

¿COMO HABLAMOS? HOW MUCH AND WHEN TO TEACH TODDLERS'  
WORDS IN A SECOND LANGUAGE

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by  
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## ABSTRACT

In this present study, we explore two conditions under which monolingual English-speaking toddlers (N=12) may learn and retain knowledge of names of familiar objects in a second language. We examined toddlers' ability to learn names of familiar objects in a foreign language given limited exposure (total of 30 minutes). Second, we considered the role of learning schedules on the participants' ability to learn familiar nouns in a foreign language. Specifically, we examined whether toddlers were better able to learn a foreign language object label if they were exposed to Spanish for five (6 minutes) massed sessions (over the course of one week) as opposed to five distributed sessions which were spread apart (over the course of several weeks). Overall, children were able to learn and retain knowledge of six names of familiar objects in Spanish, regardless of learning schedule condition. However, toddlers who were assigned massed learning schedule condition were better able to learn and retain knowledge of labels of familiar objects in a second language, even after a week of second language exposure.

*Keywords:* word learning, second language learning, learning schedule effects, retention, massed vs. distributed learning

## BIOGRAPHICAL SKETCH

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## TABLE OF CONTENTS

1. Introduction	Page 1
2. Methods	Page 9
3. Results	Page 20
4. Discussion	Page 25
5. Figures	Page 34
6. References	Page 36

## ¿Como Hablamos? How Much and When to Teach Toddlers' Words in a Second Language

Beginning from infancy, children have an uncanny ability to learn multiple languages efficiently (Kovacs, 2009). From the time infants are in their mother's womb, they can discriminate rhythmically different languages (Moon, Cooper & Fifer, 1993). By 5 months, infants can distinguish within rhythmic class, provided one of the languages is their own (Bosch, Sebastián-Galles, 2001; Nazzi, Jusczyk & Johnson, 2000). This finding suggests that at a very young age, children are developing the foundations to learn other languages. Incredibly, only a year later, at 17 months, toddlers show the ability to recognize words embedded in foreign speech (Namy & Waxman, 2000). Furthermore, other researchers have discovered that two-year-old children have the ability to learn a second label for familiar and novel objects in a second language (Koenig & Woodward, 2011). Hence, young children have the underlying cognitive foundations and aptitude to begin to dissect and understand a second language.

Given the fact that children have the ability to learn words in a foreign language, it is important to further consider some of the factors that may influence their ability to learn a second language. For example, Koenig and Woodward (2011) examined the ability of two-year-old children to learn a novel label for familiar and novel objects in a second language. A native Dutch speaker presented monolingual English learning toddlers with familiar and novel objects with Dutch labels. Then, when prompted in Dutch, toddlers with high vocabularies demonstrated



comprehension of the Dutch word. However, toddlers with low vocabularies scores where not able to show understanding of the novel Dutch word. Yet, when the Dutch speaker left and an English speaker was introduced, toddlers, even those who previously comprehended the word in Dutch, failed to select the Dutch-labeled object when requested the object in English by the English speaker. These results indicate that even children as young as two have the ability to learn a second language. However, their ability to parse out labels and their meanings in a stream of foreign language words may depend on the vocabulary skills acquired in their native tongue. Also, these findings conclude that toddlers may also restrict their knowledge of foreign languages words to speakers of that language. To ensure that toddlers would learn familiar labels in a second language, only toddlers with high vocabulary skills were included in our study and all training sessions were conducted by native Spanish speakers in Spanish.

Furthermore, learning schedules along with native language skills may influence a child's ability to learn a second language. From the onset of our lives, we are subject to learning information in a particular point in time. Researchers argue that retention of knowledge is enhanced if learning occurs over a spaced period of time as opposed to all at once (Cepeda, Vul, Rohrer, Wixted, & Pashler, 2008; Cepeda et al., 2006). This phenomenon is known as the spacing effect (Cepeda et. al, 2006). This effect is said to enhance memory of knowledge if information is distributed over time in a spaced learning schedule as opposed to the presentation of information all at once (Kornell & Bjork, 2008; Vlach, Sandhofer, & Kornell, 2008). Nevertheless, different aspects of learning recommend opposing schedules of when to present information.

Although the spaced out presentation of information may be favorable for long-term retention and generalization, it may in fact harm immediate retention and generalization, because of the heavier demands on memory while acquiring the information (Vlach, Ankowski & Sandhofer, 2011). Evaluating this conundrum of learning schedules is important given that second-language learning requires the ability to retain and recall knowledge over time rather than immediately as most researchers have evaluated.

Given this contradiction, it is important to look at research that directly compares the effects of various learning schedules on differing aspects knowledge retention and generalization. One of the few studies directly examining the effect of timing on toddlers' ability to generalize and retain knowledge is one conducted by Vlach, Ankowski, and Sandhofer (2011). In this study, the authors compared two-year-old children's ability to learn novel nouns in a generalization task. Researchers presented toddlers' with novel object categories in one of three learning schedules: simultaneous, massed, or spaced. After learning the novel object, participants were required to generalize and chose a label to a novel instance of the category, either immediately or after a 15-minute delay. Results indicate that when examined immediately, toddlers in the simultaneous learning scheduled outperformed those in the massed and spaced out conditions. In contrast, after a 15-minute delay, toddlers on the spaced out learning schedule retained the most knowledge and outperformed those in the simultaneous and massed learning schedule. In addition, a study conducted by Karpicke and Roediger (2008) suggest that repeated testing and not repeated studying over time positively increased university students' ability to learn vocabulary words in

a foreign language. These findings may have implications in word learning, as immediate examination of word knowledge may not be indicative of actual long-term retention of knowledge. Also, these findings highlight the importance of examining word learning both in the moment and over periods of time in order to better understand how word learning goes on in real-word context, especially among second-language learners.

In order to evaluate the importance of learning schedules, it is important that we make certain how to best present information in a short period of time so that toddlers can best learn words in a second language. Learning in particular is highly sensitive to how information is presented (Bjork, 1994). Given the importance and frequency in which children learn things, the manner in which participants are presented information has been highly examined in children. Some researchers have argued that the simultaneous presentation of items aids in the higher-level generalization of categories (Namy & Getner, 2002). Likewise, the simultaneous presentation of multiple items has been shown to more effectively teach infants to generalize in comparison to viewing a number of items sequentially (Kovack-Lesh & Oakes, 2007; Oakes & Ribar, 2005). However, simultaneous presentation of items may only be favorable in promoting the immediate generalization of information and not for retention. Previous researchers have concluded that presenting items sequentially may enhance memory and improve retention of information over time (Vlach, Sandhofer, Kornell, 2008). This result was even seen in vocabulary learning among children who retained knowledge of unfamiliar words better when presented the words over time than simultaneously (Sobel, Cepeda & Kapler, 2011). Since we seek to evaluate

toddlers' ability to learn words in a second language immediately and over time, we have included both presentation measures (i.e. simultaneous and sequential) in our study. By using both the simultaneous and sequential presentation measures, children have the ability to learn second language words in a way that suits both immediate and long-term retention.

