) over non-agent events. For example, when talking about events as adults, personal narrative memories center heavily around agents and their related goal-directed actions (Trabasso, Stein, Rodkin, & Munger, 1992). Indeed, it seems difficult to think of a good story that does not involve some sort of motive and the actions taken towards fulfilling the associated goal. Furthermore, recall for stories that

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include goal-directed actions are remembered at a greater rate and with more detail than events that do not include such goal-directed actions (Bower & Rink, 1999) and segmentation of video clips with respect to goal completion makes content easier to verbally recall than if the segmentation occurs mid-goal (Boltz, 1992). Such a bias is even found when describing events that are currently occurring (online description). For example, when asked to describe visual events viewed on TV, adults often comment on the goal of an object or agent rather than the source (Lakusta & Landau, 2005).

Why does this bias towards agents and their intentions appear in our memories? In may be that intentional structure provides a framework upon which to hang information. For example, remembering each individual physical action of a person washing dishes may provide a cognitive overload not conductive to memory storage, but being able to effectively group such actions using the larger intention of cleaning dishes allows us to chunk the memories into more consumable portions.

Indeed, it appears that intentional structure is a very important construct for making sense of our everyday world. Without being consciously aware of it, we interpret the actions of others as goal-directed and intentional (Baldwin & Baird, 2001). Agency and goal understanding also helps as we attempt to process the constant stream of actions, events, and information that we must interpret throughout our day. For example, when viewing continuous action sequences of a person on video, adults agree considerably concerning the boundaries (the beginning and end) of such events (Newtson & Engquist, 1976). Furthermore, these boundaries coincide with the actor's underlying intentions or goals, suggesting that events are parsed based on a form of mental purpose or goal attributed to the agent (Zacks, Tversky, & Iyer, 2001). Evidence for goal-directed event

segmentation is also found in reading-time studies, where adults are asked to read action sequences and push a button upon comprehension. Findings show that adults pause longer at event boundaries containing changes in characters and their goals, indicating increased attention and mental calculation at these points (Zwaan, Langston, & Graesser, 1995). In other words, it seems that conceptualizing events in terms of goals allows us to 'chunk together' the more fine-grained steps in an event (Baldwin & Baird, 2001). This leads to greater attention to overall goals and their completion, giving us a structure and framework upon which to conceptualize what we are seeing. This may in turn affect how well we remember such events (Baldwin & Baird, 2001; see information on Event Indexing Model, Zwaan et al., 1995).

In sum, it seems that intentions, agents, and goals all allow us to focus in on the important aspects of an event, understand it in a social setting, and remember it over time. These features may in turn contribute to increased memory for social events.

Memory and Agency in Children

Interestingly, evidence for goal understanding and biases are found very early in life. Even very young infants seem to have the capacity to view others' actions as organized by intentions (e.g. Woodward, 1998). For example, infants can track goals and intentions of a human agent toward an object, even if the location of that object shifts. 6-month-olds who view an experimenter reaching towards an object represent the action in terms of the relation between the agent and her goal (Woodward, 1998). Slightly older infants (10-12 mos.) can go beyond simple reaches to discern higher order intentional relations, as is the case when using tools such as a cane or cloth to retrieve a toy, or when pointing towards an object (Sommerville & Woodward, 2005 ; Woodward, 2003;

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Woodward & Guajardo, 2002). Infants' tendency to view actions as goal-directed

appears to be specific to the meaningful actions of intentional agents.   7-month-olds will

choose a toy after an experimenter has grasped it (goal-directed action), but not when the

experimenter exhibits an ambiguous action such as touching the toy with the back of her

hand (Hamlin, Hallinan, & Woodward, 2008). Furthermore, infants will reproduce the

toy choice of a hand, but not of a moving entity that cannot be readily identified as an

agent (Mahajan & Woodward, 2009). Therefore, it appears that infants can understand

goal-directed actions only if presented by an agent.

Event segmentation conforming to intentional goals is also evident in very young

babies. In one study by Baldwin, Baird, Saylor & Clark (2001), 10-month-olds were

shown video clips of an adult performing various goal-directed actions (e.g. bending

down to pick up a towel and then placing the towel on a counter). If the video was paused

at an inappropriate time (when the adult was just beginning to bend over) as opposed to a

goal completion (once the adult grasps the towel) the infant looked much longer at the

inappropriate pause. This suggests that, even at this young age, infants believe the correct

boundary of an event coincides with the fulfillment of the actor's goal. Much like adults,

this desire to segment events based on goals may aid in processing the plethora of

information infants are faced with daily.

From the above examples, it is obvious that the representational seed for goal

analysis is exhibited even in infancy. Later, it appears that this attention to agents and

goals may influence memory. Once they are able to speak coherently, children begin

using language in the same manner as adults when recalling autobiographical details that

are not visually present. For example, they are more likely to recall memories for

everyday events that include actions pertaining to goals (Anderson & Conway, 1997), and they often structure this recall in terms of overall goals rather than individual steps (Slackman, Hudson & Fivush, 1986).   Indeed, it seems that recall for aspects of an event that do not pertain to a goal are often excluded altogether (Travis, 1997). For example, when viewing an event where an animate object goes from the source to a goal (e.g. a mouse creeps from a bowl to a block), children aged 4-7 years will include the goal but omit the source in their linguistic recall by saying things such as "the mouse went to the block" instead of "the mouse went from the bowl" (Lakusta & Landau, 2005).

Unfortunately, most information on social episodic memory in childhood is restricted to ages where coherent verbal recall is possible. Because of this, it is difficult to draw conclusive evidence about preferences for social memory in either preverbal or semi-verbal populations. However, recent research has shown that specific methodologies hold the ability to tap into declarative memory without needing language.

