# PRACTICE DISTRIBUTION AND NOVEL WORD LEARNING IN CHILDREN

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Abstract: The current study aimed to compare the effectiveness of massed versus distributed practice in improving novel word learning in typical children between the ages of 4-7 years. The study involved twenty-four monolingual children who participated in a six-week word learning program, which included a baseline test, an immediate retention test, and four delayed retention tests. The results showed that distributed practice was more effective than massed practice in improving word learning in children. Theoretical frameworks support the findings, including encoding variability, deficient processing, reconstruction, and study-phase retrieval theories. The current study can help inform clinical decision-making for Speech-Language Pathologists working with children, providing evidence that distributed practice is more effective than massed practice in improving word learning in children.

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# CHAPTER I

## INTRODUCTION

There remain many unanswered questions regarding the optimal distribution of treatment for maximizing efficacy and the retention of gains in clinical treatment research. One domain that has garnered attention in recent years is practice distribution. Practice distribution refers to how a practice regime is spaced out to enhance mastery and retention of the target skill/task (Maas et al., 2008; Kaipa et al., 2020). Practice distribution has been explored from the framework of Principles of Motor Learning (PMLs) (Maas et al., 2008). Practice distribution ranges from massed to distributed practice. There is no or very minimal (<1 second) time lag between the practice sessions in massed practice (Shea et al., 2000; Cepeda et al., 2006). In contrast, there is a significant lag (> 1 second) between the practice sessions in distributed practice (Cepeda et al., 2006; Maas et al., 2008). Within the scope of this study, massed practice is defined as multiple trials of stimuli being presented all at once in a single session and distributed practice defined as the same number of trials as the massed being presented over the course of several sessions.

## Review of Literature

Few studies have compared the effect of practice distribution across various disciplines and domains, including limb-based motor tasks (Baddeley & Longman, 1978; Shea et al., 2000; Dail & Christina, 2004), speech-motor tasks (Maas et al., 2019) and novel vocabulary learning tasks (Bloom & Shuell, 1981; Bahrick & Phelps, 1987; Dempster, 1987; Lightbown & Spada, 1994; Bird, 2010; Kaipa et al., 2020; Kaipa et al., 2022). One of the earliest studies that examined the efficacy of massed versus distributed practice was carried out by Baddeley and Longman (1978) in four groups of postmen. The groups varied on the number of sessions a day and the duration of the practice session. The participants were trained to use a conventional typewriter and use alphanumerical codes. The participants who practiced one session for one hour a week performed better than the other three groups (practiced two hours per week, practiced two 1-hour sessions, practiced two 2-hour sessions) (Baddeley & Longman, 1978).

Similarly, Shea et al. (2000) conducted two experiments to examine the effects of practice distribution using a limb-based task (balancing on a stabilometer) and studied how well participants generalized the target task to other tasks. In the first experiment, the participants practiced two sessions of seven trials. The sessions were separated by twenty minutes for the first group and 24 hours for the second group. The participants completed variations of the keypress timing tasks in the second experiment, and the groups were distributed within and across days. The retention test was carried out 24 hours after the completion of practice. These experiments suggest that learning may be more providential when the practice sessions are distributed across longer intervals than within days (Shea et al., 2000).

Dail and Christina (2004) examined the effects of practice distribution in motor learning using golf. They had 90 golfers, both men and women, ages 17-32, and were randomly assigned to a massed or distributed group. The participants were instructed to "hole the putt" or get the ball as close as possible using a flat putting surface. There was both an acquisition and retention phase. The massed group had to practice 240 putts in a single session, while the distributed group practiced 60 putts per session over four days, amounting to 240 putts in total. Both groups performed the retention test, and 15 participants from each group over a spaced period after one day, seven days, and 28 days. The participants in the distributed group had better acquisition and retention than those in the massed group.

Bloom and Shuell (1981) examined the effects of massed and distributed practice on language learning in high school students enrolled in a French course as part of daily class activities. The participants in the massed group practiced the French words for 30 minutes in a single session, and the distributed group practiced for 10 minutes across three sessions. The authors found that the participants in the distributed group demonstrated better retention of the French words when compared to the massed group (Bloom & Shuell, 1981).

Past research has explored working memory and its effects on practice distribution. Using five different experiments, Dempster (1987) focused on encoding variability and its effects on massed and distributed practice. The study used uncommon English words as stimuli. He manipulated the encoding variability using three conditions: one sentence context condition, a three-sentence context condition, and a no-context control condition. The practice distribution was examined by presenting words with and

without intervening words. The results revealed that the multiple retrieval routes did not improve retention of new words; however, distributed practice yielded more gains in learning when compared to the massed practice group.

Kaipa et al. (2020) compared the effect of practice distribution on the retention of novel French utterances in 50 healthy participants. The participants were randomly and equally assigned to massed or distributed practice conditions and practiced eight novel French utterances 25 times each for 200 practice trials. The massed group completed the 200 practice trials in a single session. In contrast, the distributed group practiced the phrases in three sessions with a one-day interval between the practice sessions. The retention session followed two days after practice. The authors found that participants in the distributed practice group performed better than those in the massed group (Kaipa et al., 2020).

