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The relationships between extracurricular activities, rehearsal, and short-term memory recall in children

Scarlett Hammond

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by

Scarlett Hammond

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Dr. Emily Elliott

Department of Psychology

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Louisiana State University
& Agricultural and Mechanical College
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Abstract

Flavell, Beach and Chinsky (1966) completed a pioneer study on the evolution of spontaneous verbal rehearsal in memory tasks as children go through formal schooling. They determined that, as children progress through developmental stages, they begin to verbalize more during memory tasks to remember information presented to them. This verbalization is one "rehearsal strategy" that children develop. Miller, McCulloch, and Jarrold (2015) found that it is possible to teach children rehearsal strategies through "rehearsal training" which in turn improved overall recall in comparison to interactive imagery training. Rehearsal training can be seen in a variety of activities, especially extracurricular activities such as sports or dancing that may involve the utilization of rehearsal strategies. This study looked at the possible correlations between extracurricular activities, rehearsal, and short-term recall in elementary school children ages 5 to 11. Participants completed a recall task that evaluated rehearsal strategies and their guardian filled out a survey regarding the participant's extracurricular activities. Results showed a significant positive correlation between extracurricular hours and serial position scores. There was a nonsignificant negative correlation between extracurricular hours and verbalization and between verbalization and serial position scores. These findings indicate that increased extracurricular activity hours may contribute to better performance on short-term memory recall performance. Additionally, the findings indicate that verbalization does not have an effect on serial position scores and is not affected by extracurricular hours.

Keywords: extracurricular, rehearsal, recall, short-term memory

In the age of technology, children are going outside less and less during the day, meaning that their levels of physical activity have decreased substantially. It is important to consider the effects that increasing a child's physical activity can have on their cognitive abilities. Previous studies have shown that as children progress developmentally, they tend to remember information better through the acquisition of memorization techniques such as verbalization (Flavell, Beach, & Chinsky, 1966). There have also been studies that show increased physical activity can help improve these cognitive processes and academic performance (Kamijo, Pontifex, O'Leary, Scudder, Wu, Castelli, & Hillman, 2011). However, few studies thus far have examined the effect that increased physical activity, specifically in extracurricular activities that utilize routine, can have on memorization.

Rehearsal in Children

Working memory refers to "the ability to store and manipulate information over brief periods of time" (Miller et al., 2015, p. 1). Common tasks for measuring working memory involves the serial ordering of some information and a distraction task to see how well a participant can remember information after faced with a disruption, something this study will be utilizing. A person's performance on working memory tasks has been associated with predictions to academic performance, intelligence, and classroom behavior (Miller et al., 2015). Although working memory differs from short-term memory, the two have a close relationship; short-term memory is considered to focus on just storage of information, while working memory is a process for storing and manipulating information into your memory. For my study I am using the term short-term memory recall (STM) because the delay period, which will be explained further on in the methods section of this paper, does not contain a distraction task.

In their experiment, Miller et al. (2015) looked at different rehearsal strategies that children used to remember information, and trained participants in those strategies to determine how recall was affected. A rehearsal strategy is something used to remember information as it is being presented. The three types of training used in the experiment were cumulative rehearsal, interactive imagery, and passive labeling. Also known as cumulative sub-vocal rehearsal, cumulative rehearsal is when someone repeats a sequence in their head over and over in the correct serial order. For interactive imagery, the children were instructed to visualize each of the objects they were shown and to imagine those objects "being joined together and interacting with one another" (Miller et al., 2015, p. 2). The final rehearsal strategy was passive labeling, where participants were instructed to only name the item they just saw to themselves, differing from cumulative rehearsal where they named all the objects in serial order repetitively.

The results from Miller et al. (2015) showed that participants in the rehearsal groups performed better in terms of recall than those in the control group (passive labeling) no matter what age. Additionally, the three groups of participants, which were also classified into two different age groups, were matched by their initial level of performance on the verbal short-term memory task. This finding is interesting considering there is a widely-held believe that younger individuals are "either unable to rehearse, or show impoverished verbal serial recall because they do not spontaneously engage in rehearsal" (Miller et al., 2015, p. 1). This idea, that as children advance in age they being to rehearse more, is something Flavell et al. (1966) looked at in their seminal experiment.

Flavell et al. (1966) discovered in their study of children ages 5 to 11 that, as they progressed in age, children tended to display more verbalization (i.e. rehearsal) in memory tasks. This study looked at how children verbalize and examined two different hypotheses that may explain a

deficiency that younger children experience in “verbal mediated performance”. The two hypotheses, known as mediational-deficiency and production-deficiency, were originally classified as one until it was realized that there needed to be further specification on the topic. The new “mediational-deficiency” hypothesis that Flavell et al. (1966) used states that children are able to produce verbalizations when they should, but these verbalizations do not mediate like they should, making them useless. The “production-deficiency” hypothesis, on the other hand, states that a child may know the appropriate words for the situation, but they fail to produce the words verbally.

The purpose of the Flavell et al. (1966) was to examine this second hypothesis, the production-deficiency hypothesis. To do so, they gathered a group of children ages 5 – 11 as participants and administered a task to test their memory recall and verbalization abilities. This task was replicated in this current study, and involved children being presented with a set of pictures and then being asked to either immediately recall the pictures and the order they were shown or experience a delay of approximately fifteen seconds before being asked to recall the pictures and the order they were shown. Participants in this study were watched by an experimenter who judged the amount of verbalization a child produced and classified it as no verbalization or verbalization that did not constitute labeling, verbalization that was not completely intelligible but could be understood as labeling, and verbalization that was clearly labeling. Verbalization included both lip-movement and sounds made.