A method known as *deferred imitation* has been used widely to examine memory in preverbal children. This method entails the presentation of an action on an object, a delay period (from minutes to years depending on the study), and a test period where the child is then able to act on the objects his/herself (Bauer & Mandler, 1989; Meltzoff, 1985). Researchers speculate that this method often utilizes declarative memory because the ease of learning, fallibility, and flexibility of the memories parallels that of declarative memory traits at older ages. Furthermore, preverbal children who take place in a deferred imitation paradigm have been known to recall it verbally later in life (Bauer, Kroupina, Schwade, Dropik, & Wewerka, 1998).

Time and time again this method has depicted seemingly astounding results in memory, demonstrating recall even in very young infants (e.g. Barr, Dowden, & Hayne, 1996), after only one or two demonstrations (e.g. Bauer, 1992; Mandler & McDonough, 1995), and remembrance after relatively long periods of time (Carver & Bauer, 1999). For example, 6 month olds can remember how to pull a mitten off a puppet after a 24-hour delay (Barr et al., 1996), 10-month-olds and can recall a multistep demonstration three months later (Bauer et al., 2006), and during the second year of life many children show recall of multistep sequences after as long as one year (Bauer, 2000).

Amazingly, no one has investigated the various aspects of the events that create such strong memories so early in life. Based on previous findings for goal and agent biases, a plausible explanation for such robust findings may be the social nature of infant memory studies. Indeed, because all studies at this age entail deferred imitation (i.e., involving memory for a person's goal-directed actions), it is almost impossible to state whether the impressive results are indicative of memory in general or memory for agentive events more specifically. It becomes a distinct possibility that developmental psychologists have been inadvertently studying a very specific type of event memory, namely social episodic memory, instead of looking at recollection skills in general.

Present Study

In order to fully understand how agency affects memory in early childhood, a method was needed that could employ declarative memory for social vs. non-social events. In an attempt to investigate these various event structures, the present study utilized a task similar to deferred-imitation (with a presentation of action, a delay, and a test), and included the ability to regulate whether or not an agent was demonstrating the

critical actions. Study 1 used this method to study the effects of agency on declarative memory in a non-verbal format, giving children who are notoriously poor at verbal recollection (3-year-olds) a chance to exhibit social episodic memory skills. Study 2 expands upon the results of Study 1 to further pull apart the specific agentive cues necessary to enhance recollection.

Chapter 2: Study 1a

Method

Participants.

Sixty normally developing 3-year-old children participated in Study 1. This age was chosen as it represents a time when children are motivated to learn and imitate from adults (Lyons, Young, & Keil, 2007), can easily transfer information from a 2D medium to the 3D world (Barr & Hayne, 1999; Meltzoff, 1988), and have the memory capacity to recall a 6 step sequence (Bauer, 2007). Furthermore, the nonverbal nature of this task allows us to study 3-year-olds' social memory in a way that had not been demonstrated previously. All participants heard at least 60 percent English in their daily lives to make certain that all instructions in the books were comprehensible. Twenty participants (11 girls and 9 boys, M=3.03 years, range = 2.82-3.04 years) were read picture books depicting an agent putting together an object (agent condition), 20 (9 girls and 11 boys, M= 3.0 years months, range= 2.86-2.99) were read picture books where the object appeared to self-assemble (non-agent condition), and another 20 (10 girls and 10 boys, M= 2.98 years) participated without reading any books (baseline condition).

Procedure.

All data was collected in-lab at a large research University. Upon entering the experimental room, children sat next to the experimenter at a table. Each child was randomly assigned to either the agent, non-agent, or baseline condition. Children in the agent and non-agent condition proceeded through the following stages, with the baseline condition only participating in the delay and test phases. The same experimenter was present during all study phases in order to control for decreases in memory performance due to context changes (for example see Barnat, Klein, & Meltzoff, 1996).

Presentation Phase.

Using picture books, each participant was read two stories by an experimenter that depicted a 6-step sequence culminating in the assembly of objects (a bunny and a tree). The order of book presentation was counterbalanced so that half the children saw the bunny book first and the other half viewed the tree book first. These picture books varied in two respects, a visually perceivable agent and the accompanying language. In the agent condition, children viewed an agent (Sally) at the beginning of the story and saw her hands assembling the pieces throughout the sequence, thus providing a visual cue evoking goal-directed motives (Figure 1 & Figure 2). The children in this condition also heard sentences accompanying the sequence such as "Look, this is Sally! I wonder what Sally is going to make!" or "Now Sally puts this piece like this!". In the non-agent condition, children viewed pictures devoid of an agent so that the pieces appeared to self-assemble in a non-goal-directed fashion. The sentences accompanying the non-agent condition did not allude to an acting agent and instead stated things such as "Look at these things! I wonder what these things are going to make!" or "Now this piece goes like

this". In order to eliminate carryover effects, agency was held constant within conditions. Therefore, those in the agent condition saw Sally in both books, and those in the non-agent condition viewed both books without any agentive cues.

When reading the books, the experimenter used a moving point to bring attention to the key objects on each page. For example, when looking at a picture of the ears going on the bunny head, the experimenter would first point to the ears and then the top of the head to indicate the object ("Sally puts this piece…") and it's location ("like this!"). This movement helped to restrict attention to the key features of the step and allowed the experimenters to be sure each child focused on the relevant details.

A page of the book was flipped only when it was clear that the child had attended to the relevant picture for approximately three seconds (equivalent to the duration of the sentence on the page). In this way it was assured that each child viewed and attended to each picture in the sequence. The total time for the presentation phase was approximately five minutes.

Children assigned to the baseline condition did not participate in the presentation phase.

Delay Phase.