Despite extensive research in second language development and in the effects of learning schedules on knowledge, we know very little about the effects of learning schedules on second language development in children. Specifically, we know very little on how the schedule in which children are presented information would affect a toddler's ability to learn nouns in a second language. The present experiments were designed to explore this question in monolingual, English-speaking toddlers. In particular, we consider the role of massed exposure versus spaced out exposure on toddlers' ability to learn familiar nouns in a foreign language. We compare toddlers' ability to learn a second label in an unfamiliar language by exposing them to Spanish for five sessions massed over a week or five sessions spaced apart. In this experiment, the amount of Spanish exposure is held constant across all participants. However, the scheduling of the input is what we aimed to vary. For instance, participants were exposed to Spanish five days in a week, day after day or participants were exposed to Spanish two days in one week and three days in the next week. Our goal was to outline toddlers' abilities to learn a second label for a familiar object in second language and to see how their word learning abilities would vary across different learning schedules.

Thus far, we have detailed toddlers' ability to learn a second language and how their ability to do so may be effected by their learning schedule. However, along with explaining how children learn a second language, it is also important to understand the strong benefits to acquiring a second language. Although there is some evidence to suggest that there are costs to learning a second language as a child, the benefits far outweigh the disadvantages. Several recent studies have demonstrated cognitive advantages for bilingual children compared to their monolingual counterparts (Bialystok & Craik, 2010; Craik & Bialystok, 2010). One of the primary areas bilinguals have been shown to outperform monolinguals is in executive functions, even when accounting for cultural differences (Yang, Yang & Lust, 2011). Cognitive differences among bilinguals also include benefits such as outperforming monolingual children on executive control tasks, which may be a result of greater inhibitory skills (Bialystok, 1999; Carlson, & Meltzoff, 2008; Kovacs, 2009). These inhibitory skills may be due to the extensive practice bilingual children have at inhibiting one language while using another or they may be due to the practice bilinguals have in switching languages. Another finding suggests that bilinguals have an advantage in the arena of referential gestures (Yow & Markam, 2011). Three- and 4-year-old bilinguals were shown to better identify referential gestures than monolinguals. Bilingual children were better able to pick up on cues such as pointing and gazing from an informant to locate a hidden toy even if the children could not see the body of the experimenter because she was standing behind a box while the cue was directed at the right box. The amount of times children could correctly locate the object given the clues was then recorded. Bilingual children outperformed monolinguals on this task. This

“advantage” was even seen in bilingual children as young as two. Hence, learning a second language can bring many cognitive advantages into the life of child and learning how to best facilitate that learning is one of the goals of this study.

Nonetheless, in order to receive the benefits of learning a second language, we must first discover whether or not children are able to learn names of familiar objects in a second language with only thirty minutes of exposure and how children can best retain the knowledge of gained through while being exposed to an unfamiliar language. In order to understand how best toddlers learn words in a second language we must explore the role that learning schedules has on the toddlers’ ability to learn nouns in a second language.

In this present study, we explore two conditions under which toddlers may learn familiar nouns in a second language. We first must consider the role of limited exposure on toddlers’ ability to learn names of familiar objects in a foreign language. Second, we must consider the role of learning schedules on the participants’ ability to learn names of familiar objects in a foreign language. Specifically, we examined whether toddlers were better able to learn a foreign language object label if they were exposed to Spanish for five sessions massed over a week as opposed to five sessions which were spread apart over a couple of weeks. In the case of learning nouns in a second language, toddlers may be especially sensitive to the timing of second language exposure. If so, toddlers exposed more repeatedly to a foreign language over week might show better understanding of foreign language nouns than those toddlers exposed the same amount of time, yet more spaced apart over time. That is, toddlers may not be able to learn names of familiar objects in a second language, if they are not

consistently and repeatedly exposed to the second language everyday. Consequently, we then also examine the role of learning schedules on second language exposure on the toddlers' ability to learn and retain knowledge of labels in a foreign language. In particular, if massed second language exposure is necessary for toddlers to learn foreign object label, then toddlers exposed to second language in a more spaced out period of time may be less able to retain knowledge of foreign language object labels after a week. That is, children who are exposed to a second language over a longer period of time may have a harder time learning nouns in a second language and accordingly retaining knowledge of those nouns after a week. Therefore, the learning schedule and not just the frequency of second language exposure could determine how well toddlers are able to learn and retain knowledge of nouns in a second language.

In sum, the present studies were novel in examining toddlers' ability to learn second language labels as a function of limited exposure, and as a function of learning schedule. Moreover, we examined these abilities in monolingual children over a scheduled period of second language exposure. In this experiment, we compared their word comprehension and retention as a function of how limited and amassed the second language exposure and learning schedule were. These results could provide insight into toddlers' sensitivity to the timing and leaning schedule of second language exposure.

Therefore, the aim of these studies is to address the questions, can children learn familiar nouns through a number of limited play interactions in a second language and does the learning schedule of second language exposure matter for toddlers' ability to learn and retain knowledge of a foreign language object label?

## Methods

### Participants

The participants were 12 toddlers (5 boys and 7 girls) aged 22 to 35 months, ( $M = 30$  months,  $SD = 4.5889$  months). All participants were full-term at birth and from English-speaking monolingual families. Participants were recruited from various daycares in Ithaca, NY, a region of upstate New York. All participants had little to no exposure to a second language. Given the longevity of the training and procedure, a diverse age range of toddlers was selected to examine the effects of age on this experiment. Once toddlers were identified as the appropriate age for the present study, parents were contacted via letter. A total of fourteen participants were initially recruited but two participants were excluded due to their absence at the daycare during the time of the training. One participant was excluded from the retention test analysis because she no longer attended the daycare. Also, because of the absence of one participant assigned to the massed training sessions condition, he was excluded from this condition and moved into the spaced apart training condition. Lastly, all participants received a T-shirt and a thank you letter in appreciation.