Their study confirmed one of the two hypotheses, the “production-deficiency hypothesis”, which stated that children can use strategies they are taught by others to remember information but cannot produce strategies on their own. The results from this study showed that the younger children were less likely to show rehearsal or verbalization in the recall task in comparison to

older children which falls in line with the hypotheses they made concerning the experiment. The current study aimed to replicate these findings concerning verbalization and rehearsal in children.

The Effects of Extracurricular Activities

López-Vicente, Garcia-Aymerich, Torrent-Pallicer, Forns, Ibarluzea, Lertxundi, González, Valera-Gran, Torrent, Dadvand, Vrijheid, and Sunyer (2017) looked at the long-term effects of physical activity and sedentary levels on working memory performance in early childhood through a longitudinal study focusing on several age groups. There were two age groups in this study, a younger subcohort which consisted of participants who started the study at 4 years of age and an older subcohort whose participants started the study at 6 years of age. Mothers of the children in each subcohort filled out a survey regarding their child's physical activity and sedentary levels once they were recruited (when their child was either 4 or 6, depending on the subcohort in which they were placed). Although the survey questions were not identical across the regions, they were all formatted to receive a similar answer, which was the amount of time their child spent on a specific activity. Once answered, the researchers transformed the categorical variables to continuous variables to ensure that the answers were uniform in format.

The working memory portion of this experiment took place several years after these surveys were completed. Children in the younger subcohort completed the task once they reached 7 years of age and children in the older subcohort completed the task once they reached 14 years of age. The session took 25 minutes and involved child participants completing an *n*-back test. In this *n*-back test "participants have a sequence of stimuli on the computer screen, one at a time, and they have to respond (hit a button) when the current stimulus matches the one

presented n steps before" (López-Vicente et al., 2017, p. 36). Participants completed 25 trials and three levels of difficulty (1-, 2-, and 3-back) for a total of 75 trials.

For their results, the researchers focused on accuracy in the 2-back trials because "it showed better properties than the 1- and 3-back tasks (e.g., clear age-dependent slope and little learning effect) in a previous study" (López-Vicente et al., 2017, p. 36). After analyzing their results, researchers found that there was no significant difference in memory performance in the younger subcohort between those with lower or higher levels of physical activity. However, they do say throughout the rest of the article and in their summary that low levels in the younger subcohort were associated with working memory performance at a later age. In the older subcohort, they found that lower levels of activity led to a 4.22% decrease in correct responses on the *n*-back test. Additionally, high levels of sedentary behaviors were associated with a 5.07% decrease in correct responses in males in the older subcohort. Although this longitudinal study helps us better understand the impact physical activity levels can have later on in life, it does not provide a clear enough pathway from physical activity to increased memory performance. The physical activity measurements were taken at the beginning of the study and no follow-up questions were asked to determine if a participant's physical activity levels had significantly changed. To find a clearer path between the two variables, I examined Kamijo, Pontifex, O'Leary, Scudder, Wu, Castelli, and Hillman (2011), who tested the effects of physical activity intervention on working memory.

In Kamijo et al. (2011), researchers recruited forty-three children and divided them into two groups: a waitlist control group and a physical activity program group. Children in the physical activity intervention group spent two hours each day after school participating in activities that focused on cardiorespiratory fitness or muscle fitness, depending on the day.

Additionally, the children played organizational games that centered around a skill, such as dribbling. To measure cognitive ability, each participant completed the modified Sternberg task made by researchers. In this Sternberg task, participants were presented with a set of uppercase consonants that were either 1, 3, or 5 letters in length. They were then immediately presented with a lowercase consonant that was flanked on each side with question marks (to correspond with the number of letters in the initial presentation). Participants then pressed one of two buttons to indicate if the uppercase version of that letter had been present in the initial presentation they had just seen of uppercase consonant letters. For example, participants may be presented with the letters "LSRMK" and then "??r??", at which point they should press the button that indicates the "r" was presented before. Participants completed four blocks of 45 trials of this task.

After analyzing the data for task performance, researchers reported that participants in the intervention group saw overall significant improvement in their scores on the Sternberg post-test ($p = .002$; 58.4% accuracy to 68.5% accuracy), in comparison to the waitlist control group which saw no improvement in scores ($p = .9$; 65.6% accuracy to 66.0% accuracy). As expected, there were significant decreases in response accuracy as participants were presented with trials containing more letters. Additionally, differences in response accuracy between groups became smaller as participants completed trials containing 3 (70.4% accuracy for intervention and 68.2% for control) and 5 letters (61.0% for intervention and 61.1% for waitlist). Interestingly, while response accuracy increased for the intervention group (66.0% to 74.1%) they decreased for the waitlist group (72.9% to 68.8%).

It is important to note that in Kamijo et al. (2011) the intervention group did not have significantly higher response accuracy in the post-test compared to the waitlist group, they just

had a significant improvement from their pre-test response accuracy scores. Although the researchers say that "preliminary t-tests were conducted to confirm that there were no significant differences in response accuracy between groups at pre-test for each letter condition", the significant results in post-test for the intervention group would suggest otherwise (Kamijo et al., 2011, p. 8). Because the post-test results were not significant between the two groups, a significant difference in their pre-test would provide an explanation for the researchers' results. Overall, Kamijo et al. (2011) did show that physical activity intervention can have a direct result on a child's ability to perform on a working memory task.