During this phase, a delay period of 10 minutes was imposed and participants were given the option to either play a matching game or complete a puzzle. Regardless of the activity selected, the child stayed in the same room to control for contexts effects on memory. Time during the delay period was recorded using a hand-held stopwatch.

Test Phase.

During this phase, the experimenter produced a tray that contained the pieces previously seen in the storybooks. The order of test sets was the same as that of the books during presentation. Therefore if the bunny book was read first, the objects for the bunny would be presented as the first test set. The layout of the pieces on the tray was identical to that of the first page of each book.

Once the experimenter placed the tray on the table, she asked "What can you make with these?" and allowed the child to freely reconstruct the sequence in whichever way they saw fit. If the child attempted to question the experimenter about how the pieces went together, the experimenter admitted ignorance or asked the child how he/she thinks it should go together. If the child attempted three times to place a piece in the correct location but could not physically complete the step, the experimenter aided in step completion. If the child incorrectly placed any piece three times or asked for help three times, the experimenter aided in placing the object in the correct location. In this way, each child saw the objects completed in the correct manner, whether by their own devices or with help from the experimenter.

Coding.

Test trials were coded from video recordings by an undergraduate assistant blind to experimental condition. Another independent assistant coded 30% of the participants, with the two coders agreeing on 97% of total behavioral scores. Participants were coded for the number of steps completed (out of a possible 6 for each object, 12 total). Furthermore, they were coded on the number of ordered pairs completed (if step 4 comes at some point after step 1) and the number of adjacent pairs completed (for example step 2 directly after step 1, step 6 directly after step 5). The coding of the ordered and adjacent

pairs provided information as to how strictly the child encoded the temporal nature of the presentation, and whether there are certain groups or pairs of steps that seem to afford one another more readily. The total number of ordered and adjacent pairs possible for any sequence set was 5.

Results

There were no significant difference of number of steps remembered within groups based on either gender or age, therefore all the following analysis were collapsed across these variables.

In order to check for equality within sets, a planned-t comparison was run within each condition (agent, non-agent, baseline) to test the ease of construction on the tree or bunny. There were no significant differences between the number of steps completed on the tree or bunny within any of the three conditions (agent, non-agent, baseline).

As was hypothesized, there was a significant difference between conditions relating to the number of steps the child completed. A one-way between-subjects ANOVA revealed a significant effect of agency on memory in agent, non-agent, and baseline conditions ($F(2, 56)= 45.8$, $p<.000$). Post hoc analyses using the Tukey HSD criterion for significance indicates that the average number of steps completed by participants in the agent condition ($M=10.8$, $SD=1.47$) was significantly higher than those in both the non-agent condition ($M=8.15$, $SD=3.44$) and baseline condition ($M=3.7$, $SD=1.70$, see Figure 3).

Discussion

These results are intriguing and allude to many interesting theories on agency in memory. First, it appears that in an instructional assembly task, the inclusion of an agent in an event make sequences more memorable. This may be due to the fact that goal-directed frameworks provide more structure for children, allowing them to chunk together information and remember it more efficiently. However, while the non-agent group did noticeably poorer during test, a higher rate of variability seemed to indicate that certain children used techniques that allowed them to overcome the 'harder' condition.

To further investigate this idea, Study 1b involved coding and transcribing what children were saying to themselves during the test phase.

Chapter 3: Study 1b

As is often mentioned in developmental literature, preschool children frequently talk to themselves as a means of better organizing both their thoughts and behaviors, and directing their attention (see Vygotsky 1958/1962). Indeed, some argue that the characteristics of private speech "provide the best insight into the inner properties of symbolic thinking in young children", giving us direct access to the structure and strategies used for the task at hand (Patrick & Abravanel, 2000, p. 46) Furthermore, it appears that private speech increases in intensity and amount when tasks increase in difficulty (Behrend, Rosengren, & Perlmutter, 1989). Therefore, by looking at the nature of the speech that children are producing during test, we hoped to be able to gain insight into what sorts of thoughts do or do not aid in recall.

Methods

Participants.

Participants were those children that completed Study 1a.

Procedure.

The test phase portion of Study 1a was coded by an undergraduate assistant, blind to condition, who transcribed and categorized each verbal utterance made by the participants. An independent coder also blind to experimental condition coded 30% of the participants, with the two coders agreeing on 94% of total self-speech utterances. Transcriptions entailed typing the phrase uttered by the child, as well as accompanying behaviors (for example "Look this piece is red!" ::picks up rabbit nose::). Each self-speech utterance was placed into one of the following categories:

Construction Comments.

      Instructions: "This goes on that one."

      Names goal: "I'm making a bunny!"

      Response to book: "It's just like in the book!"

      Correction: "Doesn't go like that."

Non-construction Comments.

      Names/Describes a part: "It's like a yellow carrot."

      Questions: "Where could this go?"

      Other: "It's the monkey's friend."

Utterances not related to the direct task at hand or the objects involved were not coded (for example, "Today I ate Cheerios for breakfast and I like unicorns!").

Results

Interestingly, the overall number of task-related utterances that each child produced was not correlated in any way with test scores (r (38)=-.021, p=.90). Furthermore, the number of utterances within each category above had no effect on later reconstruction scores.

As amount of speech made no difference in test scores, we next sought to investigate self-speech in an 'all-or-nothing' manner to see whether it was simply uttering any of the above categories at *all* that made a difference. Therefore, for each of the above categories children received a score of '1' if they used self-speech from that particular category and a '0' if they did not. For the agent condition, those who mentioned any of the above categories at least once during test showed no significant gain over those that did not make any such utterances. However, for the non-agent condition, the type of self-speech used during test seemed to matter. Participants in the non-agent condition who verbally recounted any number of instructions ("oh, this piece goes here!," M= 9, SD= 3.01) completed significantly more steps than those in the same condition who did not (M=3.5, SD=2.12), t(16)= -2.47, p=.025. Similarly, those that mentioned their goal ("This will be a bunny!," M= 10.67 SD=1.03) completed significantly more steps than those that did not (M=7.25, SD=3.60, t(16)=-2.25, p= .009). Finally, participants that made reference to the book ("This is just how it was made in the book!," M= 11.25, SD = .25) performed better than those who did not make such references (M= 7.57, SD= 3.4), t(16)= -2.10, p= .002).

