Title: “Sentence Prediction in Developmental Language Disorder”

Protocol ID: R21DC022371-01

Date: 2026-02-24

Study Information

Hypotheses

This study aims to (1) characterize the effect of sentence- and participant-level properties on sentence prediction, (2) assess the linguistic skills underlying sentence prediction, and (3) measure the event processing that contributes to sentence prediction in 5-7-year-old school-age children with developmental language disorder (DLD) and same-age peers with typical language development (TD). First, the investigators will use eye-tracking procedures to measure how sentence complexity affects sentence prediction under conditions of varying semantic competition among potential completions. Second, the investigators will measure verb-patient and agent-verb cooccurrence knowledge and verb semantic feature knowledge. Last, the investigators will use pattern-recognition and attention tasks to measure children's processing of event participants. Across these Aims, the investigators will uncover in detail how sentence prediction is affected in children with DLD and how underlying linguistic and event-processing skills contribute to sentence prediction.

The investigators hypothesize: (1a) children with DLD's sentence prediction ability will be worse in higher-complexity sentences compared to lower-complexity sentences, (1b) compared to children with TD, children with DLD will rely on less specific prediction strategies, using broad agent/patient proto-roles over specific prediction strategies, (1c) high processing speed and strong working memory will serve as positive compensatory factors when children with DLD interpret the most challenging sentences, (2a) children with DLD have some statistical verb cooccurrence knowledge but that knowledge will not be not as well-developed as their peers', (2b) children with DLD have poorer verb semantic feature knowledge than peers and this knowledge will be more impacted than statistical verb cooccurrence knowledge, and (3) the sentence-prediction deficits of children with DLD are undergirded in some part by disturbances in event processing.

Design Plan

The investigators will preregister in detail all hypotheses, data collection procedures, and analytical plans on the Open Science Foundation (OSF) prior to data analysis and link to these plans in resultant manuscripts (see https://osf.io/b9wd2/overview for project repository). Below the investigators provide a brief summary of our anticipated plans and the investigators point the reader to the OSF repository for the most up-to-date and detailed information.

Study type

Experiment

Blinding

No blinding at the level of participant group is involved in this study as the participants will either have DLD or TD and the examiner will be aware of their diagnoses. However, participants will be not be aware of experimental manipulations as described in Hypotheses above.

Study design

The overall goal of this proposal is to characterize participant- and sentence-level factors that influence sentence prediction (Aim 1) and measure robustness of the linguistic knowledge (Aim 2) and event-processing skills (Aim 3) that underlie sentence prediction.

Randomization

Participants will either have DLD or TD and therefore will not be randomly assigned to groups. However, participants will be randomly assigned to one of four counterbalances, which will alternate the order in which tasks and trials are presented and completed.

Sampling Plan

Existing data

This study does not rely on existing data to fulfil any of the study aims with the exception of verb semantic features from Kueser et al. (in prep.) used to develop stimuli for Aim 2.

Explanation of existing data

The verb semantic feature dataset consists of the semantic features associated with early-learned verbs.

Data collection procedures

Participants include children with DLD and TD ages 5;0 to 7;11 will be included in this study. Participants will be recruited via word-of-mouth, social media campaigns, Boys Town National Research Hospital (BTNHR) Recruitment Core activities (e.g., community screenings), and the BTNRH participant registry. For each of these recruitment methods, interested caregivers and adults will be directed to the project website. This site includes the researcher's contact information and a link to an interest form. A member of the research team will contact each caregiver who completed the interest form to: 1) discuss the study, 2) verify eligibility, 3) enroll child in study, and 4) schedule a first in-person session to determine eligibility. In-person data collection will primarily take place in the Emerging Language Knowledge Lab at Boys Town National Research Hospital. Data collection for Aims 1, 2, and 3 begin in Year 1 and occur simultaneously throughout the three-year project. Child participants will be compensated at the rate of $20 cash per hour. Adult participants will complete surveys to measure properties of the stimuli.

Sample size

Children. The investigators will have a final sample size of 80 participants (40 DLD, 40 TD) for Aims 1-3 (88 total participants before anticipated 10% attrition).

Adults. The investigators will collect norming data from 100 adults representative of US demographics through online platforms; adults will be English-speaking, live in the United States, and have no known hearing, neurological, or language disorder.