Furthermore, Hsieh, Fung, Tsai, Chang, Huang, and Hung (2018) looked at the relationship between physical activity and working memory in their experiment in a small group of children in Taiwan. Hsieh et al. (2018) classified their participants into two groups, high physical activity (HP) and low physical activity (LP) based on measurements from an accelerometer. Groups were determined based on the median number of accelerometer counts per minute (median = 846 counts). Participants were then given a delayed matching test to evaluate perceptual working memory. This test had two sections which were classified as delayed and non-delayed. In the delayed condition participants were presented with a rectangle with a dot inside of it, at one of nine possible positions, on either the right or left of a plus sign in the middle of the screen. Next a screen with just the plus sign in the middle was shown for 3 seconds before another rectangle appeared. Participants had to determine if the dot was in the same place as the previous rectangle or if it had moved. In the non-delayed condition, both rectangles were presented at once and participants had to determine if the dots in each of the rectangles were in the same position. Their results found that children in the HP group had higher accuracy rates ($F(1,30) = 4.96$, $p < .05$, $\eta_p^2 = 0.61$) compared to children in the LP group.

Current Study

This current study examined how extracurricular activities affected the rehearsal strategies a child uses to remember information presented in a short-term memory recall task. Additionally, it examined the effect that long-term extracurricular activities can have on short-term memory performance. It is an extension of the Elliott et al. (2019) study, which is a multi-lab direct replication of Flavell, Beach, and Chinsky (1966). This study followed the methods section of the Elliott et al. (2019) study with the addition of a questionnaire completed by parents concerning their children's extracurricular activities. Based off of previous studies, I hypothesized that than an increase in extracurricular activities may lead to better performance on the short-term memory task. Additionally, I hypothesized that greater extracurricular activities may cause a child to perform better than another child who is similar in age or slightly older.

Participants

Participants were recruited from various elementary schools located in Baton Rouge, Louisiana. An email was sent to school principals explaining the project and asking them to share the signup form with the guardians of children in kindergarten through fifth grade. Additionally, Dr. Elliott reached out to several colleagues at Louisiana State University who had children that fell within our desired age range. A total of 57 children agreed to participate in the study, (24 male, 33 female). Following the in-person session, the survey sent out to guardians regarding extracurricular activity performance received 29 completed responses. Of those 29 completed responses, 3 were excluded because the children did not participate in the study but a sibling did, 1 was excluded because the parent filled out the survey twice, and 2 were excluded because they began the testing portion of the study but were unable to finish or their data were unusable due to not following directions. Additionally, one parent filled out one survey for her

twin daughters, but follow-up contact established that both children completed the same extracurriculars and therefore could be counted twice. In the end, 24 children (13 females, 11 males) who participated in the study and whose parent also completely filled out the survey regarding extracurriculars were included in the analyses.

Procedure

Testing for this study took place in two different environments. The majority of children were tested in Dr. Emily Elliott's lab located on Louisiana State University's campus in Audubon Hall. Some children were tested at their local elementary school, during their after school program, in the school's library or an empty classroom. Both locations had relatively the same set up and testing was conducted in the same order and manner in both locations. Participants sat behind a computer screen with an experimenter on the side of them to facilitate the computer program used to run the test and explain the study to the participant. For most trials, there were between one and two coders also in the room sitting a few feet from the experimenter and participant depending on availability for that day. However, when there was no coder in the room the computer's built-in camera was used to record the session. Later on, coders went through the video and coded the child's verbalization throughout the test. A minor assent form was procured from the participant before the test began in addition to the consent form filled out by the participant's guardian.

The experimenter and participant sat in chairs behind the computer screen while the test was conducted. First, the demographic information was entered for that participant which included: participant number, research group (LSU), age in months, grade in school, and gender (in that order). The experimenter then explained what the memory recall task would consist of based on prompts from the computer program. The experimenter explained that several pictures

would appear in a line on the screen and the participant was expected to memorize, to the best of their ability, the pictures that were highlighted by an orange color and the order in which they were highlighted. Participants then went through two practice trials, the first with two pictures being highlighted and the second with four pictures being highlighted and were asked immediately to recall the pictures they saw following each trial, by pointing to the pictures in order. It was emphasized to participants that they should just point to the pictures during the recall phase, and no mention was made of having them name the pictures for the first two sections of the memory recall task. Participants were then asked if they had any questions concerning the practice trials they just did, and if they did not then the experimenter proceeded to explain the next step.

It was then explained that during some trials they would be asked to wear a pair of painter's-taped sunglasses during a "delay" period of fifteen seconds. Participants were given the opportunity to practice putting the sunglasses on for fifteen seconds to get a feel for how long they would have to remain on, some chose to practice putting the sunglasses on while others did not. With the practice trials over and the role of the sunglasses in the delay period explained, the test began. Each participant experienced all three sections of the memory recall: delayed recall, immediate recall, and point-and-name recall. The delayed recall involved the presentation of pictures, wearing the sunglass for fifteen seconds, and then the recall of the pictures in the order they were seen. The immediate recall followed the same procedure minus wearing the sunglasses for fifteen seconds. The point-and-name recall mirrored the delayed recall, but during the presentation and recall phases the participants were asked to point and name the objects that they saw highlighted and the order they saw them; respectively.

Each section of the memory recall task involved eight trials, two trials for each number sequence of pictures (two, three, four, and five) and the trials progressed sequentially, meaning that during the delay trials participants saw two of the two-picture trials first, then the two three-picture trials, and so on until they finished with the two five-picture trials before heading onto the next section. Participants experienced either the delay or immediate recall section first, based on randomization from the computer program, followed by whichever was left from that pair, and the point-and-name section always last. After the delayed recall section participants were asked how they remembered the sequence of pictures (see Appendix B for a copy of the questionnaire). Before each point-and-name section participants were asked to name the seven pictures one at a time to ensure that the participants had a verbal label for each item (see Appendix C for a copy of the pictures). Once the point-and-name section was finished participants were informed that they had finished the test, were allowed to pick out a prize, and returned to their guardian who was waiting just outside the testing room.