<b>Participant</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>	<b>6</b>	<b>7</b>	<b>8</b>	<b>9</b>	<b>10</b>	<b>11</b>	<b>12</b>
<b>Exact Age (Months)</b>	<b>22</b>	<b>22</b>	<b>28</b>	<b>29</b>	<b>30</b>	<b>31</b>	<b>31</b>	<b>31</b>	<b>33</b>	<b>35</b>	<b>36</b>	<b>36</b>
<b>Gender</b>	<b>F</b>	<b>F</b>	<b>F</b>	<b>M</b>	<b>F</b>	<b>M</b>	<b>M</b>	<b>M</b>	<b>F</b>	<b>F</b>	<b>F</b>	<b>M</b>
<b>Participant</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>	<b>6</b>	<b>7</b>	<b>8</b>	<b>9</b>	<b>10</b>	<b>11</b>	<b>12</b>
<b>Exact Age (Months)</b>	<b>22</b>	<b>22</b>	<b>28</b>	<b>29</b>	<b>30</b>	<b>31</b>	<b>31</b>	<b>31</b>	<b>33</b>	<b>35</b>	<b>36</b>	<b>36</b>
<b>Gender</b>	<b>F</b>	<b>F</b>	<b>F</b>	<b>M</b>	<b>F</b>	<b>M</b>	<b>M</b>	<b>M</b>	<b>F</b>	<b>F</b>	<b>F</b>	<b>M</b>



## Questionnaires

All of the parents of participants were handed an extensive consent form detailing the procedure of the study along with a demographic questionnaire and Macarthur Level II Vocabulary Comprehension Form. The demographic questionnaire assessed a child's previous language experience along with ethnic and socio-economic background. The Macarthur Level II was given to assess child's vocabulary abilities and all parents replied that their child understood and said all of the items listed.

## Stimuli

Six familiar toy-like objects were chosen for the present experiment. The objects were chosen to be equally interesting and familiar to toddlers. Secondly, sets of laminated pictures were created to accompany the objects to ensure that children were shown different versions of an object. For example, as the child was introduced to a toy car, they also saw corresponding pictures of other kinds of similar cars.

Below is the list of objects chosen along with their Spanish name and translation:

<b>Object</b>	<b>Spanish Word</b>	<b>English Translation</b>
Milk Bottle	Leche	Milk
Water Bottle	Agua	Water
Toy Apple	Manzana	Apple
Toy Banana	Plátano	Banana
Ball	Pelota	Ball
Toy Car	Carro	Car

## **Apparatus**

The trainings sessions and testing procedures took place on a wooden adult-sized table and adult-sized chairs. The experimenter sat across from the child at the table. A Canon digital camera on a tripod was placed near the back wall of the room and focused directly on the child; it was used to record both the training sessions and the procedure of the task.

## **Familiarization**

All of the children who participated in the experiment were familiarized to all the experimenters of the study. The experimenters would first play with the children in their local daycare setting and then take them aside to participate in the study. During the familiarization process, the experimenters spoke in English to the children and played various games of the child's choosing. Experimenters in the study were bicultural and native bilingual Spanish and English speakers.

## **Design**

This experiment was a between group design. All participants received only a total of thirty minutes of Spanish exposure during all the training sessions. First, half of the participants (six participants) were assigned to receive the sessions amassed over one week and half of the participants (six participants) were assigned to receive the sessions spaced apart over a couple of weeks. Then, the training sessions were uniform across all participants and were designed to have five training sessions (massed or spaced apart) according to the following, described below:

1. Individual Object Training: During this training, the experimenter presented each object one at a time to the child in Spanish for one minute per object.

2. Individual Object Training: During this training, the experimenter presented each object one at a time to the child in Spanish for one minute per object.
3. Paired Object Training: During this training, the experimenter presented one pair of objects one at a time to the child in Spanish for two minutes per pair.
4. Paired Object Training: During this training, the experimenter presented one pair of objects one at a time to the child in Spanish for two minutes per pair.
5. Naturalistic Object Training: During this training, the experimenter presented all six objects at once to the child in Spanish for six minutes.

Each child was randomly assigned to one of our training conditions, which presented the objects in the following order:

For individual training sessions:

1. Condition A: Carro, Pelota, Leche, Agua, Manzana, Plátano
2. Condition B: Plátano, Manzana, Agua, Leche, Pelota, Carro
3. Condition C: Leche, Pelota, Carro, Plátano, Manzana, Agua
4. Condition D: Agua, Manzana, Plátano, Carro, Pelota, Leche

For paired training sessions:

1. Condition A: Carro-Pelota, Leche-Agua, Manzana-Plátano
2. Condition B: Plátano-Manzana, Agua-Leche, Pelota-Carro
3. Condition C: Leche-Agua, Pelota-Carro, Manzana-Platano
4. Condition D: Manzana-Plátano, Carro-Pelota, Leche-Agua

This design ensured that the participants as a whole were not subject to presentation effects during the training. In total 3 participants were assigned to each condition.

## **Training**

Participants were randomly assigned to one of the four training conditions named above. The conditions were assigned to vary the order of the words presented to the child. In each condition, the child was presented all six objects (at various times) via play with an experimenter in Spanish for five sessions. For each of the five sessions, the child was exposed to each of the six objects for one minute precisely for a total of six minutes per session. The order, in which each of the six objects was presented, was counterbalanced across conditions and sessions.

For the first two sessions, all participants first participated in an individual object-training phase. During this phase, the experimenter presented each object one at a time to the child in Spanish. The presentation of each item consisted of the experimenter speaking about an object while playing with the object and its corresponding photos with the child. During the presentation, the experimenter would describe the function of the object, the colors of the objects, as well as name in the object several times. This entire presentation was conducted in Spanish. The experimenter and the child played with each of the objects for one minute. For each session in this phase, the experimenter and child played with all six objects for a total of six minutes each session. In total, this phase lasted for a twelve minutes (six minutes per session for two sessions). Therefore, during this phase each participant was exposed to twelve minutes of Spanish via play with familiar toy-like objects.

Next, the toddlers participated in a paired object-training phase. For the following two sessions, the experimenter presented three pairs of objects to the child in Spanish. During this phase, each pair of objects was introduced individually to the child. The pairs of objects included *agua-leche* (water-milk), *manzana-platano* (apple-

banana), and *carro-perro* (car-dog). The purpose of pairing the objects was to introduce the child to the pair of objects to which they would be later asked to recall. The presentation of each pair consisted of the experimenter speaking about both objects while playing with the objects and its corresponding photos with the child. During the presentation, the experimenter would describe the function of the object, the colors of the objects, as well as name in the object several times. This entire presentation was conducted in Spanish. The experimenter and the child played with each pair for two minutes. For each session in this phase, the experimenter and child played with all three pairs for a total of six minutes each session. In total, this phase lasted for a twelve minutes (six minutes per session for two sessions). Therefore, during this phase each participant was exposed to twelve minutes of Spanish via play with familiar toy-like objects.