Comments related to the task or objects, but not directly associated with its construction (naming/describing pieces, asking questions, or other task-related comments) had no effect on test scores for the non-agent condition.

Discussion

Taken together, the total amount of talk produced by participants did not increase test scores. This suggests that general language ability does not necessarily mean better memory performance. The differences in test scores were only found when looking at whether or not children used certain categories, indicating that memory does not depend on how much you think about an aspect of an event, but whether you think about it at all.

Children in the agent condition did not need additional cues such as self-speech to effectively complete the sequence. This may indicate that the framework provided by the agent increased memory and decreased task demands. It is also possible that consistently high scores in the agent condition masked any improvements that self-talk could provide. Therefore, given a more difficult task where there was more within-condition variability, the effect of self-talk on the agent condition may be more evident.

Children non-agent condition only showed increased memory if their self-speech alluded to the goals of the sequence, mentioned the events in the book, or guided their own reconstruction verbally. In this condition, it was only those that were able to provide themselves with external verbal frameworks that exhibited increased memory.

The behavioral results of Study 1a, along with the self-talk data of Study 1b, provide evidence that agency increases memory for an event by constructing a goal-directed cognitive framework. However, it does not address how much agentive information is necessary in order to see these memory effects. Furthermore, low-level

processing explanations may conclude that Sally's hands provided additional physical information that could result in better performance at test. For example, seeing the agent pushing one piece onto another in a picture may convey information about which hand positions may be most beneficial for completion of that step, which objects are most important to attend to in that step, and the relative size of the pieces in relation to a hand. All of this information could result in better accuracy at test without tapping into memory effects.

Whereas the talk data from Study 1b suggests that cognitive frameworks are necessary for increased memory, a more stringent study was needed to explicitly test this possibility. Therefore the goals of Study 2a were twofold. First, it sought to further explore the extent to which agentive cues are necessary to increase memory. For example, how much agentive information is necessary in an event in order to increase memory? Secondly, it sought to investigate whether the physical properties of the pictures in Study 1a simply provided more information about manual construction, resulting not in better memory but better performance.

Chapter 4: Study 2a

Study 2a attempted to look at the effects of decreased agentive cues in a sequential memory task. In this study, the agent appeared only in the introductory and ending picture. All instructional pictures (showing the assembly of the pieces) did not include an agent and appeared exactly as those in the non-agent condition. Therefore, the only visual cue to agency in the agent condition was her presentation next to the objects at the beginning, and her reappearance at the end with the finished object. If prior research is correct, the simple presentation of the sequence as a goal-directed action

should be enough to improve memory. Furthermore, the removal of the agent allows us to investigate the extent to which physical cues added in later performance. With this task, it is hoped that we will be able to portray a more accurate picture of the nature that agency plays on social episodic memory.

Methods

Participants.

Forty-eight normally developing 3-year-old children participated in Study 2a. All participants heard at least 60 percent English in their daily lives. Twenty-four children (11 girls and 13 boys, M= 2.95 years, range = 2.79-3.10 years) were read sequential picture books depicting an agent on the first page (agent condition), 24 (11 girls and 13 boys, M= 2.97 years, range= 2.79-3.15 years) were read picture books without an agent in any picture (non-agent condition). All children participated in a baseline phase either before (N=24) or after (N=24) test.

Procedure.

The procedure was the same as that of Study 1 with the following exceptions: the agent condition included pictures of Sally in only the first and last page, with all instructional pictures void of any visual agent, thus becoming exactly the same as the non-agent condition's instructional pictures (see Figures 4,5,6). The language accompanying the book mirrored that of Study 1. Therefore, the agent condition related the object movements to the character ("Sally put this piece here") even in her absence, while the non-agent condition mentioned the movements of the object themselves ("This

thing went here"). Thus, for the agent condition, Sally was mentioned verbally in the instructional pictures even though she wasn't visibly present.

Participants also participated in a within-subjects baseline phase, allowing for fewer participants and a more equal motivational ground between the test and baseline sequences. This baseline was administered either directly before or directly after the test phase, with time of baseline counterbalanced across subjects. In order to accommodate this within-subject baseline, while also keeping the number of books read the same as Study 1, we added an additional stimulus set that culminated in a bug (Figure 6). Therefore each child would be read books on two of the three stimulus sets, with the third set used as the baseline. The order of presentation was counterbalanced so that each set was equally presented as the first book, the second book, or the baseline set within the sample.

For those children that received the baseline set before test, the delay phase was reduced to eight minutes. This allowed a two-minute period for the child to complete the baseline, so that the test set was presented after ten minutes. In this way, the time between presentation and test was the same regardless of whether the baseline was presented before or after test.

The existing stimuli were altered slightly in order to better inform the temporal order of the sequence. For example, in study 1 the bunny sequence contained two identical eye pieces which were placed on one after another, making it difficult to judge which should technically come first. In study 2, this issue was resolved by fusing the eye pieces and making each step more individually distinct (see Appendix for complete list of original and revised sequence steps).

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Coding.

Coding procedures were the same as those in Study 1a. An undergraduate assistant blind to experimental condition coded all participants from video recordings. Another independent coder also blind to experimental condition coded 30% of the participants, with the two coders agreeing on 95% of all behavioral scores.