A survey regarding extracurricular activities was emailed out to the parents after participant testing was finished (see Appendix A for a copy of the questionnaire). It was determined that the guardians would be able to give the most accurate answers for the questionnaire in comparison to the participants. This survey was constructed through LSU Qualtrics and was distributed to guardians in December of 2019. In the survey, guardians were asked to choose from a list what extracurriculars their child participated in, with an option at the end for them to write in any activities that may have been left of out the list. After choosing the activities they then answered questions concerning the amount of time their child had been involved in each activity such as hours per week and months per year. The second section of the questionnaire resembled the first but focused on musical instruments that their child practiced.

Results

To analyze the data from this study I utilized a correlation analysis to test the relationships of our variables (extracurriculars, rehearsal, and working memory; see Table 1). The goal of this analysis was to determine how extracurriculars affect the amount of rehearsal a participant engages in, whether increased rehearsal affects accuracy in a short-term memory task, and if high levels of extracurriculars activities correlated to higher accuracy in the memory task. Results showed a non-significant negative correlation between verbalization and extracurricular hours ($p = 0.613$, Pearson's $r = -0.109$). There was also a non-significant negative correlation between verbalization and serial position score ($p = 0.325$, Pearson's $r = -0.210$). The analysis showed a significant positive correlation between extracurricular hours and serial position score ($p = 0.013$, Pearson's $r = 0.499$). Other significant results are between age in months and extracurricular hours ($p = 0.003$, Pearson's $r = 0.586$) and between age in months and serial position score ($p < 0.001$, Pearson's $r = 0.499$). There was a non-significant negative correlation between age in months and mean verbalization score ($p = 0.640$, Pearson's $r = -0.101$). A mediation analysis was conducted with extracurricular activities acting as the mediator on ages in months for serial position score (see Table 2). There was a nonsignificant indirect mediation effect ($p = 0.873$) and a significant direct mediation effect ($p < .001$).

Discussion

The first hypothesis for this study was that higher levels of extracurricular activity may lead to better performance on the short-term memory task. This hypothesis was supported based on the results of the memory recall task. The correlation analysis showed that as participants spent more hours in extracurriculars activities their chances of a higher serial position recall score rose. Although in the proposal for this study I expressed the idea that this correlation would

be the result of children better rehearsal from their extracurricular activities, the correlation analysis between extracurricular hours and mean verbalization was non-significant. However, the insignificant negative trend towards 1 (which indicated clear verbalization during testing trials) indicated that further testing with larger sample sizes would be a promising future direction.

Additionally, this study derived verbalization as a measure of rehearsal in participants from Flavell et al. (1966) but did not find the same results as their study (see Table 3). While Flavell et al. (1966) found that children verbalized more as they aged, this study found no significant correlation between age and verbalization scores. In fact, the results showed a slight, non-significant negative correlation between the two variables. Due to the age of the original study, it is possible that children have learned other, internal rehearsal strategies that are more effective and have caused the decrease in verbalization scores. Miller et al. (2015) explored two different types of non-verbal rehearsal, which are cumulative sub-vocal rehearsal and interactive imagery, in their study. It is possible that children are practicing these internal rehearsal strategies and are becoming more successful at internalizing rehearsal as they age.

There are other factors that may explain the correlation between extracurricular activity and serial position recall scores besides rehearsal. Physical activity has been known to have effects on cognitive performance because of increased blood flow to the brain. One way to test this difference would be to have an experiment with two different groups of physical activity: extracurricular activities that involve strategy and regular physical activity, such as running, that do not involve strategy. Additionally, a demographics survey for parents and guardians to fill out could be used to account for other variables that may influence outcomes such as socioeconomic status, access/use of tutoring services, and reading levels outside of schoolwork.

The second hypothesis that greater levels of extracurricular activity may cause a child to perform better than another child who is similar in age or slightly older is not supported by the results. The idea behind this hypothesis was that extracurricular activities would again improve rehearsal in children and therefore help them perform better on a short-term memory recall task. However, the results of the mediation analysis of extracurricular activities on the relationship between age and serial position score show otherwise. It is possible that more extracurricular activities may put a child above other people in their age group but not above or at the same level as children ahead of them because of other factors involved in a child's abilities to rehearse and recall information. The educational tools children are given as they advance through school could be what set the older children apart in terms of serial position scores, despite having similar or fewer hours of extracurricular activities. Additionally, higher attention spans and continuing brain development could play a role.

There are several improvements that could be made for future replications or extensions of this study. The largest obstacle faced in this study involved the survey portion which would need to be modified for future usage. There were errors in the collected questionnaire data because guardians were allowed to write-in their answers for each question after selecting their child's extracurricular activities. One possible solution for this would be changing the answer format to a drop-down list for each question. For example, for a question like, "what months out of the school year did your child participate in an activity?", there would be a drop-down menu for the start month and end month.

Another future improvement to this study would be having guardians fill out the survey while their child is participating in the memory recall task, which would also give them something to do while their child was being tested. There were some instances where parents

wanted to be in the room with their children which resulted in possible distractions for the child. Additionally, having guardians fill out the survey when they bring their child in for testing would ensure that we would collect a timely and accurate response. There were 57 participants that were run through the memory recall task and less than half of those had a survey filled out by their guardian. The survey for this study was sent out anywhere from a few weeks to several months after the child participated in the recall task, which was detrimental to the response count. There is a possibility that guardians unknowingly put in extracurricular hours from after their child participated in the memory recall task but before they received the questionnaire. Having the survey done immediately upon arrival would likely mean receiving a more accurate response and being able to sort out any problems guardians may face with the survey in a timely manner.

