Official Title: Retrieval-Based Word Learning in Developmental Language Disorder: Verb learning
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Definition: Type of uploaded study document. Select one.

- Study Protocol: The written description of the clinical study, including objective(s), design, and methods. It may also include relevant scientific background and statistical considerations (if the protocol document includes the statistical analysis plan, use "Study Protocol with SAP and/or ICF" option). Note: All amendments approved by a human subjects protection review board (if applicable), before the time of submission and that apply to all clinical trial Facility Locations must be included.
- Statistical Analysis Plan (SAP): The written description of the statistical considerations for analyzing the data collected in the study. Includes how data are analyzed, what specific statistical methods are used for each analysis, and how adjustments are made for testing multiple variables. If some analysis methods require critical assumptions, the written description should allow data users to understand how those assumptions were verified.

Purpose

Word learning is one of the principal weaknesses in children with developmental language disorder (DLD). Our previous work has shown that special benefits accrue when these children must frequently recall newly introduced words during the course of learning. The focus of the current study is learning verbs. The goal of the study is to extend our findings on the benefits of retrieval practice by increasing children's absolute levels of verb learning while maintaining the advantage that repeated retrieval holds over comparison methods of learning. We include typically developing peers as a comparison group.

Participant selection

Preschool children with DLD are recruited through local speech-language pathologists and preschool teachers. Children with typical language development are recruited through advertisements in parent newsletters, preschools, and community events.
For interested families, a phone interview is used to screen for the following eligibility requirements:

1) current age between 4;0 and 5;11 (years; months)
2) monolingual English speaker; or bilingual speaker with significant English exposure from birth.
3) no significant neurological condition or neurodevelopmental disorder (e.g, ASD).

Informed consent is obtained at the first session and eligibility testing is then completed. To be eligible, the child must:

1) pass a pure tone hearing screening in both ears at 20 dB at 500, 1000, 2000, and 4000 Hz
2) score above 75 on a test of non-verbal intelligence *(Kaufman Assessment Battery for Children – Second Edition).*
3) complete the *Structured Photographic Expressive Language Test – Preschool 2* and receive a standard score in the following range:
    a. To be included in the DLD group, children had a standard score below 87. This cutoff score has been found to show good sensitivity and specificity (Greenslade et al., 2009).

b. To be included in the TD group, children had a standard score above 87.

All children also complete the Peabody Picture Vocabulary Test – Fifth Edition. Parents complete a questionnaire that includes mother's total years of education. The PPVT standard scores and years of maternal education are both used as covariates in all statistical analyses.

For eligible children, 6 sessions are scheduled to complete the study.

Word learning procedure

In the current study, the investigators seek to improve the absolute levels of word form recall for verbs. Using a within-subjects design, children will learn eight novel verbs, four at a time. Each set of four will be learned over two consecutive days, with two words in the repeated spaced retrieval condition and two words in a repeated study condition, presented in alternating order. The referents for these novel words will be video-recorded transitive actions performed by actors on objects and presented on a laptop screen. The actors and objects used in these videos systematically vary to promote learning of the verb meaning. For each verb, there are two different agents combined with two different objects, creating 8 unique videos per verb. The novel words are monosyllabic (consonant-vowel-consonant) and are matched across conditions according to phonotactic probability and neighborhood density (based on Storkel & Hoover, 2010).

Two learning periods for each set are held on consecutive days. For novel verbs in the RSR condition, the first two retrieval trials are immediate retrieval trials. After viewing and listening to a study trial (e.g., "The woman is pumming the cow. That woman is pumming the cow"), the video is re-presented and the child is given the retrieval prompt ("What's happening here? The …"). After this, all retrieval trials appeared after the other three novel verbs hae intervened (these are the spaced retrieval trials). All retrieval trials–immediate and spaced– are directly followed by another study trial for the same novel verb. The novel verbs in the repeated study condition received the same kinds of study trials but no retrieval trials. The second day is identical to the first day except that the order of the items is changed. Across the two days, there are a total of 16 study trials for each novel verb and 12 retrieval trials (four immediate, eight spaced) for each novel verb in the RSR condition. The same number of study trials are provided for the novel verbs in the two conditions.

See https://doi.org/10.1044/2024_JSLHR-24-00321 Appendix A and B for stimuli and learning schedules.