Lastly, for the last session, all participants first participated in a naturalistic object-training phase. During this phase, the experimenter presented all the objects at once to the child in Spanish. The purpose of presenting all the objects at once was to simulate a naturalistic learning environment for the child. The presentation of the items consisted of the experimenter speaking about and playing with an object and its corresponding photos, which the child chose. During the presentation, the experimenter would describe the function of the object, the colors of the objects, as well as name in the object several times. This entire presentation was conducted in Spanish. The experimenter directed the child to play with each of the objects for about one minute per object. For the last session in this phase, the experimenter and child played with all six objects for a total of six minutes. In total, this phase lasted for a six

minutes (six minutes per session for one session). Therefore, during this phase each participant was exposed to six minutes of Spanish via play with familiar toy-like objects.

In total, all of the participants across all four training conditions were exposed to thirty minutes of Spanish (six minutes per session for five sessions) via play with familiar toy-like objects.

*Number of Days Taken To Complete Training.* Given the variable attendance of many participants at the daycare, our ability to precise control the number of days which participants completed the training varied. Within our two learning schedule conditions, participants completed the training in the following number of days:

<b>Participant</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>	<b>6</b>	<b>7</b>	<b>8</b>	<b>9</b>	<b>10</b>	<b>11</b>	<b>12</b>
<b># Of Days To Complete</b>	<b>5</b>	<b>5</b>	<b>5</b>	<b>6</b>	<b>6</b>	<b>7</b>	<b>7</b>	<b>9</b>	<b>11</b>	<b>18</b>	<b>29</b>	<b>30</b>
<b>Gender</b>	<b>F</b>	<b>F</b>	<b>F</b>	<b>M</b>	<b>F</b>	<b>M</b>	<b>M</b>	<b>M</b>	<b>F</b>	<b>F</b>	<b>F</b>	<b>M</b>

### **Testing Procedure**

Toddlers were randomly assigned to partake in one of four testing conditions. In each condition, the child was presented two objects in Spanish and then asked to point and place the correct object in a small green box. Which of the two familiar objects was the selected item and which served as the incorrect object was counterbalanced across participants. Also counterbalanced was the order in which the objects were presented (e.g., *carro* first or *perro* first). Finally, the side of presentation was also counterbalanced (i.e., the correct object on the left side versus the right side).

First, all toddlers participated in practice test trials. During these trials, participants were asked to correctly identify three of the six objects in Spanish. However, if the child was not able to understand the identification trial in Spanish, the experimenter would then ask the child to identify the objects in English (the word for the object was still the Spanish word for the object). For example, a participant was asked “¿A dónde esta el *carro*? Me puedes enseñar el *carro*?” if they did not understand the experimenter would then ask the child, “Where is the *carro*? Can you show me the *carro*?” The purpose of these practice trials was to familiarize toddlers with the nature of the comprehension task and immediate and retention test trials. Given that previous research findings suggest that 18 to 24 month olds use a reference to figure out the noun in a speech stream we were confident that with practice toddlers in our study would be able to parse out the selected noun in Spanish and begin to comprehend it (Kedar, Casasola & Lust, 2006). Also, the child was being trained during these practice trials to understand not only the object name but also the flow and sentences and sentence structure in Spanish. The experimenter aided this process by using gestures and cues to indicate the location of the box and the placement of the selected item during the practice test trials. After the first four training sessions, participants were presented two items on either the left or right hand side of a box. Then, the experimenter directed the child to focus their attention on the items. For instance, the experimenter would say “Mira, mira esto!” (Translation: Look, look at this!) Afterwards, the experimenter would proceed in asking the child which of the items was the selected object (e.g. ¿A dónde esta el *carro*? Me puedes enseñar el *carro*? Translation: Where is the car? Can you show me the car?) Then, the child

would proceed to point out his or her choice. Next, the experimenter asked the child to place the selected object in the small green box. For example, “Mira, a donde esta el *carro*? Puedes poner el *carro* en la caja?” (Translation: Look, where is the car? Could you put the car in the box?) Regardless, of whether the child’s choice was correct or incorrect, the experimenter always smiled and said, “thank you”.

Next, all children participated in immediate test trial. During the immediate test trial, participants were asked to correctly identify all of the six objects. The purpose of this trial was to measure the toddlers’ comprehension of the object training in Spanish. Just as in the practice test trials, during the final trial, participants were presented two objects and asked to identify and place an object in a small green box. For instance, the experimenter would say “Mira, mira esto!” (Translation: Look, look at this!). Afterwards, the experimenter would proceed in asking the child which of the items was the selected object (e.g. ¿A dónde esta el *perro*? Me puedes enseñar el *perro*? Translation: Where is the dog? Can you show me the dog?). Then, the child would proceed to point out his or her choice. Next, the experimenter asked the child to place the selected object in the small green box. For example, “Mira, a donde esta el *perro*? Puedes poner el *perro* en la caja?” (Translation: Look, where is the dog? Could you put the dog in the box?). Regardless, of whether the child’s choice was correct or incorrect, the experimenter always smiled and said, “thank you”.

Below is the list of objects participants had to choose from during the testing procedure:

<b>Object Choice One</b>	<b>Object Choice Two</b>
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Carro (Translation: Car)	Pelota (Translation: Ball)
Manzana (Translation: Apple)	Plátano (Translation: Banana)
Agua (Translation: Water)	Leche (Translation: Milk)
Pelota (Translation: Ball)	Carro (Translation: Car)
Plátano (Translation: Banana)	Manzana (Translation: Apple)
Leche (Translation: Milk)	Agua (Translation: Water)

\*The order and placement of the object varied per condition to ensure a counterbalanced procedure.

The final segment of the procedure was a retention test trial included to determine if the toddlers' comprehension would last one week after the training sessions had concluded. The children were examined exactly as in the final-test trial during the retention test trial. Toddlers were then scored for their comprehension in all the test trials.

*Language Comprehension During Testing Procedure.* During the testing procedure, some participants had difficulty understanding the question being asked by the participants. After repeating the procedure question twice, (e.g. ¿A donde esta el *perro*? Puedes poner el *perro* en la caja? Translation: Where is *the dog*? Can you put *the dog* in the box?) the experimenter would then translate the question in English and ask the child once again in English without translating the familiar object noun (e.g. Where is *el perro*? Can you put *el perro* in the box?). The number of testing trial procedure for which a participant needed translation was then recorded.