Another improvement would be to do further analysis on the different sections of the memory recall test. Some participants performed very well on certain sections and then performed poorly on others (See Table 4). Further research could be done into the cause of this difference and whether it has to do with the difference between sections (such as initial rehearsal in the point-and-name section compared to the first two sections). By breaking down the different sections of the memory task, further exploration could also be done on the effects of different extracurricular activities on these sections. Different extracurricular activities promote different types of rehearsal and memory recall, which the testing portion of this study does through its three sections. However, research into this idea required also looking at the limitations of this study.

The limitations of this study revolved largely around the sample size of this study. Earlier in this discussion it was mentioned that a future experiment could look at two different types of

physical activity which were extracurricular activity and “regular” physical activity. A larger sample size would allow for this to happen, in addition to further distinguishing between types of extracurricular activities. Different extracurricular activities require different levels of rehearsal and strategizing and classifying these as higher or lower in terms of rehearsal would be beneficial for future research. Additionally, a larger sample size would allow for partial correlations to control for age in months. The sample size of the current study was too small to successfully complete additional analyses.

In conclusion, the results of this study indicated that children who participate more in extracurricular activities may have better short-term memory. The results also indicated that an increase in extracurricular hours does not lead to an increase in verbalization. Finally, the results of this study indicated that verbalization does not have an impact on short term memory recall and provided several clear avenues for future research.

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Table 1

Correlation Matrix of Extracurricular Hours, Age in Months, Mean Verbalization Scores, and Serial Position Scores

		Ex. Hours	Age in Months	Mean Verb.	SP Score
Ex. Hours	Pearson's r	—			
	p-value	—			
Age in Months	Pearson's r	0.586 **	—		
	p-value	0.003	—		
Mean Verb.	Pearson's r	-0.109	-0.101	—	
	p-value	0.613	0.640	—	
SP Score	Pearson's r	0.499 *	0.826 ***	-0.210	—
	p-value	0.013	< .001	0.325	—

Note. * p < .05, ** p < .01, *** p < .001

Table 2

Mediation Estimates of Extracurricular Hours

Effect	Estimate	SE	Z	p
Indirect	0.0125	0.0778	0.160	0.873
Direct	0.7609	0.1328	5.729	< .001
Total	0.7734	0.1077	7.179	< .001

Figure 1:

Histogram and Scatterplot Graphs Among the Four Variables.