Results

There were no significant difference of number of steps remembered within groups based on either gender, age, or the time baseline was presented (before or after), therefore all the following analysis were collapsed across these variables. In order to check for equality within sets, a one-way ANOVA was run within each condition (agent, non-agent, baseline) to test the ease of construction on the tree, bunny, or bug. There were no significant differences between the number of steps completed on any of the three sets within either condition.

Between conditions, there was no significant difference relating to the number of steps the child completed. An independent sample t-test revealed no significant effect of agency on memory in either the agent (*M*= 7.08, *SD*= 2.9) or non-agent conditions (*M*=6.63, *SD*=2.70), *t*(46)=.563, p= .938, see Figure 7) . Furthermore, there was no significant difference between the number of ordered (agent *M*=3.16, *SD*=1.83; non-agent *M*=3.16, *SD*=1.76) or adjacent pairs (agent *M*=.84, *SD*=.91, non-agent *M*=1.3, *SD*=1.4) between the groups.

Discussion

The presentations in Study 2a resulted in a more stringent test on the effects of

agency on memory. It included minimal visual agency cues, with Sally present in only the very first and last picture of the sequence and absent in all instructional pictures. Interestingly, this minimal amount of agency did not result in better recall at test compared to the non-agent condition. Participants in both conditions completed the same average number of steps, and completed them using similar temporal orders.

These results raise questions concerning the results of Study 1a. Did an agentive framework increase memory or was it simply the physical cues provided by the hands? Were the scores in Study 2a the result of taking away important agentive cues during the sequence? If the results of Study 2a were based on a lack of agentive reminders, children in both the agent and non-agent conditions should show a benefit when using self-directed speech in much the same manner as the non-agent condition in Study 1b. Study 2b sought to investigate the nature of participant's self-speech during test when minimal agentive cues are provided.

Chapter 5: Study 2b

Methods

    Participants.

Participants were those children that completed Study 2a

    Procedure.

Self-speech utterances were coded from video recordings by an undergraduate assistant blind to experimental condition. An independent coder also blind to experimental condition coded 30% of the participants, with the two coders agreeing on

97% of total self-speech utterances. Transcription and coding procedures were exactly the same as those found in Study 1b, including use of the same self-speech categories.

Results

Similar in nature to Study 1b, we found no significant effect of overall amount of talk on test scores ($r(45)=-1.57$, $p=.344$). Furthermore, the number of utterances within each category had no effect on later reconstruction scores.

As in Study 1b, we also looked at whether uttering self-speech in certain categories at *all* resulted in better test scores than those who did not make such utterances. When investigated in this manner, it appeared that certain types of self-speech aided in later memory recall for both the agent and non-agent conditions, unlike Study 1b where only the non-agent condition benefitted certain verbal strategies. Participants in both conditions that provided themselves with instructions completed significantly more steps ($M=7.53$, $SD=2.55$) than those who did not provide such information ($M=5.2$, $SD=2.87$), $t(45)=-2.64$, $p=.01$). Furthermore, children that mentioned the book reconstructed significantly more steps ($M=8.75$, $SD=1.75$) than those who did not ($M=6.42$, $SD=2.87$), $t(42)=-2.19$, $p=.034$. Unlike Study 1b, there were no significant differences for those that did ($M=7.66$, $SD=1.52$) or did not ($M=7.00$, $SD=2.70$) name the goal of sequence ($t(26)=-.41$, $p=.68$).

Comments related to the task or objects, but not directly associated with its construction (naming/describing pieces, asking questions, or other task-related comments) had no effect on test scores for the non-agent condition.

Discussion

Similar to Study 1b, the amount of self-talk was not found to be important for later test scores. Rather, it was whether or not the participants provided themselves with instructions or mentioned the book at all that resulted in better reconstruction. All other categories of self-speech (naming the goal, naming/describing the objects, asking questions, correcting oneself, and other task-related comments) did not increase test scores for either condition.

Unlike Study 1b, both the agent and non-agent condition benefitted from certain construction-related self-speech. This suggests that stripping the sequence of visual agentive reminders eliminated the goal-directed framework in the agent condition. Therefore, participants must compensate by using their own self-speech as a memory cue and guiding factor in reconstruction.

Taken together, it appears that a visual reminder of agency may be necessary in all parts of the sequence in order to increase memory performance. In the absence of a visual cue to agency, verbal frameworks may support memory in some children.

Chapter 6: General Discussion

Across the two studies, we sought to explore the extent to which the inclusion or exclusion of an agent in a pictorial event impacted memory in 3- year old children. Previous research has focused on memory for agents in verbal recall settings (e.g. Anderson & Conway, 1997,), and thus has often cited pre-school children as having poor memory for narrative events (see Trabasso & Nickles, 1992; Bauer, 2007). However, the infant literature shows the astonishing ability to remember sequences when presented by

agents in deferred-imitation paradigms (e.g. Barr, Dowden, & Hayne, 1996; Bauer, 2000; Bauer et al., 2006). Using this conflicting evidence as motivation, we explored the extent to which a goal-directed sequence in pictures effects the later reconstruction of the sequence in a non-verbal format. This way, we were able to easily test 3-year-olds remembrance of a sequence without relying on their poor verbal skills, while also looking at the early effects of agency on memory.

In Study 1, it appeared that providing an agent or character in a sequential picture-book aided in later recall for the sequence. Children that had seen the event sequence assembled by an agent were able to reconstruct significantly more steps than those who had seen the sequence without an agent. Furthermore, both the agent and non-agent conditions were able to reconstruct significantly more steps than the baseline condition, where participants did not view the sequential pictures before test. These results illustrated that the inclusion of an agent significantly bolstered later memory for an event.