*Scoring.* All sessions were video recorded and toddlers' object choices were scored offline. The first object that the infant placed in the box was recorded as the

child's choice. During the practice test trials, participants could score from 0 to 3 correct responses. Likewise, because toddlers were asked about their comprehension of each object six times during the immediate testing and retention test trials, they could score from 0 to 6 correct responses.

## **Hypothesis**

In this experiment, our primary goal is to examine the role of limited exposure on toddlers' ability to learn and retain knowledge of labels for familiar objects in a foreign language. We also aim to compare toddlers' word comprehension and retention as a function of how learning schedules of second language exposure. Given previous findings, such as those of Koenig and Woodward (2011) and Vlach, Ankowski, and Sandhofer (2011), we hypothesize that children, regardless of their learning schedule condition, will be able to learn the six familiar objects in Spanish from 30 minutes of playtime in Spanish. However, in comparing word comprehension and retention as a function of how amassed or spaced apart the second language exposure, we suppose that children who received massed learning schedule will outperform children in the spaced out learning schedule in the immediate test trials, despite receiving the same amount of training session in Spanish. Yet, given the "spacing effect" found in previous studies, we hypothesize that children who are in the spaced-out learning schedule condition to outperform those toddlers in the massed learning schedule condition in their ability to retain knowledge of familiar nouns in Spanish.

## Results

In this experiment, we examined toddlers' word comprehension and retention as a function of how limited and sequential sessions of second language exposure were. The results are listed below:

Table One.

Test Trial	Overall Mean Accuracy	SD	Range
Practice Test Trial One	.7500	.1543	.6667-1.00
Practice Test Trial Two	.6667	.3178	0.00-1.00
Practice Test Trial Three	.7500	.2512	0.00-1.00
Practice Test Trial Four	.6388	.3612	0.00-1.00
Immediate Test Trial	.7639	.1500	.6667-1.00
Retention Test Trial	.7333	.1956	.6667-1.00

Table Two.

Test Trial	Mean Accuracy for Massed Learning Schedule	Mean Accuracy for Spaced Out Learning Schedule
Practice Test Trial One	.7778	.7333
Practice Test Trial Two	.8000	.5715
Practice Test Trial Three	.8000	.5715
Practice Test Trial Four	.6000	.6667
Immediate Test Trial	.8666	.6429
Retention Test Trial	.7667	.7000

*Practice test trials.* After each of the first four training sessions, each toddler participated in a practice test trials. Each toddler participated in a total of four test practice trials. During each of these trials, participants were asked to correctly identify three out of three objects in Spanish. These trials were shortened from the original 6 items in order to have the child focus on the rhythm and structure of the testing procedure. A one-sample t-test in comparison to chance was conducted for each of the practice-test trials.

For the first practice test-trial, toddlers showed significant comprehension for the familiar words in Spanish (Chance = 0.50,  $M = .7500$ ,  $SD = .1543$ ,  $t(8) = 4.583$ ,  $p = 0.003$ ) regardless of their learning schedule assignment. For the second practice test-trial, toddlers showed did not show comprehension for the familiar words in Spanish (Chance = 0.50,  $M = .6666$ ,  $SD = .3178$ ,  $t(12) = 1.817$ ,  $p = .097$ ) regardless of their learning schedule assignment. This may have been due to the fact that we introduce the practice-test trial in Spanish to most participants and therefore they were still trying to gain an understanding of the format of the test-trial in Spanish. For their third practice test-trial, toddlers showed significantly better comprehension for the familiar words in Spanish than in the second test-trial (Chance = 0.50,  $M = .7500$ ,  $SD = .2512$ ,  $t(12) = 3.447$ ,  $p = 0.005$ ) regardless of their learning schedule assignment. For their final practice test-trial, toddlers did not show significant comprehension for the familiar words in Spanish (Chance = 0.50,  $M = .6388$ ,  $SD = .3612$ ,  $t(12) = 1.332$ ,  $p = 0.210$ ). Given their previous success in prior practice test-trials, the significant drop in the fourth practice test trial in accuracy may have occurred because the majority of participants were tested in Spanish without an English translation. In essence, participants began to show comprehension of the test-trial as well as the Spanish words used during their practice test-trials regardless of their specific learning schedule condition.

Next, a linear mixed-model analysis of variance was conducted to evaluate effects and interactions of the first four practice-trials. The mixed model analysis revealed no significant learning schedule effects, age effect, or the number of total

days taken to complete all five training sessions. There was also no significant interaction between learning schedules and age of the child.

*Immediate Test Trials.* Our main analyses examined the role of limited exposure on toddlers' ability to learn names of familiar objects in a foreign language. We were especially interested in whether performance varied when a toddler was placed on a massed learning schedule versus when a toddler was placed in a more spaced out learning schedule. A one-sample t-test was conducted on the immediate test trials for children in both learning schedule conditions. Overall, children showed significant comprehension of the Spanish words after the five training sessions in *Placement* task (Chance = 0.50,  $M = .7639$ ,  $SD = .1500$ ,  $t(12) = 6.093$ ,  $p < .000$ ) regardless of their learning schedule assignment.

Furthermore, a linear mixed-model analysis of variance (ANOVA) revealed a significant effect in learning schedules,  $F(1, 5) = 6.556$ ,  $p = 0.044$ . Toddlers who received the massed learning schedule condition ( $M = .8666$ ) performed better during the immediate test trials than toddlers who received the spaced apart learning schedule condition ( $M = .6429$ ) (See Figure 1). Also, the mixed-model yielded one significant interaction between learning schedules and age,  $F(1, 5) = 5.998$ ,  $p = 0.05$ . Younger children in this study who received massed learning schedule condition performed significantly better than younger children who received a more spaced out learning schedule condition. However, this interaction was not as seen in older children. In contrast, there were no significant fixed effects of age  $F(1, 5) = 0.102$ ,  $p = 0.762$ , or the number of total days taken to complete all five training sessions,  $F(1, 5) = 0.160$ ,  $p = 0.760$ . These results converge to show a significant effect of learning schedules on

children's ability to learn names of familiar objects in a second language. Yet, despite the difference between massed and spaced out learning schedule all of the participants still managed to learn the majority of familiar words in Spanish.

*Retention Test Trials.* Our secondary analyses examined the role of limited exposure on toddlers' ability to retain knowledge of names of familiar objects in a foreign language. We were especially interested in whether retention varied when a toddler was placed on a massed learning schedule versus when a toddler was placed in a more spaced out condition. A one-sample t-test was conducted on the retention test trials for children in both the massed and spaced out learning schedule conditions. Overall, children showed significant retention of the Spanish words after the five training sessions in *Placement* task (Chance = 0.50,  $M = .7333$ ,  $SD = .1956$ ,  $t(12) = 3.772$ ,  $p < .004$ ) regardless of their learning schedule assignment.