The studies mentioned above point to the beneficial nature of distributed practice over the massed practice in novel language learning in adults (Bloom & Shuell, 1981; Kaipa et al., 2020; Kaipa et al., 2022). These findings have been reinforced by theoretical frameworks including (1) encoding variability, (2) deficient processing, (3) study-phase retrieval, and (4) semantic reconstruction hypothesis (Janiszweski et al., 2003; Bird, 2010; Callan & Schweighofer, 2010; Toppino et al., 2018; Kaipa et al., 2022). The encoding variability framework suggests a relationship between the stimuli, the background environment, and the input encoded (Kaipa et al., 2022). According to deficient processing theories, less efficient processing and encoding occur in massed practice due to the false impression created in the working memory due to familiar successive trials (Koval, 2019; Callan & Schweighofer, 2010; Gerbier & Toppino, 2015;

Kaipa et al., 2022). Study-phase retrieval theory discloses that the repetition of an item retrieves one's memories of the repeated item's earlier occurrences and associated conditions (Greene, 1989; Janiszweski et al., 2003; Siegel & Kahana, 2014). This retrieved information, in turn, is associated with the repeated item, thus providing an additional cue for retrieval. Finally, the semantic reconstruction hypothesis declares that the degree of reconstruction is strengthened when the stimuli are reconstructed using multiple-spaced trials (Janiszweski et al., 2003).

Similar to the adult studies mentioned above, few studies have examined practice distribution in children. Maas et al. (2019) compared the treatment variables' practice amount and practice distribution in childhood apraxia of speech (CAS) using an alternating-treatments single-subject design with multiple baselines design. The results revealed that high-intensity and massed practice showed better results for motor speech learning in children with CAS.

Allen (2013) compared the efficacy and intensity of the multiple oppositions approach on the phonological performance of fifty-four children with speech sound disorder. The participants were assigned into three groups (high intensity, low intensity, and control) and were required to practice the target consonants and consonant clusters differing in the place of production, manner of articulation, and voicing. The participants in the high-intensity group had better gains when compared to the other two groups. From the practice distribution framework, the high-intensity group could be labeled as distributed and the low-intensity group as massed based on the total number of trials. This also falls under this studies definition of massed and distributed. Kovacs (2017) investigated the effect of massed versus distributed practice in treating children

diagnosed with CAS. A modified dynamic and temporal tactile cueing was used as the treatment stimuli. Two participants between 5 and 11 years received treatment in both forms in an alternating treatment design with multiple baselines. The author found better performance (marginal) using massed practice over distributed practice.

Moss (1995) compared the effects of massed and distributed practice while completing reading and math tasks in second and fourth-grade students. One hundred ninety students were assigned to massed or distributed groups and completed the tasks in nine weeks. The author found that the participants learned math better in a massed practice condition despite the insignificant group difference. Similar trends were reported for the reading tasks as well.

Another study in school-aged children examined massed and distributed practices related to behavior and tact maintenance. This study had two participants whose parents conducted the sessions at home. A total of 180 trials were presented each week. The participant in the massed group completed 180 trials in a single session. In contrast, the child in the distributed group completed 45 trials for four days. The study found higher maintenance and retention for the distributed participant than the other group (Haq & Kodak, 2014).

Although adult literature suggests the effectiveness of distributed practice over massed practice in speech-motor and language-learning tasks, few studies have been conducted in children. The emerging adult literature findings may generalize to children even though certain caveats include the age, sex, cognitive, social, and linguistic background of the participants, the task, and the research design employed. Few studies have found distributed practice to be better than massed practice in children for speech

motor tasks (Allen, 2013; Haq & Kodak, 2014). Some of these studies have been conducted in the clinical population (Allen, 2013; Maas et al., 2019). Additionally, few studies found the massed practice effective or no significant difference across the practice distributions (Moss, 1995; Haq & Kodak, 2014; Kovacs, 2017). Limited studies have used novel words (nonwords) to compare the effects of practice distribution on language learning.

Considering the above limitations, we systematically compared the effectiveness of massed versus distributed practice in novel word learning in typical children between the ages of 4 and 7. A pre/post-research design systematically evaluated the two practice conditions and compared the baseline to post-training outcomes. This was done to help us determine if the learning outcomes vary as a function of the practice distribution. A study of this nature can help clinicians make a clinical decision regarding stimulus presentation and practice distribution.

**Hypothesis/Research questions**

The current study compared the effectiveness of massed versus distributed practice in novel word learning of words in typical children between 4-7 years. We attempted to answer the following research questions.

1. Whether participants in the distributed group learned novel words better than those in the massed group across the six-week timeline.
2. Whether the participants in both groups performed similarly across the three tasks.

Following the previous adult literature, we hypothesize that participants in the distributed group will learn and retain the novel words better than those in the massed group (Bloom & Shuell, 1981; Maas et al., 2019; Kaipa et al., 2020). We also predicted that the participants would perform better on comprehension tasks when compared to phonological form and expression tasks (Shorr & Dale, 1984; Montgomery, 2004).

# CHAPTER II

## METHODOLOGY

The study followed a quasi-experimental research design and was approved by the Institutional Review Board at Oklahoma State University (OSU) (IRB-21-367). The parent/caregiver of the participant provided written consent for their child's participation in the study. This six-week study recruited participants from various cities in Oklahoma. The following sections detail participants, stimuli, procedures, and analyses.

## Participants

Twenty-four monolingual English-speaking children aged 4-7 years with typical speech, language, and hearing participated in the study. Nine males and 15 females were recruited (M = 5.46; SD = 0.98). Participants were recruited from the Child Development Lab, child research labs at Oklahoma State University (OSU) (including Language Learning Lab and Phon Farm Development Lab), and various daycares in and around Stillwater. Additionally, fliers were posted in the OSU speech-language-hearing clinic, children's museum, arts center, and various daycares within the community. The participants were screened using the Fluharty-Preschool Speech and Language Screening test for age-appropriate speech and language skills. Those who passed the screening were eligible to participate in the study. The eligible participants were randomly allocated to two groups: massed and distributed. The participants were randomly and equally distributed, with 12 in the distributed group and 12 in the massed group.

The parents/caregivers of the participants completed the consent form, language background questionnaires, socioeconomic status, and speech-language-cognitive measures. Trained undergraduate and graduate research assistants carried out data collection. Training included instruction on administering and scoring background measures and stimuli and lasted about 5 hours.