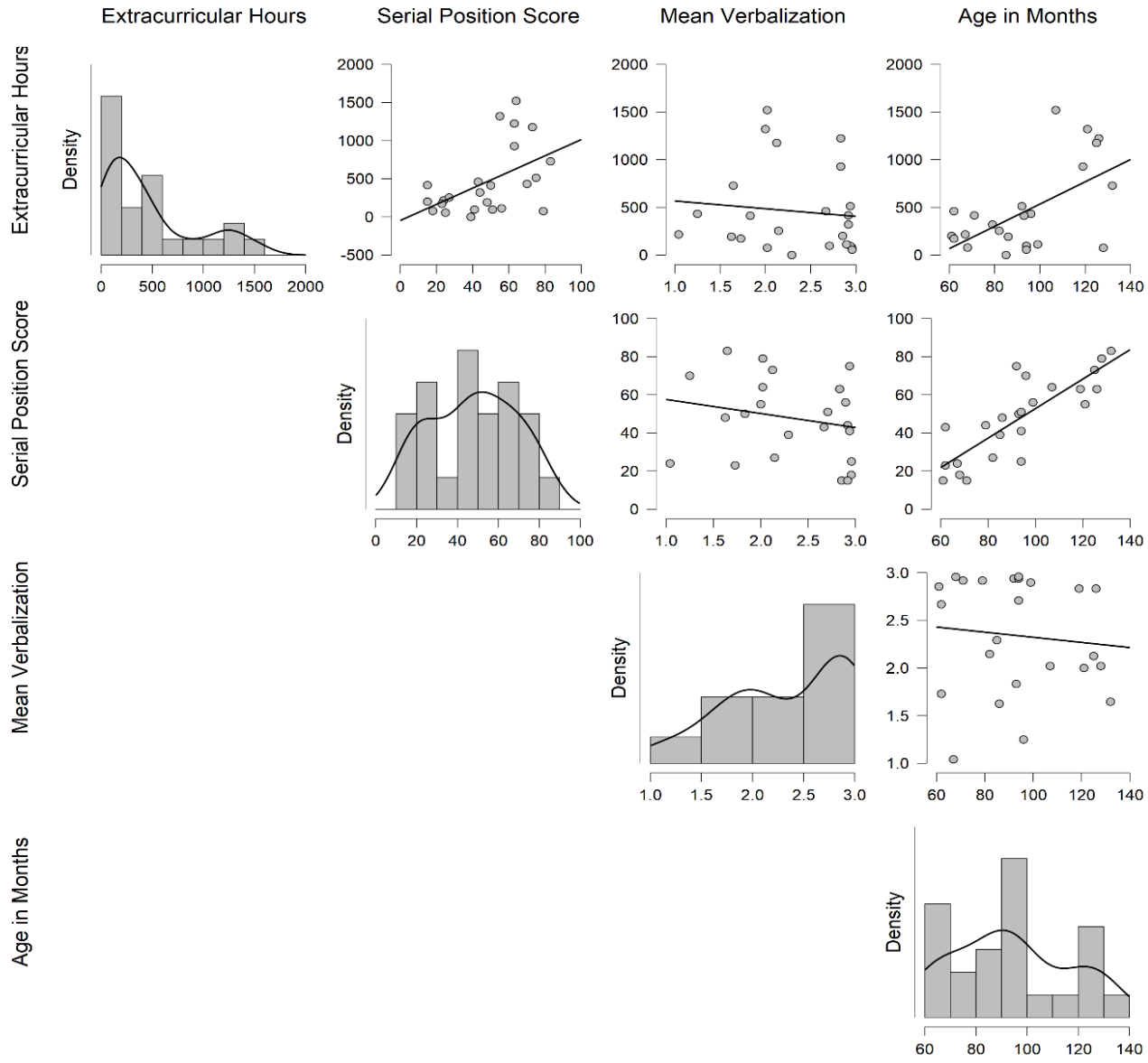


Table 3

Number of Ss Showing 1+ Verbalization Instances on Each Segment of Each Subtask.

	Segments and Subtasks					
	Presentation		Delay		Recall	
Age	IR	DR	DR	PN	IR	DR
5 (5)	2	2	3	4	3	3
6 (2)	0	0	0	1	2	0
7 (2)	1	2	1	2	2	2
8 (8)	5	5	6	5	7	6
9 (1)	1	1	1	1	1	1
10 (3)	1	3	1	2	2	3
11 (3)	3	3	3	3	3	3

Note. In parentheses beside each age number is the number of participants in that age group.

Table 4

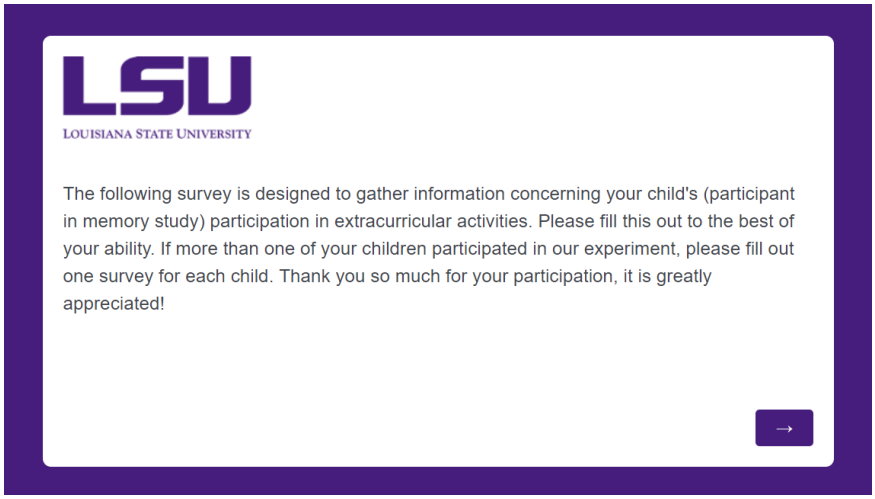
Number of words recalled in the correct serial position by each participant.

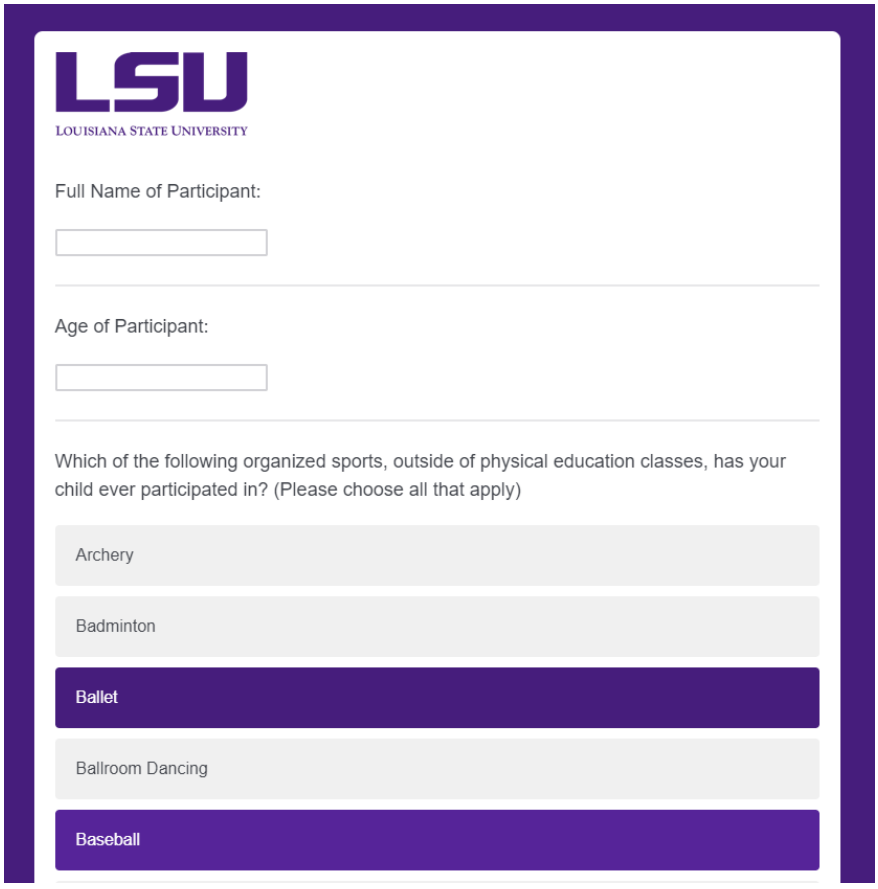
	Memory Recall Test Section			
Participant ID	**Delayed**	**Immediate**	**Point & Name**	**Grand Total**
107	4	2	9	15
108	5	9	4	18
109	9	14	20	43
111	4	4	7	15
114	3	13	8	24
118	12	8	3	23
200	14	22	12	28
201	27	27	21	75
202	22	25	23	70
203	10	17	12	39
210	7	10	10	27
215	13	20	11	44
302	13	21	16	50
303	12	17	12	41