Moreover, a linear mixed-model analysis of variance (ANOVA) revealed a significant effect in learning schedules,  $F(1, 4) = 18.477$ ,  $p = 0.013$ . Toddlers who received the massed learning schedule condition had better retention rates ( $M = .7667$ ) during the retention test trials than toddlers who received the spaced apart learning schedule condition ( $M = .7000$ ). However, in comparison with the immediate-test trials ( $M = .7639$ ,  $SD = .1500$ ) retention of names of familiar objects in Spanish was not as pronounced in the retention test trials ( $M = .7333$ ,  $SD = .1956$ ) (See Figure 1). In addition, there was a significant effect in the retention rates based on the number of total days taken to complete all five training sessions within the spaced out learning schedule condition,  $F(1, 4) = 11.097$ ,  $p = 0.029$ ,  $\eta_p^2 = 4.0052$ . Children in the spaced out learning schedule condition who took more days to complete all five training

sessions had poorer retention rates than children who completed all five training sessions in less number of days. Also, the mixed-model yielded one significant interaction between learning schedules and age,  $F(1, 4) = 21.52, p=0.01$ , Younger children in this study who received spaced out learning schedule condition were unable to retain knowledge of Spanish words significantly worse than older children who received the spaced out learning schedule condition. Also, there is also a significant negative impact on children's ability to remember words in a second language when exposed over a very spaced out learning schedule. More specifically, when children took a large number of days (i.e. 30 days) to complete all five training sessions, they were significantly less able to remember the words taught to them throughout that period. Yet, despite the considerable difference between massed and spaced out learning schedule conditions, all of the participants still amazingly retain the majority of their knowledge of familiar words in Spanish.

Age Effects during the Retention Test Trials. There were no significant fixed effects of age overall  $F(1, 5) = 0.179, p = 0.694$ . However, there were significant age effects during the retention test trials. These results converge to show a significant effect of spaced out learning schedules condition on young toddlers' ability to retain names of familiar objects in a second language. Further analysis revealed that the main age effects were among children in the spaced out learning schedules condition. The younger toddlers in our study (those below 30 months) were not able to perform significantly above chance ( $M = .528$ ) especially in comparison to older toddlers (those above 32 months) who were able to retain knowledge of Spanish words significantly above chance ( $M = 1.00$ ). Therefore, when younger toddlers (those aged below 30

months) are taught names of familiar objects in Spanish they are unable to retain this knowledge in comparison to older toddlers (those aged above 32 months).

*Differences between Practice Test Trials, Immediate Test and Retention Test Trails.* As final analyses, we aimed to examine differences between the practice test trials, the immediate test trails and the retention test trials, to see if there were significant differences among toddlers in different learning schedule conditions as well as with age and the number of days it took to complete all five of the training sessions (See Figure 2). A linear regression model was conducted in order to complete this analysis. The model showed no significant differences between the practice test trials, the immediate test trials and the retention test trials ( $F=0.800$ ,  $p=.537$ ). The model also revealed no significant effects or interactions of the differences between the immediate test trials and the retention test trials.

## **Discussion**

[So in your hypothesis, you are considering mere exposure as opposed to practice or the retesting effect?]

The results of the present experiment show that regardless of learning schedule toddlers with limited Spanish exposure have the ability learn and retain knowledge of names of familiar objects in a second language. However, toddlers who were assigned massed learning schedule condition were better able to learn and retain knowledge of labels of familiar objects in a second language, even after a week of second language exposure. In both test trials, immediate and retention test trials respectively, massed learning schedule condition (86% accuracy for immediate test trial and 77% for



retention test trial) vs. spaced out learning condition (64% accuracy for immediate test trial and 70% for retention test trial) toddlers showed significant comprehension during the immediate test trial of the names of familiar objects in Spanish.

The results of the present experiment are significant in documenting an effect limited second language exposure and learning schedules on how toddlers' learn and retain knowledge of names of familiar objects in a second language. By the age of three, monolingual children have the ability to learn and retain knowledge of names of familiar objects in a second language with only thirty minutes of exposure. The overall accuracy of the immediate and test trials show that toddlers were able to learn and retain knowledge of these labels in a second language significantly above chance. However, their ability to learn and retain such knowledge is affected by learning schedules of second language exposure,. This result suggests that little exposure time in a second language is needed for a child to begin to learn and retain knowledge of names of familiar objects in the second language. The results also suggest that the efficacy of learning and retaining knowledge names of familiar objects in a second language is influenced by the learning schedule of the second language exposure. The results are significant in demonstrating that although limited second language exposure can spark learning, the kind of exposure and how the exposure takes place over time is influential in the learning and retention of knowledge.

Interestingly, toddlers were able to learn familiar words in a second language immediately following limited second language exposure, regardless of their assigned learning schedule. In both test trials, massed learning schedule condition (with an accuracy of 86%) vs. spaced out learning condition (with an accuracy rate of 64%),

toddlers showed significant comprehension during the immediate test trial of the names of familiar objects in Spanish. Nevertheless, children in the massed learning schedule condition outperformed children in the spaced out learning schedule condition in the immediate test trails suggesting that a massed learning schedule condition may promote immediate comprehension of familiar words in a second language. Furthermore, this result suggests that toddlers' do not require extended experience with two languages to comprehend familiar word labels in a foreign language irrespective of how this exposure takes place over time.

Moreover, in both learning schedule conditions, massed learning schedule condition (with an accuracy of 76%) vs. spaced out learning condition (with an accuracy rate of 70%), toddlers showed significant comprehension during the retention test trial of the familiar words in Spanish performed a week after limited exposure. Yet, it is important to note that unlike the immediate test trials, children in the spaced-out learning schedule condition did perform better in the retention test trials (with an accuracy rate of 70%) than in the immediate test trials (with an accuracy rate of 64%) whereas the children assigned to the massed learning schedule performed worse in the retention test trials (with an accuracy rate of 76%) than in the final test trials (with an accuracy rate of 86%).

These results also show that although children in the massed learning schedule condition outperformed their peers in the spaced-out learning schedule condition during the retention test trails (see Table Two). The massed learning schedule participants ability to remember names of familiar objects in Spanish decreased over

time whereas the ability to remember names of familiar objects in a second language increased with children in the spaced-out learning schedule condition.