Study 2 sought to expand upon these results, investigating the extent to which a visible reminder of an agent was necessary for improved memory effects. If only the initial idea of an agent was necessary for creating a goal-directed framework of the event, including the agent in the very first and last pages of the sequence should be enough to increase memory. It was found that removing the visual agent from all instructional pictures of the sequence eliminated the memory effects found in Study 1, even when verbal reminders remained. Participants in the agent condition completed the same number of steps at test as those in the non-agent condition, indicating that the inclusion of a visual agent in the instructional pictures was necessary for increased memory.

Interestingly, it appears that all participants in Study 2 dropped to the level of performance of the non-agent condition in Study 1. That is, there was no statistical difference between the Study 1 non-agent condition (*M*=8.16, *SD*=3.44) and the Study 2 agent (*M*= 7.08, *SD*= 2.9) or Study 2 non-agent (M=6.63, *SD*=2.70) conditions as reported by a one-way between-subjects ANOVA ($F(2,64)=1.42$, *p*=.249). This suggests that having the agent visible in only the very first and last picture of the book was just as effective as having no agent at all.

As mentioned previously, the possible explanations for these data are twofold. It may be that the agent pictures in Study 1 allowed for a continual visible reminder of agency, which aided in the ability to see and think about the sequence as goal-directed. These reminders were significantly decreased in Study 2, where the visual agent appeared in only 2 pictures even though a verbal reminder of the agent remained. If this was the case, it would suggest that agentive information increases general memory for the sequence. However, it may also be that the agent's visual cues in the instructional pictures provided physical information that helped the participants better understand the correct way to construct the object. If this is the case, results suggest that test scores were based purely on cues that increase performance instead of increasing memory.

In Study 1, the agent was present both in the pictures and the related sentences ("Sally puts this piece like this!") resulting in both visual and auditory reminders of the goal-directed actions ensuing. In Study 2, the visual aid of the agent was only present in the first and last non-instructional pictures, although the sentences remained the same. As is shown in previous adult work on instructional learning, the visual aspects of technical directions are often more important than the accompanying text in terms of later memory

for the sequence (Kools, van de Wiel, Ruiter, & Kok, 2005). Therefore keeping the agent in only the verbal sentences may not have been enough to facilitate a goal-directed framework and thus increase memory.   Furthermore, when reading text with accompanying pictures, the reader often attempts to visually locate elements mentioned in the text "in order to establish referential links" between the two modalities (Dupont & Bestgen, 2006). When these two streams of input do not match up (for example, hearing that "Sally does this" but not seeing Sally in the picture), a disconnect occurs that may effect later memory. Therefore, it may simply be important to have a character present in every picture f the book as a reminder of agency, regardless of whether or not the hands are on the objects.

The importance of external visual aids or reminders has long been cited in the literature as integral to early abstract thinking and frameworks. Piaget often noted the importance of concrete objects when first learning cognitive tasks such as counting or conservation (e.g. Piaget, 1964; Piaget & Inhelder, 1969). Furthermore, external pictures have been found to aid in preschoolers' ability to remember social roles, such that a child who is given a picture of an ear remembers that he is supposed to listen and not talk (Diamond, et al., 2007). It is not until much later that these external cues are directed inward, becoming "condensed and converted" to more automatic and unconscious activity (Luria, 1973) . Therefore, it may be that a constant visual reminder of the agent is necessary because many 3-year-old children are not able to automatically construct a goal-directed cognitive framework without it

Another explanation of the data may be that the agent condition in Study 1 provided physical information concerning the construction of the pieces. The hands of the

agent may have conveyed information such as the relative size of the objects, or where

the child's own hands should be placed in order to piece together the sequence. If this

were the case, later reconstruction differences between conditions would be interpreted

not as memory effects, but as performance effects (those in the agent condition simply

learned how to construct the sequence more efficiently). However, this low-level

processing explanation seems unlikely. First, in Study 1 the agent constructs the objects

away from her while standing behind them. The agent thus used hand positions and

movements not conductive to the child's test situation, where the sequence was always

constructed in a head-on format. However, future coding could explore this option

investigating the extent to which the children mimic the hand placement of the agent

during reconstruction. Secondly, in Study 2 the agent was visible in both the first and last

page of the agent-condition book, allowing participants to see the relative size of all

objects of the sequence. This added information in Study 2 did *not* increase participant

test scores, demonstrating the ineffectiveness of relative size information for later

performance.

The self-talk data further supports the initial conclusion that increased test scores

are results of memory, not simply physical performance. In Study 1, it was shown that

self-talk does not facilitate better memory in the agent condition, presumably because

they were given the framework of a goal-directed action and thus needed no additional

help. However, in the non-agent condition, self-talk relating to instructions, responses

relating to the book, and reporting the goal was integral to better performance. Those that

were able to provide themselves with a directional goal framework (by naming the object

they were to complete or providing themselves verbal instructions) performed at nearly

the same level as their agent-condition counterparts. However, in the non-agent condition, those that did not utilize construction-related self-talk performed significantly lower.

The self-talk data in Study 2 demonstrated further effects of imposing structure through speech. As is also seen in the behavioral data, the talk data shows no significant difference between the agent and non-agent condition for any category of speech. However, collapsed across conditions, certain types of talk were found important to sequential recollection. Similar to the results in Study 1, children who recited instructions to themselves ("This piece goes here!") and who made references to the book ("Sally did it like this!") remembered significantly more steps than those who did not. This illustrates the extent to which construction-related speech again helps in reconstruction of the sequence. Together, these data suggest that the agent books in Study 2 were missing an important component necessary to bolster memory. Without being able to use a goal-directed framework, self-speech was needed as a supplement.