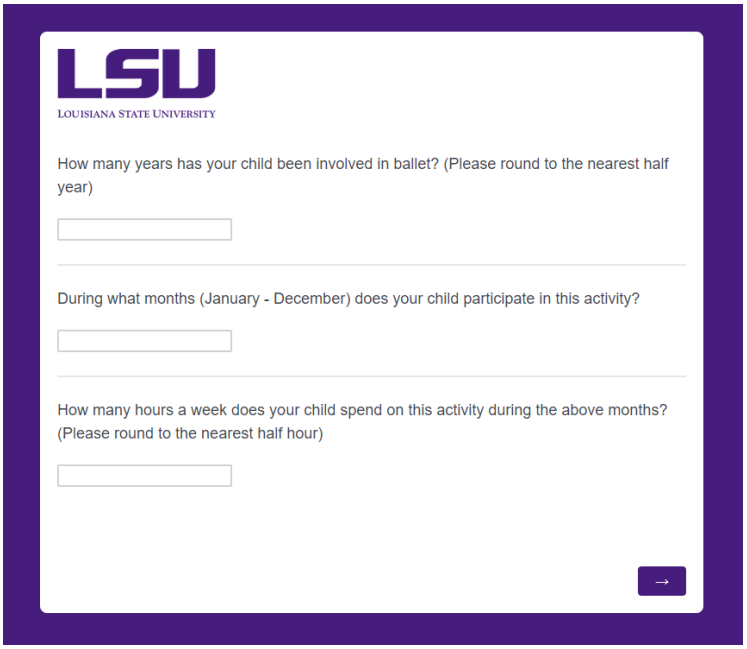
304	16	20	15	51
311	21	19	24	64
313	10	9	6	25
314	19	17	20	56
400	28	27	28	83
406	26	20	17	63
411	26	25	28	79
412	23	25	25	73
500	26	19	18	63
510	15	24	16	55
Grand Total	375	431	383	1169

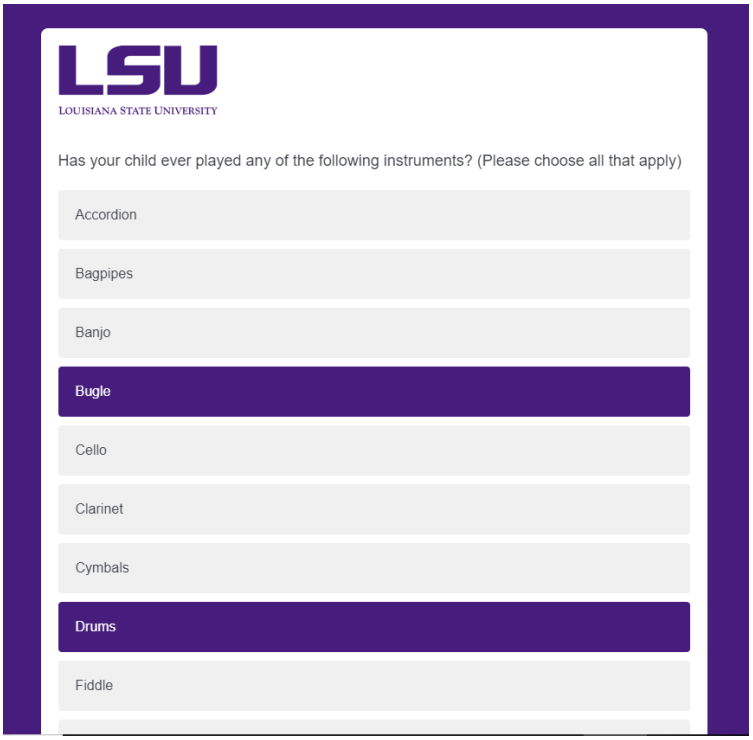
Note. The maximum possible recall score for each participant was 84.