## Background Measures and Stimuli

### *Parental Consent*

The parents/caregivers completed the consent form before their child participated in the study. The consent form detailed the purpose of the study, procedures, confidentiality, and the rights of participants.

### *Background Measures*

The parents completed additional questionnaires to provide information on the participants' language background and socioeconomic status. The Alberta Language and Development Questionnaire (ALDeQ)© and the Alberta Language Environment Questionnaire (ALEQ) were used to collect the language background of the participant. ALDeQ© is a parental questionnaire that provides information on a participant's early milestones and current abilities in their first language (Paradis et al., 2010). ALEQ is a parental questionnaire that reports the language use among family members and the richness of the native language of the participant (Paradis, 2011). In addition, the parents completed the McArthur Scale of Subjective Social Status to provide information on their sociodemographics.

### *Speech-Language-Cognitive Measures*

Multiple standardized assessments were administered to gather additional information on the speech-language and cognitive skills of the participants. The assessments included: the Kaufman Assessment Battery for Children – II, the Goldman-Fristoe Test of Articulation-III, the Peabody Picture Vocabulary Test -II, and the Structured Photographic Expressive Language Test.

**Kaufman Brief Intelligence Test Second Edition (KBIT-2)**. KBIT-2 (Kaufman & Kaufman, 1990) is a standardized assessment tool used as a brief measure of intelligence. This tool has several subtests to measure a child's intelligence (like vocabulary & matrices). This test includes a basal and ceiling, which provide an age minimum and maximum for the level of performance.

**Goldman-Fristoe Test of Articulation-3 (GFTA-3)**. GFTA-3 (Goldman & Fristoe, 2015) is a standardized assessment used to assess and/or diagnose a child's capacity to produce age-appropriate consonants. Only the 'sounds in words' subsection was administered.

**Peabody Picture Vocabulary Test (PPVT)**. PPVT (Dunn & Dunn, 2004) is a clinical tool that examines verbal intelligence and abilities by examining the examinee's vocabulary knowledge.

**Structured Photographic Expressive Language Test Preschool-2 (SPELT P2).** SPELT-P2 (Dawson et al., 2005) assesses expressive language through morphology and syntax using picture stimuli.

***Word Learning Paradigm***

The participants learned fifteen novel words selected from past studies that explored novel word learning in children (Chiat & Roy, 2007; Kan & Kohnert, 2008; Adolf & Patten, 2017; Leonard et al., 2019; Kapa & Erikson, 2020). The study used novel images from the Novel Object and Unusual Name Database (Horst & Hout, 2016). The novel words were audio-recorded, overlaid with a visual stimulus, and presented using PowerPoint. The word-learning paradigm is described in detail in the procedure section below. The novel words used for training are provided in Appendix 1.

During the initial phase of the study, the researchers shortlisted 24 words from past research and pilot-tested it with two children aged between 3-6 years (Alt & Plante, 2006; Chiat & Roy, 2007; Kan & Kohnert, 2008; Alt & Suddarth, 2012; Adolf & Patten, 2017; Leonard et al., 2019; Kapa & Erikson, 2020). The researchers found that some

words had an accuracy rate below 25% and were discarded from the final list of words used for training.

## Procedure

Participants in the massed group completed their novel word training in a single session and the distributed group completed it across four sessions spread across two weeks. Both groups completed a baseline phase before training. Both groups completed an immediate retention test post-training and multiple delayed retention sessions across four weeks. During the baseline, immediate retention, and delayed retention phases, the participants completed three sets of tasks: (i) an expressive task, (ii) a phonological form task, and (iii) a comprehension task. Each of these tasks and the phases are explained below.

### *Baseline phase*

The researchers debriefed the participants on the nature of the experiment. The participants in both groups completed the baseline on the first day of their participation, which lasted for about twenty minutes. The baseline phase assessed the participants' comprehension and expression of the novel words used in the study. The participant was shown a target image during the expressive task and asked the participant to recall the novel name. The participant was shown a target image in the phonological form task, and the experimenter verbally provided three possible labels. The participant was required to point to the corresponding dot to express choice (for example, Dot 1 for option 1, Dot 2 for option 2, etc.). The final task is the comprehension task in which the participant selected the choice from four target images as the experimenter verbally produced the novel word labels.

### *Training phase*

The researcher instructed the participants on the goals of the learning task and motivated them to learn novel vocabulary during the training phase. The training phase varied slightly for both groups. The participants in the massed group completed their training in week 2 in a single session. The participant practiced each novel word 20 times, totaling 300 trials. On the other hand, participants in the distributed group practiced the 300 trials divided into four sessions spread across two weeks (75 trials each), with each word being presented five times per session. After the stimuli were presented, the researcher said, "this is the (novel word)" or a sentence of a varying degree. These sentences were pre-scripted and written in the notes section of each PowerPoint slide. After the researcher stated the presented sentence, they clicked the audio icon, which enabled a pre-recorded pronunciation of the novel word. Finally, the participant was then asked to say the presented novel word.

### *Retention Phase*

The retention phase included an immediate retention session conducted immediately after the practice and a delayed retention session conducted five days after the practice session. The retention sessions were like the baseline phase, wherein the participants completed the expression, phonological form, and comprehension tasks. All fifteen words were included in the baseline, training, and retention for comparison purposes. The participants completed the immediate retention after they completed the 300 practice trials. Both groups returned for the delayed retention every week (once) for four weeks. The procedure is detailed in Table 1.

**Data & Statistical analysis**

The background measures provided information on the participants' socioeconomic status and language environment. The raw scores on the standardized assessments like the KBIT– II, GFTA-3, PPVT, and SPELT P2 provided information on the speech-language and cognitive skills of the participants. Table 2 depicts the demographic details and the raw scores of the standardized assessments. During the baseline and retention sessions, the word-learning task collected each participant's percentage of correct phonemes for the expressive tasks, while the phonological, comprehension, and expressive tasks were scored as either correct or incorrect.