Sample size rationale

Given our planned sample size, a power analysis shows that the investigators will be able to detect an effect size of 0.4 (small-medium) for the main effect of Group and 0.4 (small-medium) for the main effect of Complexity. The investigators will be able to detect an effect size of 0.3 (small-medium) for the two-way interaction between Group and Complexity.

Stopping rule

The investigators will terminate data collection when the investigators have data sets from 40 children with DLD and 40 with TD. Note that any given child can participate in more than one Aim if desired if they meet enrollment criteria.

Variables

Diagnostic group (DLD, TD) is a categorial variable based on a cut-point of 92 on the Test of Narrative Language 2 (TNL-2; Gillam & Pearson, 2017).

Aim 1

- Sentence complexity model (agents): Proportion time spent looking at the target image from verb onset to final noun onset divided by looking to any image (e.g., “Something was kicked by the boy”)
- Sentence complexity model (patients): Proportion time spent looking at the target image from verb onset to final noun onset divided by looking to any image (e.g., “Someone is kicking the ball”)
- Semantic competition model (agents): Proportion of (Target + Specific distractor looking) / (Target + Specific + Broad + Unrelated distractor looking)
- Semantic competition model (patients): Proportion of (Target + Specific distractor looking) / (Target + Specific + Broad + Unrelated distractor looking)
- Cognitive processing factors model (agents): Proportion time spent looking at the target image
- Cognitive processing factors model (patients): Proportion time spent looking at the target image

Aim 2

- Cooccurrence statistics task accuracy: Accuracy of judgement (0/1)
- Cooccurrence statistics task reaction time: Reaction time
- Semantic feature task accuracy: Accuracy of judgement (0/1)
- Semantic feature task reaction time: Reaction time

Aim 3

- Event participant pattern recognition (accuracy): Accuracy of for item (0/1)
- Event participant pattern recognition (eye gaze): Proportion looks to target area of interest (AOI) out of both AOIs from 0-4000 ms

Analysis Plan

Statistical models

The investigators will use Bayesian mixed-effects models to test our hypotheses. In all models, the investigators will include random intercepts of Item (corresponding to trial) and Participant. All models include fixed effects for Group (TD/DLD) and Sex (Male/Female). Specific models will vary in their inclusion of other terms and interactions based on hypotheses. Models with continuous outcomes will use linear mixed-effects regression; models with proportion outcomes will use beta mixed-effects regression; models with binary outcomes will use logistic mixed-effects regression. Our power analyses simulated standardized effect sizes (mean difference divided by standard deviation) ranging from d = 0.0 through d = 2.0 in steps of 0.1. The investigators ran 1,000 simulations for each possible effect size. Above, the investigators reported the smallest detectable effect size given our planned sample size at alpha = 0.05 and power ≥ 0.80. The investigators ran models with 80 participants (our planned final sample size after accounting for attrition).

Transformations

The investigators will take transformations as necessary to meet modeling assumptions and to aid model fitting.

Inference Criteria

When making directional predictions, the investigators will use one-tailed tests; otherwise, the investigators will use two-tailed tests. Where appropriate, the investigators will correct for multiple comparisons.

Data exclusion

The investigators will exclude data if a child does not provide sufficient data for analysis for if a child has not been exposed to English since birth or has a diagnosis of permanent hearing loss, autism, or intellectual disability. The investigators anticipate that this would require us to exclude no more than 10% of the data.

Missing data

The investigators take steps to reduce this risk by designing tasks that are enjoyable with varying difficulty so that all participants can contribute data. Our use of mixed-effects models ensures that the investigators can flexibly handle missing data (Baayen et al., 2008). In addition, the investigators are well-powered to detect small-medium effect sizes.

References

Baayen, R. H., Davidson, D. J., & Bates, D. M. (2008). Mixed-effects modeling with crossed random effects for subjects and items. *Journal of Memory and Language*, *59*(4), 390–412. https://doi.org/10.1016/j.jml.2007.12.005

Gillam, R. B., & Pearson, N. A. (2017). *Test of Narrative Language: Second Edition*. Western Psychological Services.

Kueser, J. B., Horvath, S., & Borovsky, A. (In prep.). *Semantic feature norms for early-learned English verbs*.

Combined Consent Form

For adult participants, parents/guardians, and youth ages 11 and older

To participate in a research project entitled

Vocabulary knowledge and sentence processing

Optional: Download consent form

IRB Protocol: 24-21-XP

IRB Approved: 06-27-2024

This exemption will remain in effect as long as the protocol continues to meet eligibility criteria.