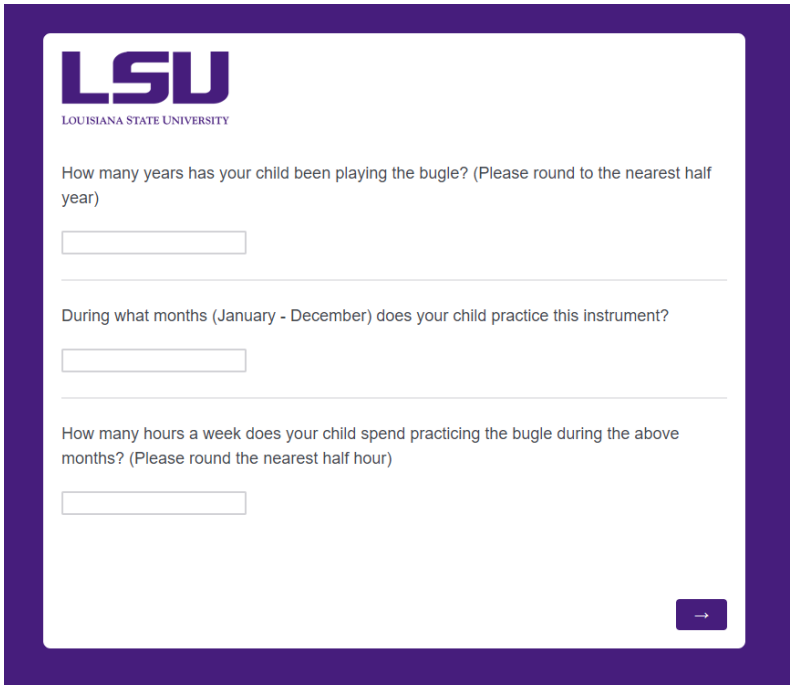
Appendix A

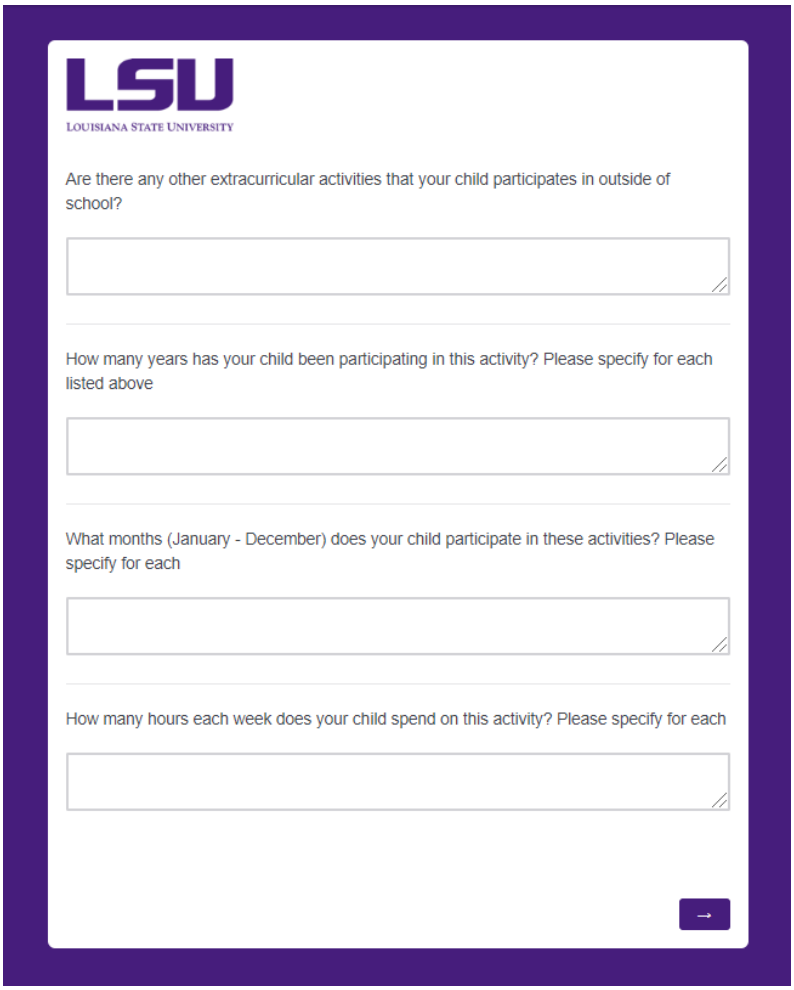

LSU
LOUISIANA STATE UNIVERSITY
The following survey is designed to gather information concerning your child's (participant in memory study) participation in extracurricular activities. Please fill this out to the best of your ability. If more than one of your children participated in our experiment, please fill out one survey for each child. Thank you so much for your participation, it is greatly appreciated!
→


LSU
LOUISIANA STATE UNIVERSITY
Full Name of Participant:
Age of Participant:
Which of the following organized sports, outside of physical education classes, has your child ever participated in? (Please choose all that apply)
Archery
Badminton
Ballet
Ballroom Dancing
Baseball


LSU
LOUISIANA STATE UNIVERSITY
How many years has your child been involved in ballet? (Please round to the nearest half year)
During what months (January - December) does your child participate in this activity?
How many hours a week does your child spend on this activity during the above months? (Please round to the nearest half hour)
→


LSU
LOUISIANA STATE UNIVERSITY
Has your child ever played any of the following instruments? (Please choose all that apply)
Accordion
Bagpipes
Banjo
Bugle
Cello
Clarinet
Cymbals
Drums
Fiddle


LSU
LOUISIANA STATE UNIVERSITY
How many years has your child been playing the bugle? (Please round to the nearest half year)
During what months (January - December) does your child practice this instrument?
How many hours a week does your child spend practicing the bugle during the above months? (Please round the nearest half hour)
→


LSU
LOUISIANA STATE UNIVERSITY
Are there any other extracurricular activities that your child participates in outside of school?
How many years has your child been participating in this activity? Please specify for each listed above
What months (January - December) does your child participate in these activities? Please specify for each
How many hours each week does your child spend on this activity? Please specify for each
→

Appendix B

How did you do this task?

When you saw the pictures, you knew
you were supposed to try to remember them,
so you could point to the same ones afterward, right?
What did you do to remember them? How did you go
about trying to keep them straight in your head?

Please tell us how you tried to remember the pictures.

Please check the box, or boxes, below, if needed to clarify any of the above.

I said the picture names to myself, one at a time.

☐

I said the picture names to myself, over and over, adding on a new picture each time.

☐

I thought about the way the pictures looked.

☐

I did not do anything special to remember them.

☐

Something else.

☐

Done

Appendix C

comb

flag

pencil

apple

moon

owl

flower