The data was entered into SPSS 26.0 (IBM Corp., Armonk, NY) for statistical analysis. A mixed model analysis of variance was carried out to compare the group performance during novel word learning across the three tasks and various phases (baseline, immediate, and delayed retention phases). There were four delayed retention phases as we collected the participants' ability to retain the novel words for four weeks. The data was analyzed as a function of the scores of the word-learning tasks. The between-group factor was two groups (massed and distributed groups), and the within-group factor was the data points (baseline, immediate retention, delayed retention across four weeks). The alpha value was set at .05.

# CHAPTER III

## RESULTS

The results of the mixed-model analysis of variance revealed that there was a significant main effect of the task, $F$ (2, 44) =32.82, $p < .001$ and the participants performed better on the comprehension task ($M$ = 59.38; $SD$ =) in comparison to phonological form task ($M$ = 52.50; $SD$ =) and expression task ($M$ = 44.91; $SD$ =); ($F$ (2, 21) = 34.21; $p<0.01$). The participants also performed significantly different across the various phases of learning, $F$ (5,110) =140.63, $p < .001$. The participants performed better on the retention phases (immediate and delayed) when compared to baseline ($M$ = 2.86; $SD$ =); ($F$ (5,18) = 90.64; $p<0.01$). The results also revealed that both the groups differed significantly in their learning, $F$ (1, 22) =5.41, $p<0.05$. The participants in the distributed group ($M$ =57.61; $SD$ =) were able to retain the novel word better than those in the massed group ($M$ =46.86; $SD$ =).

# CHAPTER IV

## DISCUSSION

The current adult literature supports the use of distributed practice for novel word learning (Bloom & Shuell, 1981; Kaipa et al., 2020; Kaipa et al., 2022), while the available literature in children is divided on the utility of distributed practice (Allen, 2013; Haq & Kodak, 2014; Maas et al., 2019, Kovaks, 2017; Moss, 1995). The current study aimed to compare two practice schedules to determine which promotes novel word learning in preschool children between the age of 4-7 years and found that distributed practice yielded better retention of the novel words over six weeks. Participants performed better on the comprehension task than the other two tasks. The study results are discussed below with the initial hypothesis posed.

1. Whether participants in the distributed group learn novel words better than those in the massed group across the six-week timeline?

The current study aimed to compare two practice schedules to determine which promotes novel word learning in preschool children between the age of 4-7 years and found that distributed practice yielded better retention of the novel words over six weeks. Participants performed better on the comprehension task than the other two tasks. The study results are discussed below with the initial hypothesis posed.

2. Whether participants in the distributed group learn novel words better than those in the massed group across the six-week timeline?

In congruence with the majority of the available literature, the current study also found the distributed practice schedule to facilitate novel word learning in comparison to massed practice (Bloom & Shuell, 1981; Allen, 2013; Haq & Kodak, 2014; Kaipa et al., 2020; Kaipa et al., 2022). Past studies have employed various cognitive frameworks and theories to explain the benefits of distributed practice, including deficient processing, encoding variability, semantic reconstruction hypothesis, and study-phase retrieval (Janiszweski et al., 2003; Bird, 2010; Callan & Schweighofer, 2010; Toppino et al., 2018; Kaipa et al., 2022). Other factors that support distributed practice in literature are discriminatory processing, memory consolidation, contextual difference, and reduced mental fatigue (Kaipa et al., 2020; Haq & Kodak, 2014; Dail & Christina, 2004; Montgomery, 2004; Shea et al., 2000; Dempster, 1987; Shorr & Dale, 1984; Bloom & Shuell, 1981)

Theoretical frameworks like (1) encoding variability, (2) deficient processing, (3) study-phase retrieval, and (4) semantic reconstruction hypothesis provide support for spaced practice (Janiszweski et al., 2003; Bird, 2010; Callan & Schweighofer, 2010; Toppino et al., 2018; Kaipa et al., 2022). These theories suggest that spaced teaching

supports novel word learning, storage, and later retrieval. Encoding variability theory suggests how environmental differences affect our learning and retention ability (Kaipa et al., 2020; Dail & Christina, 2004; Shea et al., 2000; Dempster, 1987). When facilitating distributed practice, the information is received by the brain in different contexts, thus affecting the learner's ability to retain the knowledge due to the varying neural pathways created during the learning period (Kaipa et al., 2020; Dail & Christina, 2004; Shea et al., 2000; Dempster, 1987). More and differing neural connections are created by providing multiple different environments in the distributed group. More retrieval cues are available during distributed practice compared to other practice schedules (Kaipa et al., 2020; Dail & Christina, 2004; Shea et al., 2000; Dempster, 1987). The participant's environment is manipulated as the background changes each time during the training session, creating a new neural connection each session creating multiple neural pathways for the novel words (Kaipa et al., 2020). Various studies have attributed the neurophysiological framework and availability of additional neural pathways in promoting encoding variability in distributed practice (Maas et al., 2019; Kovaks, 2017; Dail & Christina, 2004; Shea et al., 2000; Dempster, 1987). This encoding variability has also facilitated novel learning in the clinical population (Aguilar et al., 2018).