Our results are mostly consistent with our hypothesis and previous research in second language learning and the efficacy of learning schedules. The findings of Koenig and Woodward (2011) concurred with our findings that even children as young as two have the ability to learn a second language with limited second language exposure. Just as in the Koenig and Woodward's study, participants with high vocabulary scores (all participants in this study had high vocabulary scores) in our experiment were able to parse out labels and their meanings in a stream of foreign language words for familiar objects in a short period of time. This result is further supported by Namy and Waxman (2000) who found that at 17-months, toddlers' showed the ability to recognize words embedded in foreign speech. Thus, our results are consistent with previous findings that toddlers begin to show comprehension of second-language words given limited second-language exposure.

Likewise, our findings are consistent with previous research, which shows that there are learning and retention differences among different learning schedule conditions. In Vlach, Ankowski, and Sandhofer's (2011) study, the authors found that when examined immediately toddlers in the simultaneous learning scheduled outperformed those in the massed and spaced out conditions. In contrast, after a 15-minute delay, toddlers on the spaced out learning schedule retained the most knowledge and outperformed those in the simultaneous and massed learning schedule. Although, children in the massed learning schedule condition in our study outperformed those in the spaced out learning schedule condition in both the final and

retention test trials, toddlers in the spaced-out learning condition had retention test trial accuracy increase over the course of a week. This finding suggest that although retention rates may be lower in the spaced out learning condition, retention of second language may improve over time with more spaced out second language exposure. Hence, our findings are somewhat similar to previous literature, despite toddlers in the massed learning schedule condition outperforming those toddlers in the spaced out learning schedule condition on both the immediate and retention test trials.

Of course, an alternative possibility to explain the discrepancy in results between our study and results reported by Vlach, Ankowski, and Sandhofer's (2011) is that older toddlers may succeed at a different learning schedule than younger toddlers. The age effects found in the retention test trials seem to suggest that younger toddlers retain knowledge poorly when assigned the space out learning schedule. Also, the effect of learning schedules may be constricted to learning new words in a primary language and not in learning new labels for familiar objects in a second language. While this explanation is certainly possible, we suspect it may not fully explain our results. If so, an age effect would have not been observed and toddlers would have performed similarly across both test trials. The difference in accuracy rates across the test trails suggests that toddlers' are influenced by learning schedules in how they learn and retain knowledge of names of familiar objects in a second language. They also begin to show a trend in performance levels in test trials but our limited sample size may not display this effect fully.

The current findings fall short in their ability to explain our entire hypothesis and conduct a perfect experiment. First, we are unsure if children were unable to retain

knowledge of labels of familiar objects in Spanish merely because of the learning schedule or the amount of retesting conducted which would emphasize learning. Also, given our limited sample size it is difficult to extrapolate findings towards broader results. It was also a challenge for researchers in this project to recruit toddlers in a specified age range throughout the greater New York area therefore the specified age range was increased to include early and late toddlerhood. Lastly, although vocabulary measures were given to parents, at times parents inaccurately report their child's vocabulary skills and differing vocabulary comprehension measures could have provided more insight into the fine-tune differences in vocabulary skills among our sample.

The present results provide important insights into how children might begin to learn a new language. Being exposed to second language in through an amassed learning schedule, may promote early immediate comprehension of names of familiar objects in a second language. This finding may be especially true with younger children whose retention accuracy ( $M=.528$ ) of second language decreased with a spaced-out learning schedule . Also, it is important to note that spaced out learning schedule may promote long-term retention of words in a second language learning and that immediate comprehension may not be indicative of future retention in second language learning. This inference is plausible given the decrease in accuracy rates among participants in the massed learning schedule condition. Both these findings, the decrease in accuracy rates among participants in the massed learning schedule condition and younger toddlers in the spaced out learning schedule condition, may provide further insights in word learning, as the type of learning schedules one may

receive may promote or deter immediate comprehension or long-term retention of second language words.].

The findings from this study have several important implications for current debates on second language learning in early development. The results suggest that as early as three years of age, monolingual toddlers' are keenly sensitive to limited second language exposure and in particular, what schedule limited second language exposure is given. This sensitivity is in line with research done in both second language learning and in learning schedules. Furthermore, the results show how toddlers efficacy of learning and retaining knowledge of names of familiar objects in a second language is influenced by the amount and learning schedule of the second language exposure, consistent with arguments presented by Koenig and Woodward (2011) and Vlach, Ankowski, and Sandhofer's (2011). In this study, the introduction of limited second language exposure created a potentially restrictive situation for children with no previous second language exposure to comprehend six familiar words in a second language. Yet, from even the first practice test trials, toddlers' began to show comprehension of the all the labels of familiar objects being taught to them in Spanish (see Table One). Therefore, toddlers showed evidence of using limited second language exposure to inform their comprehension and retention of word learning in a second language. Similarly, given the limited second exposure, toddlers showed varied comprehension and retention rates of names of familiar objects in a second language with the differing learning schedule conditions. In this case, the use of a different learning schedules showed that children in the massed learning schedule condition outperformed their peers in the spaced-out learning schedule condition during the

immediate and retention test trails. However, their ability to remember familiar words in Spanish decreased over time whereas the ability to remember labels of familiar objects in a second language increased with children in the spaced-out learning schedule condition.

To conclude, the current results are the first to document an impressive degree of flexibility in toddlers' ability to learn names of familiar objects a second language over a period of time. The results highlight the role of limited exposure and learning schedules in toddlers' ability to learn and retain knowledge of familiar words in foreign language. First, based on limited exposure, monolingual toddlers have the ability to learn and retain knowledge of second labels for familiar objects in a foreign language, regardless of the learning schedule they are given the second language exposure. That is, by the age of three, limited second language exposure can initiate comprehension and retention of names of familiar objects in foreign language in varied learning schedule conditions. Second, when faced with a limited exposure in a foreign language, toddlers assigned to the massed learning schedule conditions had a boosted ability to learn and retain knowledge of a label in a foreign language. Specifically, showed that children in the massed learning schedule condition outperformed their peers in the spaced-out learning schedule condition during both the immediate and retention test trails. Finally, this study demonstrates that in the face of limited second language exposure, toddlers can quickly learn words in a new language, although they do so best when they are taught in a massed learning schedule. In sum, these results add to the growing body of literature that demonstrates the role of learning schedule have on second language learning and how that

demonstrates learning schedules influences how young children begin the mighty task of learning more than one language.