Taken together, it seems obvious that, even when the agentive cues are not available during the instructional phase, variation in recall is mediated by the structure children provide themselves. Explicitly mentioning the agent or goal during the test phase resulted in better memory for the sequence, whereas other comments relating to the pieces (such as describing the physical properties of the pieces, e.g. "This is small") did not. This shows that recalling elements highlighted by the agent's hands (positioning, size, etcetera) was not effective enough to increase performance. However, comments relating to the goal-directed nature of the sequence did increase test scores.

Chapter 7: Future Directions & Conclusions

Further research may be necessary in order to distinguish between performance and memory explanations of the data. One method increasing in popularity with young children is that of Event Related Potentials or ERP. This method relies on averaging brain waves elicited by a time-locked stimuli during passive viewing. Utilizing ERPs would allow us to view the effects of memory in a passive and non-verbal manner, as opposed to having the children show evidence of memory through rebuilding of the sequence. Differences in ERPs between the agent and non-agent conditions would, by nature, show effects of memory, not performance.

Other possible directions include exploring additional behavioral manipulations. One manipulation could entail presenting conditions where the agent is visually present but not acting on the objects, providing a constant reminder of the goal-directed nature of the sequence without increasing physical cues. Another possibility could be an agent condition where Sally is seen in all the pictures but not verbally mentioned, allowing us to asses the importance of the visual versus verbal agency cues. Future coding projects could entail looking at the extent to which children mimic the hand formations found in the Study 1a agent condition, or differences in general activity between conditions.

The results of these studies help to inform our general knowledge on social episodic memory. It seems that, if given a significant amount of agency information in an event, memory is increased in young children. However, at this age, the amount of information alluding to a goal-direct action by an agent may need to be significant. Previous research on story understanding echoes these sentiments. In one study, it was found that 5-year olds were able to remember significantly more about a story if they

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were provided with additional information pertaining to a character's intentions (Yui, 2002). Without a significant amount of information relating to goal-directed actions, the events in the stories were largely forgotten. Therefore, it seems that it is not only an agentive character that is necessary, but also the amount of agentive information that can be drawn from the story for later recollection.

Appendix

Study 1 Sequence Steps by Set

Bunny Sequence

1. Put bunny head on black base

2. Place white part of eye on the head

3. Place one pupil on the eye white

4. Place the other pupil on the eye white

5. Place one ear into the holes on top of head

6. Place the other ear into the holes on top of head

Tree Sequence

1. Place tree trunk into green base

2. Place branch through hole in tree trunk

3. Hang one monkey on tree branch

4. Hang other monkey on tree branch

5. Place leaves on top of tree trunk

6. Place raccoon on top of leaves

Study 2 Sequence Steps by Set

Bunny Sequence

1. Place bunny head on black base

2. Place white part of eyes on the head

3. Place fused black pupils on head*

4. Place nose on head under eyes*

5. Place bowtie on neck area under nose*

6. Put fused ears into hole on top of head*

Tree Sequence

1. Place tree trunk into green base

2. Place branch through hole in tree trunk

3. Hang vine on one end of branch*

4. Place leaves on top of tree trunk

5. Put second set of leaves onto end of branch*

6. Place raccoon on top of first set of leaves

Bug Sequence*

1. Place bug body onto pink flower base

2. Place legs vertically onto white body

3. Put round head on top of white body

4. Place wings behind body

5. Put eyes on top of round head

6. Place antenna into hole on top of head

New addition or change in set from original Study 1 stimuli
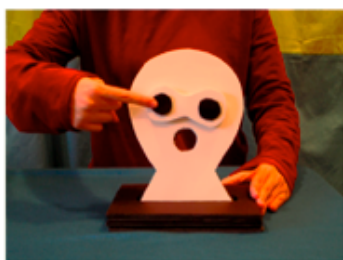
Agent Bunny   Non-Agent Bunny
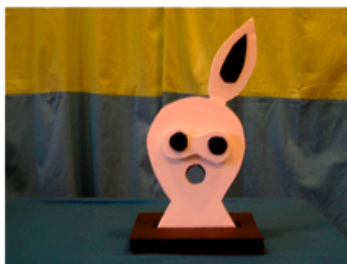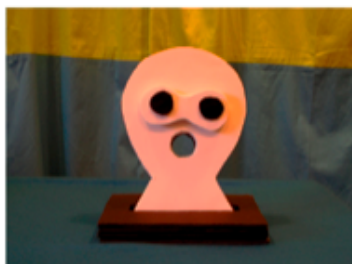
Figure 1. Bunny picture book stimuli in agent and non-agent conditions for Study 1.
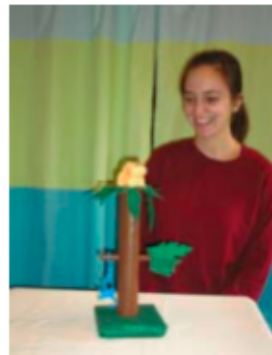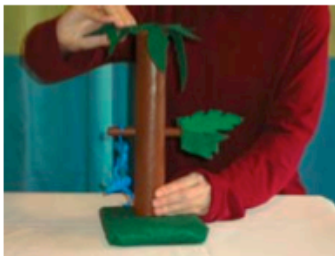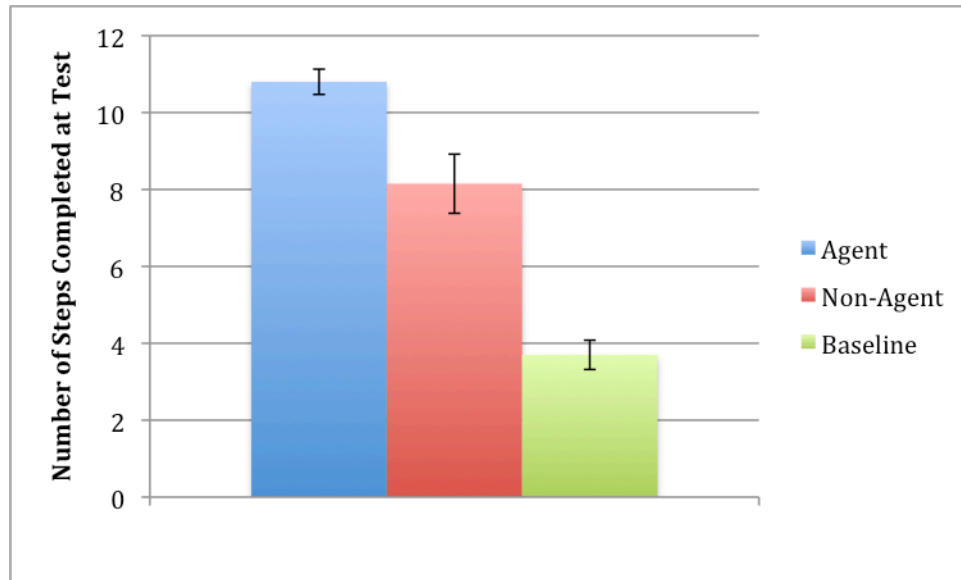
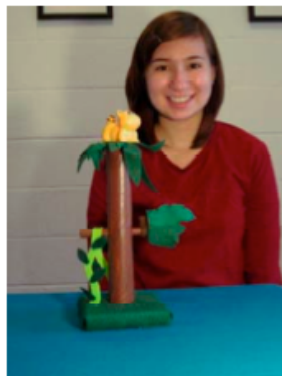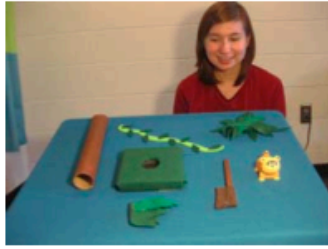Agent Tree   Non-Agent Tree