Based on deficient processing theory, repeated exposures like massed practice may not engage full attentional processing because of residual activation of the previous trials. Additionally, the sense of familiarity while carrying out massed practice trials might provide a false impression of learning, which may not be beneficial while recalling the novel words. (Kovacs, 2019). Callen & Schweighofer (2010) used a vocabulary-learning experiment in which participants paired a word with a novel word in massed and

distributed conditions while functional magnetic resonance imaging was carried out. Participants had better recall of novel words during the distributed practice condition when compared to massed practice. The brain imaging results suggested that the left frontal operculum (known to be associated with encoding via verbal rehearsals) demonstrated increased activity in the distributed condition when compared to massed condition. The authors found evidence for the deficient processing theory as there was reduced activity in the left frontal operculum with multiple presentations of novel words during massed practice. Overall, the results suggest that distributed practice mediates the activity in the left frontal operculum by encoding via verbal rehearsals facilitating long-term retention.

The semantic reconstruction hypothesis predicts that repeated presentation of stimuli strengthens the recreation of the stimulus later (Janiszweski et al., 2003; Jacoby, 1974). The reconstruction of stimulus over time promotes better retention of novel words (Thios & D'Agostino, 1976). In massed practice, as the stimulus is repeated multiple times, the target is still available in the short-term memory and does not need to be reconstructed. On the other hand, in distributed practice, a reconstruction of the stimuli is required as there is a time delay between training sessions.

Haq & Kodak (2014) explained that distributed practice yielded better results due to differential reinforcement related to discriminatory processing. In addition, they also discussed that distributed practice yielded better results because participants under the distributed practice conditions could build on partial imprints of the information as they were taught with spaced intervals which are absent in the massed group (Haq & Kodak, 2014).

The number of trials and stimuli presented also affects the participants' ability to process, retain and recall novel words. Dempster (1987) discussed that learning from the context promotes learning vocabulary. They also mentioned that children test better when they space their studying over time than cramming the night before (Dempster, 1987). In the distributed group, participants practiced the novel words across four sessions. Spacing out the practice session could have helped the participants in the distributed group effectively retain and recall the novel words rather than cramming them. Another factor determining a participant's ability to retain the stimuli is the context of the presentation (Dempster, 1987). As participants in the distributed practice had the opportunity to come back for more than one practice session, they would have benefited from the different contextual factors across the sessions.

Several changes at the molecular, cellular, synaptic level, and systems-level alterations within the brain promote the creation of long-term memories from the short-term presentation of stimuli (Stickgold, 2005). Memory states become stable when long periods of inactivity or rest fall between periods of activity, allowing memory to become consolidated, thus decreasing the likelihood of the individual forgetting the novel words or other information interfering with the novel words. The interval between training sessions in distributed practice allows for memory consolidation as the memory states become more stable over rest periods. It also allows novel words to be transferred from short-term to long-term memory. However, the information in the massed group is stored in short-term memory, and there is no time interval between training sessions (Shea et al., 2000; Bloom & Shuell, 1981).

During the training phases of this study, the participants in both groups had different mental demands, as those in the distributed group engaged in the training activity for a shorter time than those in the massed group. With a longer training time, the level of mental fatigue was greater in the massed group, whereas participants in the distributed group received rest periods (Kaipa et al., 2020). Shea et al., (2000) mentioned that physical or mental fatigue could have caused an effect in their experiment. Dail and Christina (2004) also mentioned that mental fatigue could be a potential contributing factor for participants in the massed group to perform poorly compared to their distributed learning group. Prior studies analyzing the effects of massed versus distributed practice have been limited to motor tasks, French utterances, and some articulation-based tasks. Few studies have been done analyzing the effects of novel word learning in children, and to our knowledge, a study has never been conducted looking at both novel word learning and practice distribution.

3. Whether the participants in both groups performed similarly across the three tasks.

Of the three tasks, participants performed better on comprehension, followed by the phonological form and expressive tasks. During the comprehension task, the participant chose the corresponding image to its novel word pair from four images. Nash and Donaldson (2005) suggested that choosing a target image from a given set of images is an ideal tool for assessing comprehension and does not rely on a participant's phonological or semantic understanding of the target word. The task does not require the participant to retain the phonological or semantical properties of the word to demonstrate comprehension. Gray (2004), as a part of a larger study, found that children performed

better on the comprehension task than the expression task. This trend also aligns with vocabulary development in children (Luinge et al., 2006). Children comprehend a novel word before they can express it verbally.

Prior studies using comprehension tasks have also seen high results indicating its effectiveness in measuring receptive language (Shorr & Dale, 1984; Montgomery, 2004). Shorr and Dale (1984) compared the effects of an object-manipulation task to a sentence comprehension task in which the participants had to point to the corresponding picture that matches the sentence taught. The results revealed that children performed better on comprehension tasks when compared to expression tasks (Shorr & Dale, 1984). The expressive task required participants to verbally produce the novel word, which was harder than the other two. Expression of words happens after comprehension and phonological form are attained (Luinge et al., 2006). The participants in the current study performed poorly on expressive tasks as they required verbal production of the novel words. Phonological and semantic understanding of the target word was needed before the expression of the target words (Nash & Donaldson, 2005). Nash and Donaldson (2005) conducted a word-learning study to examine the word-learning deficits in children with SLI. After the training session, the children engaged in five tasks in order to gauge the extent of their semantic and phonological abilities. They found that the children performed poorly on expression tasks compared to other tasks.

# CHAPTER V

## CONCLUSION

The current literature on practice schedules in children is inconsistent compared to adult literature. There is extensive adult literature that suggests distributed practice to be beneficial in comparison with massed practice; it is difficult to generalize this to children due to various factors, including participant-related factors (like age, sex, cognition, and language ability), parent-related (quality & quantity of stimulation) and research-related factors (like tasks and research design). Several studies found that the massed practice yielded better retention of skills compared to the distributed group (Childers & Tomasello, 2002; Haq & Kodak, 2014).