Outcome measures

Primary outcome measures:

Verb Recall measure at 5 minutes. For each set, after the child has completed the learning session of the second day, a five-minute break is given. Then a recall test of each verb is administered. The prompts for this 16-item test are the same used for the retrieval trials in the learning period ("What's happening here? The …") to which the child would respond using the verb in a full sentence (e.g., The woman is pumming the frog). Each verb is tested with four items, two learned items and two generalization items (differing in actor or object of the verb). For this test, the verbs are presented in blocks of alternating item type (i.e., the verbs are first tested using learned items, then generalized items, followed by another block of learned, then generalized items).

Verb Recall measure at one week. One week after learning, the Verb Recall test is re-administered.

Verb Recall in a New Structure measure. After the one week recall test, the children are asked to use the novel verbs in a structure different from the one in which they learned the verb (i.e. The Noun likes to Verb the Noun). There are 16 items in this test, 4 for each verb. Two of the videos are familiar from the learning period; two differed from the learning period in choice of actor or object of the verb.

Verb Recognition measure. The third test administered at one week required the child to point to the video corresponding to a sentence they heard. There are four items per novel verb, half representing learned items and half representing generalization items.

Secondary outcome measures:

Peabody Picture Vocabulary Test – Fifth Edition is completed. Standard scores are obtained and used as a covariate in all statistical analyses.

Parents complete a questionnaire that includes mother's total years of education. Years of maternal education is used as a covariate in all statistical analyses.

Scoring

Verb Recall measure. Sixteen items are used for the word form recall test for each set. Items are scored based on accuracy of recalling the novel verb form and use of the target sentence structure.

Steps are used in the scoring of children's word forms:
1) Productions of real words alternatives to the novel word (e.g., "kicking") are scored as incorrect.
2) Productions that appear to be attempts at the novel word but are not accurate are submitted to the scoring system of Edwards et al. (2004). Each consonant is awarded one point each for correct place, manner, and voicing. For vowels, one point is given for each of length, height, and backness. An additional point is credited for correct syllable shape (CVC). Given that all novel words had the syllable shape CVC, all fully adult-like pronunciations earned 10 points. For any non-adult-like production to be scored as correct, the production is required to have a higher point total than the total that would be given if the child is instead trying to produce one of the other novel words.

Criteria for correct use of the target sentence structure is production of the subject/agent noun, the correct novel verb inflected with *-ing*, and the object/patient noun (e.g., "Woman pumming the cow"). Allowances are made if the children used the wrong noun if the error constituted a reasonable misidentification. Because many children with DLD in this age range are inconsistent in their use of auxiliary *is,* inclusion of this grammatical morpheme is not required.

Verb Recall in a New Structure measure:
To be scored as correct, the response had to include the subject/agent noun, the verb *like*, and the correct novel verb in bare stem form (e.g., "Man like to pum the frog"). The grammatical morphemes present third person singular *-s* and infinitival *to* are used inconsistently by children with DLD at this age (Leonard, 2014) and are therefore not required.

Verb Recognition measure: Sixteen items are used for the verb recognition test.
The child's picture pointing response is recorded at the time of test. The score for the recognition test is the number of items in which the child pointed to the correct video in a two-video pairing.

Data analysis plan

Mixed-effects models will be used to evaluate the children's responses on the verb recall measure, the verb recall in a new structure measure, and the verb recognition test. Models will be run with and without the covariates of PPVT-5 and maternal education in years. The number of items correct is the outcome measure for each analysis. The verb recall test is administered five minutes after the learning period and one week later. For this test, diagnostic group (DLD, TD) is a between-participants variable and learning condition (RSR, repeated study), time (five minutes, one week), and item type (learned, generalized) are within-participants variables. The verb recognition test is administered only at the one-week mark and therefore did not include time as a variable. The verb recall in a new structure test, also administered only one week later, required the children to use a sentence structure not used during the learning period, so neither item type nor time is included in the analysis. We included random slopes for learning condition, item type, and time when they did not approach zero.

Main-effects models and full factorial models with all possible interactions will be tested hierarchically. The main-effects models are presented initially with no interactions to provide a baseline of each model variable. Statistically significant interactions are then presented and relevant simple effects are reported. Effect sizes are presented as partially standardized beta coefficients (b_{std}). These are comparable to *d*, though they reflect conditional standardized mean differences conditioned on other variables in the model. To account for non-normal error terms, we used boot-strapped standard errors with 1,000 replicates. Stata Version 18.0 (StataCorp, 2023) is used for the mixed-effect model analyses.