This form shows that [first_name] [last_name] [dob] agrees to participate in a research study with Boys Town or Boys Town National Research Hospital in Omaha, NE.

In the sections that follow, the word "we" means the study investigator and other research staff. If you are a parent or legal guardian who is giving permission for a child, please note that the word "you" refers to your child.

IMPORTANT INFORMATION ABOUT THIS STUDY We are conducting a research study about what you know about words, how you learn about words, and how you understand words and sentences. We hope to learn how word knowledge forms in children and adults and how this might affect children who have difficulty learning language. Before you decide if you want to join, we will discuss what the research is for and how you would be involved. We will also discuss how your research data and your private health information are protected and shared. Please stop and ask if you want something explained to you. Your participation in this study is completely voluntary. You do not have to join. If you decide to join, you can still quit the study at any time. No matter what, Boys Town will not change the way we treat you and your family. If you decide to quit the study, you may ask that your audio/videotaped material be destroyed. If you decide to quit the study, please contact Justin Kueser at justin.kueser@boystown.org.

PROCEDURES If you agree to take part, you will complete 1-7 15-minute to three-hour sessions. We will establish a mutually agreed-upon schedule for the session(s) prior to beginning the study. If you are participating in person, then we will complete the following activities: Background information: You will be asked to answer questions about your demographic information, speech, language, and hearing history, and to provide some information about you. This will take 15-20 minutes. Otoacoustic emissions (OAE): This test measures how well you can hear. An earplug will be placed into your ear canal. You will hear sounds and we will record the sounds your ear produces in response to these sounds. All you need to do is sit quietly during the test. This test takes five minutes. Pure-tone audiometry (standard hearing test or screening): This measures how well you can hear. You will hear sounds over headphones and indicate when a sound is heard. You may be asked to play a game to tell the tester when they hear the sounds. Either the pure-tone or OAE hearing screening will be done. This test will take five minutes. Speech-language assessment: This measures your ability to understand and use language. We will complete standardized speech-language tests that involve pointing to pictures and saying words and sentences. You may also complete a language sample where we audio and video record you talking to your child or the researcher. The assessment will take between 15 minutes and three hours. We will share the results from this assessment with you after your participation is finished. Experimental language task: This measures your ability to understand, use, and/or learn aspects of word meanings. You will point to pictures, answer yes/no or rating questions, describe word meanings, and tell us other things you know about words. The experimental language task will take between 15 minutes and four hours. Experimental eye tracking task: This measures your ability to understand word meanings and sentences. You will see pictures and movies on a screen while you hear words and sentences. During this task, we will use an eye tracker to measure how you look at images on the screen. Before participating in this task, we will place a small sticker on your forehead so that the eye tracker can locate your face. The experimental eye tracking task will take between 15 minutes and two hours. If you are participating online, then we will complete the following activities: Background information: You will be asked to answer questions about your demographic information and to provide some information about you. This will take 1-2 minutes. Experimental language task: This measures your ability to understand, use, and/or learn aspects of word meanings. You will point to pictures, answer yes/no or rating questions, describe word meanings, and tell us other things you know about words. The experimental language task will take between 5-20 minutes. We plan to recruit 1,000 participants for this study. You will be paid at a rate of $20/hour for your participation. Children will also be given a small, age-appropriate prize (e.g., a small toy) valued at $1-3. You will be compensated with cash if participating in person or through the participant recruitment platform if participating online. ·

RESEARCH PARTICIPANT AGREEMENT Taking part in this study will not make you an employee of Boys Town.

POTENTIAL RISKS, DISCOMFORTS, OR OTHER PROBLEMS The primary risks for are boredom and fatigue. We will take breaks and use games, toys, activities, and breaks as needed to reduce these risks. There is a risk of loss of confidentiality of data. Please see the Confidentiality section below for how we will keep your information safe. Please note that the sounds you will hear will be presented at acceptable loudness levels and will not cause discomfort or damage to hearing. There may also be unknown risks associated with being in this study.

BENEFITS There are no direct benefits to you. However, the knowledge we gain from this study may eventually inform how we design educational interventions for children and adults who struggle to learn words and understand sentences.