The results from the current study revealed that participants in the distributed practice retained the novel words better than those in the massed practice schedule. The study also found that children in both groups performed better on the comprehension task when compared to the phonological form and expressive tasks. Memory consolidation, mental fatigue, and contextual difference also contribute to the group difference. Various theories, including the encoding variability framework, semantic reconstruction hypothesis study-phase retrieval, and deficient processing has provided support for these results (Janiszweski et al., 2003; Bird, 2010; Callan & Schweighofer, 2010; Toppino et a, 2018; Kaipa et al., 2022).

The current study is clinically relevant and can inform evidence-based interventions available for children with vocabulary deficits. The study aided in understanding the utility of massed versus distributed practice in novel word learning. Furthermore, it supports how comprehension activity should precede phonological form identification and expression task in clinical application. The outcomes of this line of research can guide clinicians on how to incorporate word learning to promote long-term retention in clinical intervention.

**Limitations of the Study**

Although the current study found that distributed practice was beneficial for novel word learning, it has a few limitations. The first limitation is the small sample size. The current study recruited twenty-four participants. The second limitation was that each of the retention tests presented the stimuli in the same order sequence. Another limitation was participant attrition due to the six-week research design. We also had a couple of participants who could not complete their participation due to covid-19 and quarantine. The third limitation is the age difference among the participants. Although both groups had similar mean ages, few participants were younger than the others in both groups. The younger participants (N=2) found it difficult to focus during the practice session, which could have affected their word-learning scores in the retention sessions.

## Future Directions

Future directions include increasing the sample size, narrower the age gap among participants, and matching the participants across ages. The results from the study can serve as evidence for Speech-Language Pathologists for the presentation of the target stimuli. It would be helpful to carry out the study over zoom or online platforms to reduce participant attrition. Extending this line of work to children with various language disorders demonstrating semantic or vocabulary deficits would be clinically beneficial. It would be appropriate to add additional delayed retention sessions, either three months or six months later, to see the long-term retention of the novel words.

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# APPENDICES

## APPENDIX A

The Word List

1. pɛb
2. kub
3. gɪp
4. tɛɪd
5. lɑm
6. nokɛn
7. bæbɪn
8. kɪdɪt
9. bɪm
10. wæb
11. tɪnɪk
12. fonɪk
13. mok
14. tæm
15. mæbɛp

APPENDIX B

Tables

Table 1: The timeline of the data collection sessions across the two groups.

| **Timeline** | | **Massed** | **Distributed** |
|---|---|---|---|
| **Week 1** | Day 1 | Baseline (15 words) | Baseline (15 words) |
| | Day 1 | No session | Practice 15*5 words |
| | Day 3 | No session | Practice 15*5 words |
| **Week 2** | Day 1 | No session | Practice 15*5 words |
| | Day 3 | Practice 15*20 = 300 trials<br>5-10 mins break after practice session<br>Immediate Retention (15 words) | Practice 15*5 words<br>5-10 min break after practice session<br>Immediate retention (15 words) |
| **Week 3** | Day 1 | Delayed Retention (15 words) | Delayed Retention (15 words) |
| **Week 4** | Day 1 | Delayed Retention (15 words) | Delayed Retention (15 words) |
| **Week 5** | Day 1 | Delayed Retention (15 words) | Delayed Retention (15 words) |
| **Week 6** | Day 1 | Delayed Retention (15 words) | Delayed Retention (15 words) |

Table 2: Demographic, Standardized test raw scores and their standard deviation (in parenthesis).

| Variable | Massed Group | Distributed Group |
|---|---|---|
| **Age (years)** | 5.75 (0.97) | 5.17 (0.94) |
| **Maternal Education** | 17.33 (3.11) | 17.83 (2.17) |
| **PPVT-4** | 120.08 (12.94) | 117.83 (20.97) |
| **GFTA-3 Sounds in words** | 9.5 (9.98) | 12.42 (9.09) |
| **SPELT** | 25.75 (4.03) | 27.08 (5.73) |
| **KBIT-verbal knowledge** | 20.55 (5.02) | 20.31 (6.09) |

APPENDIX C

Figures

Figure 1: The mean word learning scores of the participants for the comprehension task across the phases (baseline, immediate, and delayed retention phases).

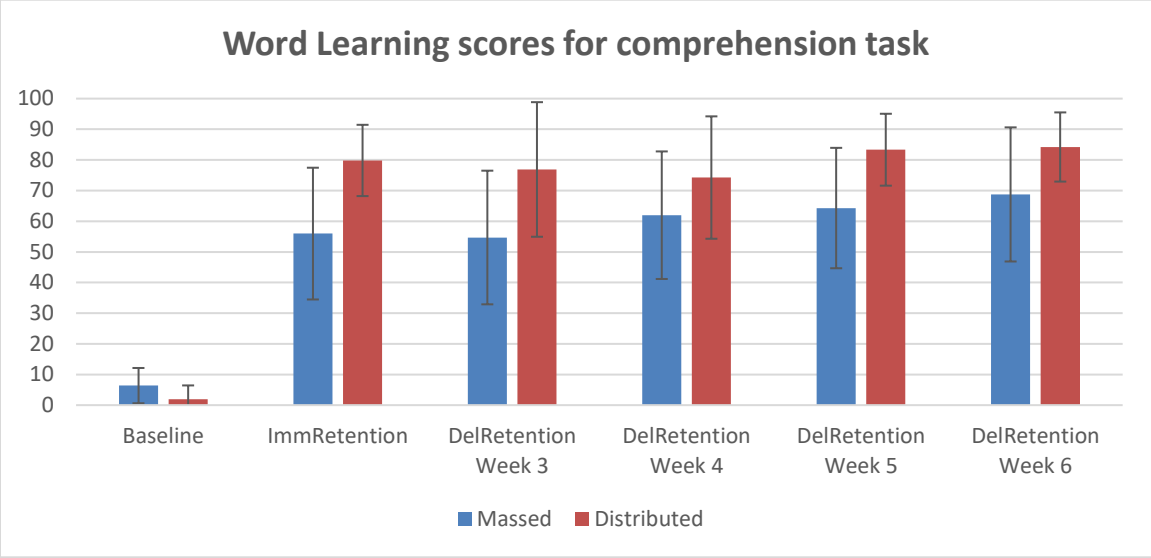


Figure 2: The mean word learning scores of the participants for the phonological form task across the phases (baseline, immediate, and delayed retention phases).