## Figures

Figure 1

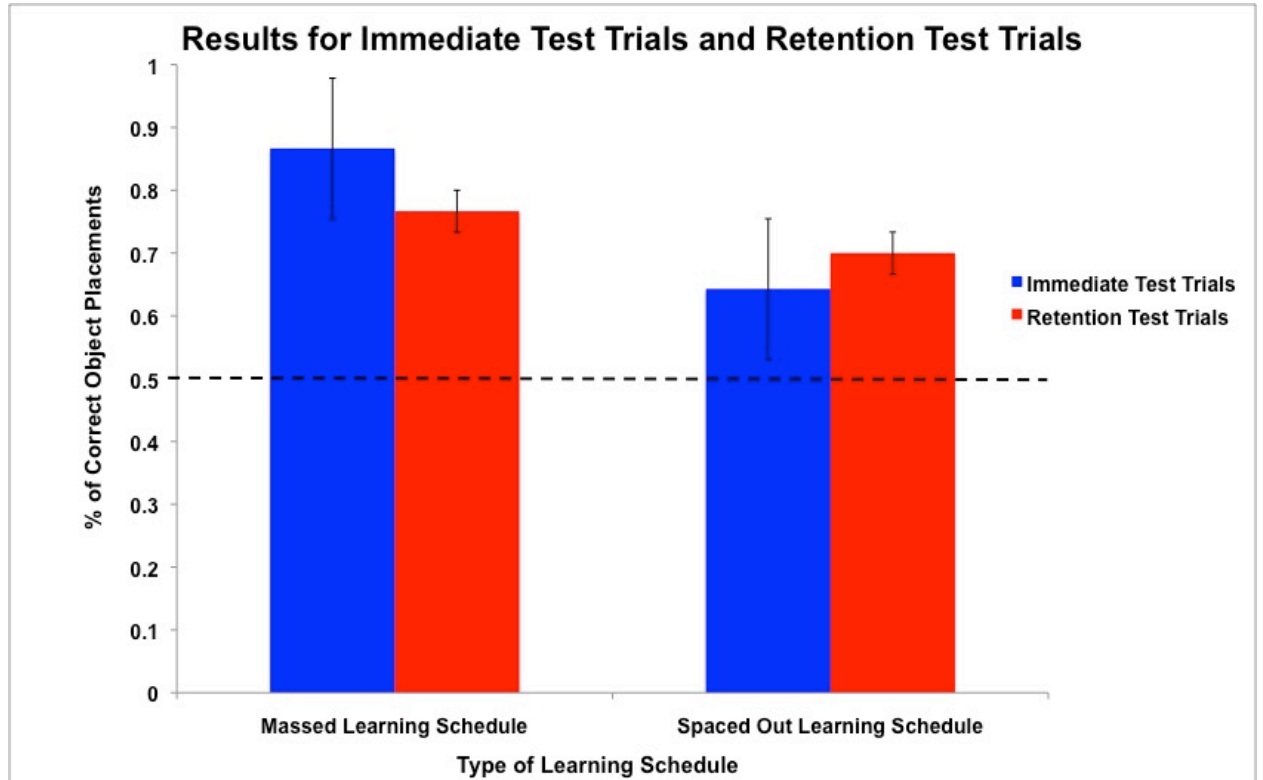
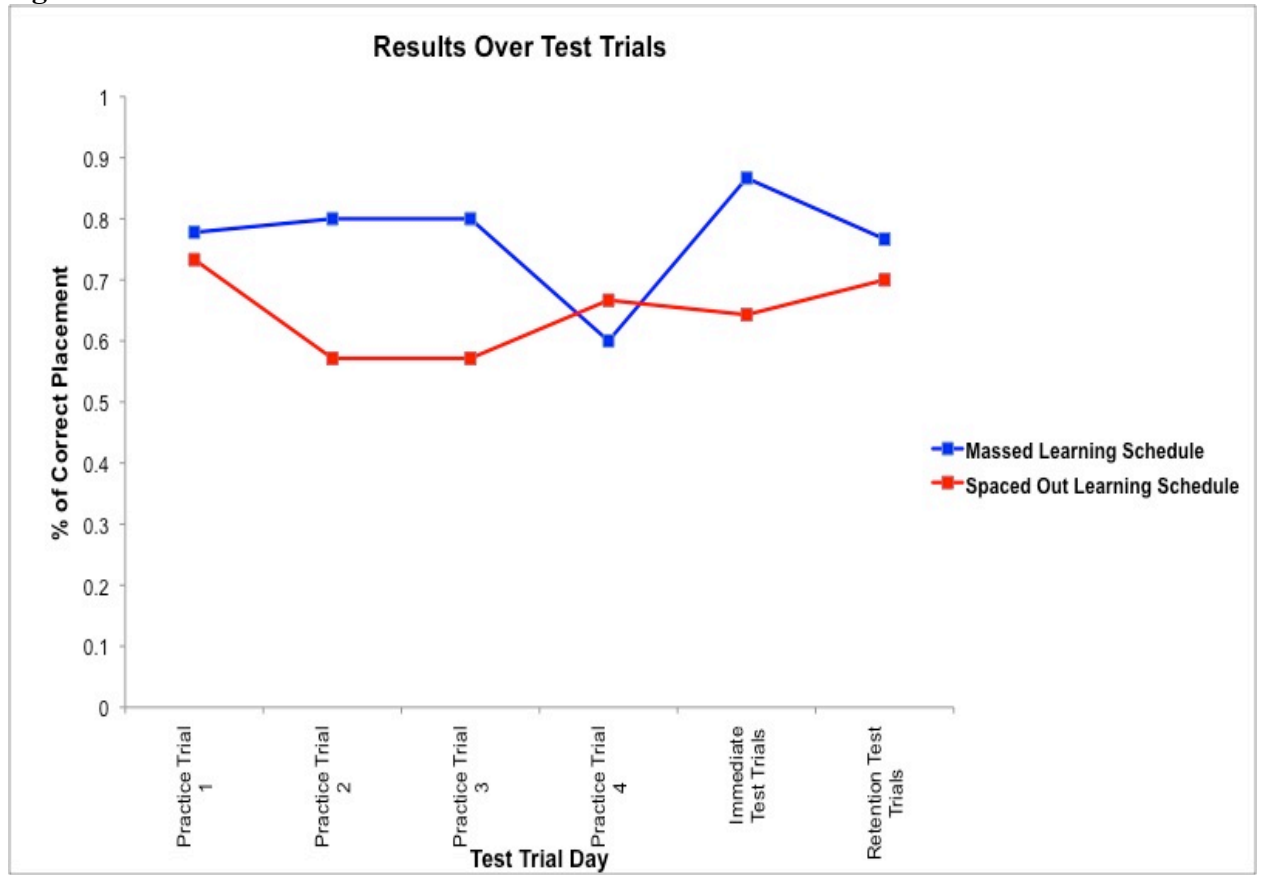


Figure 2



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