PROTECTING YOUR INFORMATION There are different kinds of information that we collect during a research study, such as contact information or medical information. This section of the form explains what information we will collect from you, how we protect it and who might see it or use it. Confidentiality

- We do everything we can to keep your information private, although there is always a chance someone could find out your information is from you.
- We will not reveal your identity unless it is required by law.
- We won't use your real name if we publish or present the results from this study.
- If you disclose abuse, neglect, or exploitation of a child, vulnerable adult or other protected individual, we may be required to report the information to authorities, including law enforcement.
- We may use or share de-identified (all identifying information removed) data with other researchers. You won't be told specific details about these future research studies.

Protected Health Information
- Boys Town has rules to protect information about you, including our Notice of Privacy Practices. Federal laws, such as the federal medical Privacy Rule, and state laws also protect your privacy. These laws require that we get your permission to use or share your protected health information, also called "PHI".
- We will need PHI about you that may reveal who you are. This includes things learned from the procedures described in this consent form. We may also collect other information such as your contact information or information from your medical records, but only as described in this form.
- Signing this form means you are giving us permission, called your "authorization", to use and share PHI protected by the Privacy Rule.
- It is your choice whether you share your PHI. If you decide not to give us permission, you may not take part in this study.
- We may gather PHI about you, such as your
- Name
- Address
- Dates: Date of birth
- Telephone numbers
- Email addresses
- Biometric identifiers, including finger or voiceprints, and audio recordings
- Full face photographic images, video recordings and any comparable images
- For the most part, only the researchers on this study will see your information. However, we might be required to share your PHI with the following people:
- State and Federal Government agencies who regulate research (such as the Food and Drug Administration).
- Other people at Boys Town. This may include people that review research studies, their staff, lawyers, and other Boys Town staff.
- Other sites in this study, or the companies or government agencies that sponsor the study.
- We will try to make sure that everyone who needs your PHI keeps it private. However, if we share your information with others outside of Boys Town, we cannot guarantee that those people will protect your information.
- We may continue to use and share your PHI until you withdraw your permission.
- You can cancel your permission allowing us to use and share your PHI at any time by writing to Justin Kueser (justin.kueser@boystown.org). Once you cancel your permission, you will not be in the study, and we will stop collecting PHI about you. We may have already collected some PHI about you. We may continue to use and share that PHI for this study.

We are asking permission to add research results and PHI about you to a database we or other Boys Town researchers may use without contacting you for permission. This database has been approved by Boys Town's Institutional Review Board (a committee that oversees research studies). If you do not want your research results added to the database, please mark either or both below. If you change your mind later, please contact the researcher for this study.

☐ I DO NOT want my research results and PHI added to a database.

Researchers at Boys Town may also use the PHI from the database to contact you in the future about studies to take part in.

☐ I DO NOT want to be contacted about future studies.

RESEARCHER CONTACT INFORMATION If you have any questions about the research, contact the researcher responsible for this research: Justin Kueser, Ph.D., CCC-SLP Director, Emerging Language Knowledge Lab Boys Town National Research Hospital 425 N. 30th St., Omaha, NE 68131 531-355-5035 justin.kueser@boystown.org IRB Contact Information If you would like to talk with someone about your rights as a participant in this research study or about ethical issues with this research study, please contact the Boys Town Institutional Review Board by phone at 531-355-6700, or by email at irb@boystown.org.

STATEMENT OF CONSENT I have the legal authority to sign this form. I have discussed the above information with the researchers. All of my questions have been answered. I give permission for the researchers to use and share my PHI as described in this form and as I indicated above. I voluntarily agree to take part in the study. We are required by law to provide you with a signed copy of this form. It contains valuable information about the study and your rights as a study participant. If you are participating online, you will receive an electronic copy of this signed form sent to an email address that you provide. It will be a "PDF" document. If you are unable to open the "PDF" document, or you would prefer to receive a paper copy at no cost to you, please contact the researcher listed above. Your email may be part of the research record. Staff who are part of the study team will have access to the emails. Because BTNRH cannot control the security of email messages once we send them, we need your permission to email you. The email will not contain health information, and the link will be login protected, but once the link is opened it may reveal health information. Do you want to receive the link to the eConsent via email? Provide your email address here to receive your copy: _____

Participant First Name

_____

Participant Middle Name

_____

Participant Last Name

_____

[first_name] [last_name]
Participant Signature

_____
(Participant Signature)

Today's Date

_____

Parent's First Name

_____

Parent's Last Name

_____

Parent's/Guardian's Signature

_____
(Parent / Guardian Signature)

Date

_____

Name of Legally Authorized Representative
(if applicable)

_____

Relationship to Participant
(If applicable)

_____

Researcher sign here

_____

Today's Date

_____