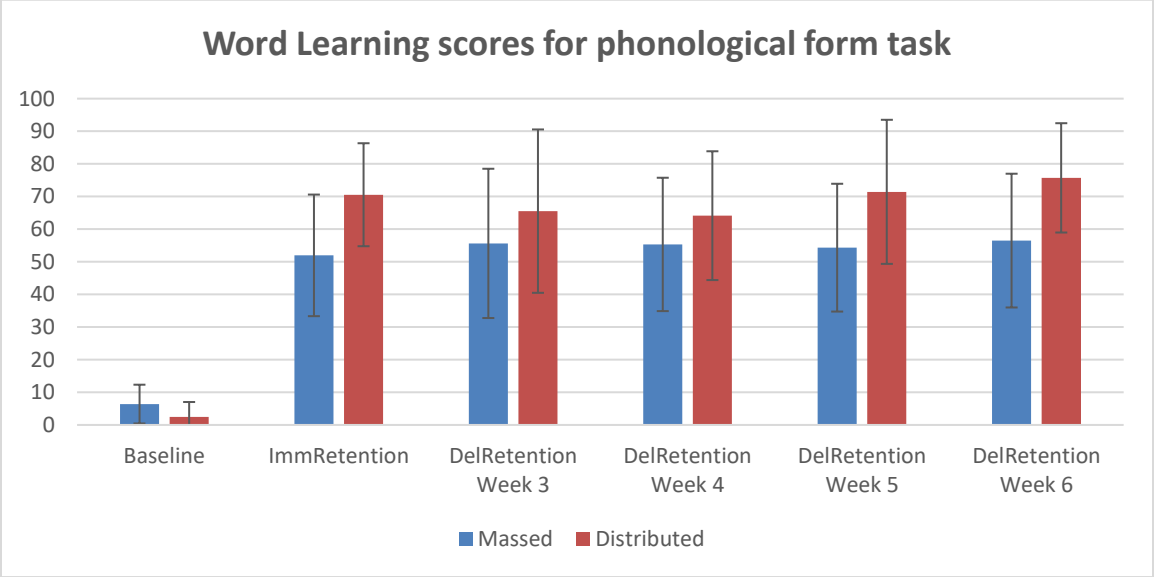
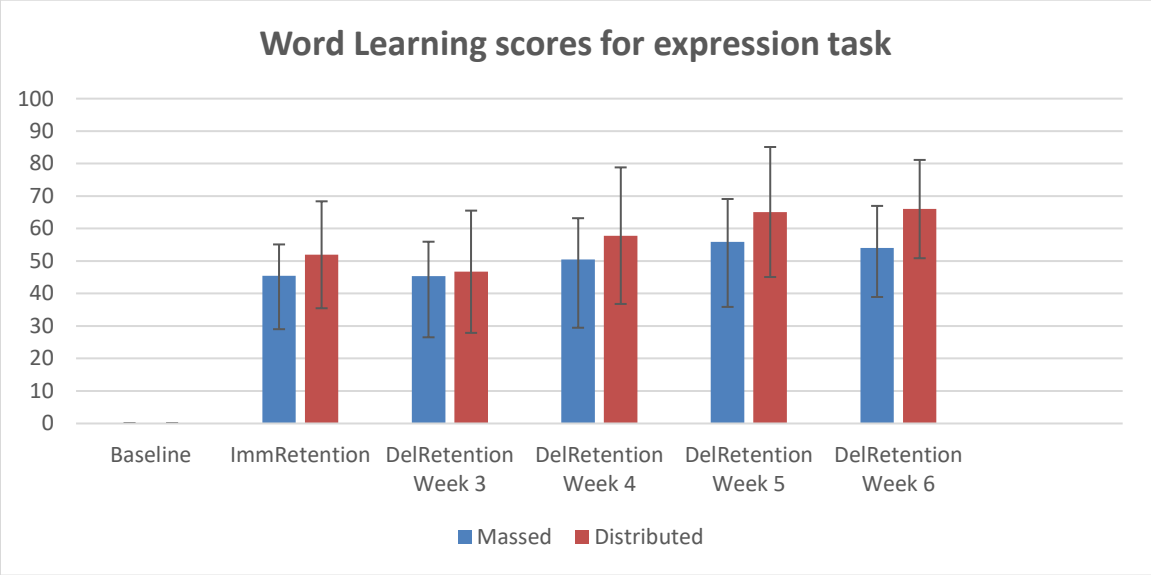


Figure 3: The mean word learning scores of the participants for the expression task across the phases (baseline, immediate, and delayed retention phases).



APPENDIX D

IRB Letter of Approval

**Oklahoma State University Institutional Review Board**

| | |
|---|---|
| Application Number: | IRB-21-367 |
| Proposal Title: | Practice Distribution and Novel Word Learning in Young Children |
| Principal Investigator: | Roha Kaipa |
| Co-Investigator(s): | Grace Touchstone |
| Faculty Adviser: | |
| Project Coordinator: | |
| Research Assistant(s): | |

**Status Recommended by Reviewer(s): Approved**

| | |
|---|---|
| Study Review Level: | Expedited |
| Modification Approval Date: | 04/12/2022 |

The modification of the IRB application referenced above has been approved. It is the judgment of the reviewers that the rights and welfare of individuals who may be asked to participate in this study will be respected, and that the research will be conducted in a manner consistent with the IRB requirements as outlined in section 45 CFR 46. The original expiration date of the protocol has not changed.