Figure 2. Tree picture book stimuli in agent and non-agent conditions for Study 1.

Figure 3. Number of completed steps (out of 12) for agent, non-agent, and baseline conditions in Study 1a.

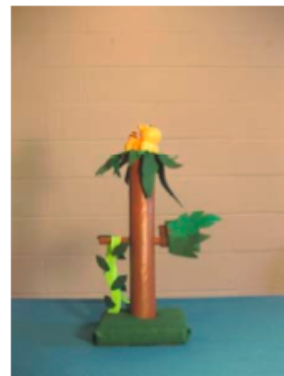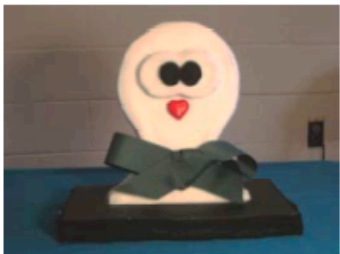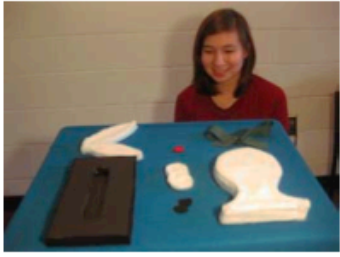Agent Tree   Non-Agent Tree

Figure 4. Tree picture stimuli for agent and non-agent condition in Study 2.
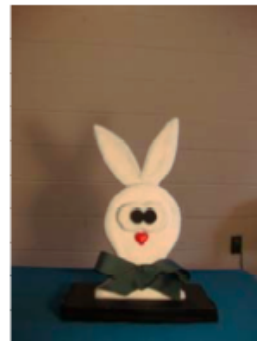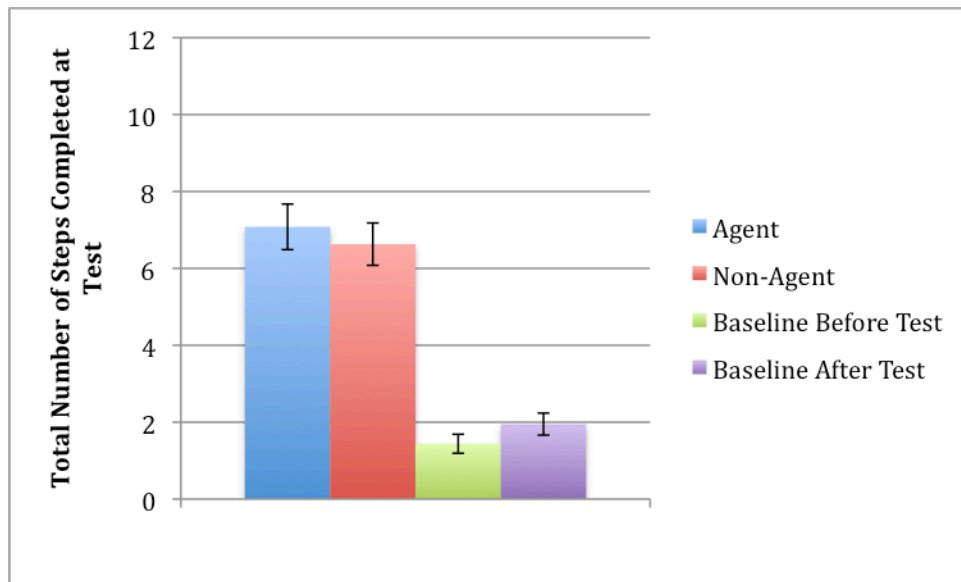
Agent Bunny   Non-Agent Bunny

Figure 5. Bunny picture stimuli for agent and non-agent conditions in Study 2.

Agent Bug   Non-Agent Bug

Figure 6. Bug picture stimuli for agent and non-agent conditions in Study 2.

Figure 7. Number of completed steps completed at test for agent, non-agent, baseline before test, and baseline after test sets in Study 2.

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