Modifications Approved:
Modifications Approved: Adjusting compensation from $120 to $75 due to budgetary constraints.

The final versions of any recruitment, consent and assent documents bearing the IRB approval stamp are available for download from IRBManager. These are the versions that must be used during the study.

As Principal Investigator, it is your responsibility to do the following:

1. Conduct this study exactly as it has been approved.
2. Submit a status report to the IRB when requested
3. Promptly report to the IRB any harm experienced by a participant that is both unanticipated and related per IRB policy.
4. Maintain accurate and complete study records for evaluation by the OSU IRB and, if applicable, inspection by regulatory agencies and/or the study sponsor.
5. Notify the IRB office when your research project is complete or when you are no longer affiliated with Oklahoma State University.

Sincerely,

Oklahoma State University IRB
223 Scott Hall, Stillwater, OK 74078
Website: https://irb.okstate.edu/
Ph: 405-744-3377 | Fax: 405-744-4335| irb@okstate.edu

# APPENDIX E

## Informed Consent

**PARENT/ GUARDIAN PERMISSION FORM**

**OKLAHOMA STATE UNIVERSITY**

**PROJECT TITLE:** Practice Distribution and Novel Word Learning in Young Children

**INVESTIGATORS:**
Roha Kaipa, PhD, Assistant Professor, Department of Communication Sciences and Disorders, Oklahoma State University.

**PURPOSE:**
Practice distribution refers to how a practice regime is spaced out, ranging from massed to distributed practice. There is limited research that examines effects of practice distribution in novel language tasks in children. Hence, the proposed study aims to compare the role of massed versus distributed practice in novel word learning among typical children and children with language impairments (those diagnosed with a language disorder and are receiving language therapy).

**PROCEDURES**
The study will take place at the Child Development Lab or Language Learning Lab at OSU and across multiple weeks (5-6 weeks). Prior to the start of data collection, a parent/caregiver will be asked to complete this consent form, demographics/ social-economic status forms, and language background/language development questionnaires on behalf of the child participating. This process will take no longer than 1 hour. Children will complete word learning across one or two weeks (depending on the group) and comeback once every week for four weeks for follow up sessions. In addition, background language/vocabulary-related assessments will also be completed. Time commitment may vary, but will consist of a minimum of 5-6 weeks, i.e. the participant's caregiver will have the option to extend the background data collection portion of the study across multiple sessions to accommodate their schedule and/or to better fit the child's attention span. The responses of the participants will be noted on a record form, in addition to being audio-recorded.

**PRECAUTIONS**
Safeguards in place will include: face masks for all participants, face masks and face shields for all experimenters, Plexiglas separation screens for participants who elect to participate in a physical lab space, disinfectant spray/cleaning procedures, and a waiting period for disinfection between participants. Any currently mandated social distancing protocols (at the state and University levels) will be practiced continuously as needed.

**RISKS OF PARTICIPATION:**
There are no known risks associated with this project, which are greater than those ordinarily encountered in daily life.

**BENEFITS OF PARTICIPATION:**
Participating in the current study may not benefit your child directly. However, your child's participation will help the researcher to answer relevant research questions regarding word-learning skills in typical children as well as those with language impairments, which may have considerable clinical implications. Please indicate to the researcher if you would like to receive a copy of the study's results.

**CONFIDENTIALITY:**
The records of this study will be kept private and confidential. However, there is a minimum risk associated with loss of privacy as the child's age and date of birth will be collected as a part of the study. The

Approved:
Protocol #: IRB-21-367

experimenter will keep this identifying information confidential and not share it during analysis, presentation, or publication. Any written results will discuss group findings and will not include information that will identify your child. Research records will be stored securely, and only the researchers and trained lab members will have access to the records. The consent process and data collection may be observed by research oversight staff responsible for safeguarding children's rights and well-being of those who participate in the research.

**COMPENSATION:**
You, the parent/caregiver will receive a $75 gift card at the end of your child's participation in the study. Compensation will be provided in person after participation is complete. You will not receive a partial payment if the child withdraws from the study halfway.

**CONTACTS**:
You may contact the researchers at the following addresses and phone number, should you desire to discuss your child's participation in the study and/or request information about the results of the study: Roha Kaipa, Social Sciences and Humanities, Dept. of Communication Sciences and Disorders, Oklahoma State University, Stillwater, OK 74078, (405) 762-4674.
If you have questions about your rights as a research volunteer, you may contact Dr. Michael Criss, IRB Chair, 219 Cordell North, Stillwater, OK 74078, 405-744-3377 or irb@okstate.edu.

**PARTICIPANT RIGHTS:**
I understand that my child's participation is voluntary; that there is no penalty for refusal to participate, and that I am free to withdraw my permission at any time, without penalty.

**CONSENT DOCUMENTATION:**
I have been fully informed about the procedures listed here. I am aware of what my child and I will be asked to do and of the benefits of my participation. I also understand the following statements:
I have read and fully understand this permission form. I sign it freely and voluntarily. A copy of this form will be given to me. I hereby give permission for my child _____ to participate in this study. By initialing here ___ I acknowledge that my child is providing verbal assent to participate in this study.

_____ _____
Signature of Parent/Legal Guardian Date

I certify that I have personally explained this document before requesting that the participant sign it.

_____ _____
Signature of Researcher Date

Approved:
Protocol #: IRB-21-367

VITA

Grace Madelaine Touchstone

Candidate for the Degree of

Master of Science

Thesis: PRACTICE DISTRIBUTION AND NOVEL WORD LEARNING IN CHILDREN

Major Field: Communication Sciences and Disorders

Biographical:

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Professional Memberships:

National Student Speech Hearing Association