Symposium Title: Spoken Language Abilities in Down Syndrome

Chair: Marie Moore Channell

Discussant: MaryAnn Romski

Overview: Most individuals with Down syndrome (DS) experience difficulties with spoken language, which can significantly impact everyday functioning across the lifespan. Despite a relatively rich body of literature documenting the broad phenotypic patterns of strength and weakness across language domains in this population, the exact nature of these impairments is still unclear. Importantly, more work is needed to characterize the nuances of language development to better understand such impairments and to optimize targets for interventions across various communication contexts in this population. Facilitated by an expert in language acquisition and intervention approaches in children with intellectual and developmental disabilities, this symposium presents study findings using three large data sets on language development in DS. Presentations 1 and 2 report findings from between-group and within-group approaches, respectively, to examine verb production difficulties during narration in children, adolescents, and young adults with DS. Presentation 3 discusses inference generation, also in the context of narration, in youth with DS. The symposium concludes with Presentation 4, a study of cognitive predictors of performance on standardized language measures in children, adolescents, and young adults with DS. Together, these presentations aim to specify patterns of spoken language impairment and identify potential cognitive, social-cognitive, and linguistic targets for interventions to improve communicative competence in this population.

Paper 1 of 4

Paper Title: Verb Production in Down Syndrome, Intellectual Disability, and Typical Development

Authors: Marie Moore Channell, Susan J. Loveall, Frances A. Conners, Leonard Abbeduto

Introduction: Individuals with Down syndrome (DS) experience a range of spoken language impairments, especially within the domain of expressive syntax. Despite a relatively large body of research, the nature of the impairment in DS is still not well understood. Some studies have suggested that individuals with DS may struggle with aspects of verb production, specifically rates of overall verb use, relative to younger, language-matched typically developing (TD) children (Hesketh & Chapman, 1998; Michael et al., 2012), while others have failed to document this difference (Grela, 2002), instead citing differences in the variety of verbs used. Only one study has examined verb production in DS relative to same-aged peers with intellectual disability (ID), reporting lower rates of verb use by individuals with DS relative to those with fragile X syndrome matched on age and nonverbal cognitive ability level (Channell et al., 2015). However, only main verbs were examined, excluding grammatical and semi-auxiliary verb types. Clearly, more research is needed to determine the extent of the verb production deficit in DS and, in particular, its relation to intellectual disability. Thus, the purpose of this study was to examine total verb production in DS relative to age-matched peers with mixed-etiology ID and younger TD children matched by nonverbal cognitive ability level.

Methods: Participants were 41 individuals with DS (10.27 – 21.96 years; M = 15.08, SD = 3.25) matched to 23 individuals with ID (13.00 – 19.03 years; M = 15.36, SD = 1.94) on chronological age (p = .71) and 29 TD children (4.14 – 6.82 years; M = 5.24, SD = .72) on Leiter-R growth scores (p = .98). Participants completed the Narrative Task (Abbeduto et al., 1995) in which they viewed a wordless picture book and were instructed to retell the story to an examiner. Audio recordings of the narratives were transcribed by trained personnel using Systematic Analysis of Language Transcripts (SALT; Miller & Iglesias, 2006) software and segmented...
into C-units (i.e., an independent clause and its modifiers, including dependent clauses). Participants’ transcripts were coded for the use of verbs within their narratives (inter-coder reliability was good, ranging from 83-98%). Verb density was calculated as the proportion of C-units containing a verb, and verb diversity was calculated as the number of different verbs used.

**Results:** Preliminary analyses revealed that the group with ID had significantly higher Leiter-R growth scores than the other two groups; thus, all analyses statistically controlled for this variable. An ANCOVA examining verb density revealed a significant main effect for participant group, F(2,89) = 3.57, p = .03. Pairwise comparisons showed that the group with DS (estimated marginal Mean = .72) used significantly fewer verbs than the groups with ID (M = .78) or TD (M = .85), which did not significantly differ from one another. An ANCOVA examining verb diversity revealed no significant main effect for participant group, F(2,89) = 0.66, p = .52, suggesting that there were no group differences in the number of different verbs used (estimated marginal Means: DS = 37.21; ID = 33.69; TD = 38.12).

**Discussion:** These results suggest that individuals with DS struggle with rate of verb production relative to other individuals with ID as well as children with TD matched on nonverbal cognition. Notably, this difference was observed even in the context of narrative story retell, which tends to elicit more syntactically complex spoken language than other sampling contexts. These comparisons also reveal that the verb production deficit in DS extends beyond what can be attributed to general intellectual disability. Interestingly, however, the null findings in verb diversity across the groups suggest that individuals with DS use a variety of different verbs, meeting developmental expectations, despite their reduction in overall use of verbs. Thus, interventions aimed at enhancing verb use may need to focus on sentence structures that support the inclusion of verbs over learning new verbs. Future work includes examining rates of use of different types of verbs across the three participant groups. Such nuanced characterizations should further specify intervention targets with the long-term goal of improving syntactic abilities and spoken language more broadly in this population.

**References/Citations:**
grammatical, lexical, mental state, etc.) in this population. The purpose of the present study was to examine verb use in DS in the context of narration. Specifically, we aimed to (1) describe the pattern of use by verb type (grammatical vs. lexical; mental state vs. metalinguistic vs. action) in individuals with DS, and (2) examine predictors of verb density and diversity for grammatical and lexical verbs in DS.

**Methods:** Forty-one individuals with DS (10.27 – 21.96 years; M = 15.08, SD = 3.25) participated in this study. Participants completed the Narrative Task (Abbeduto et al., 1995), in which they viewed a wordless picture book and were instructed to retell the story to an examiner. Audio recordings of participants’ narratives were transcribed by trained personnel using Systematic Analysis of Language Transcripts (SALT; Miller & Iglesias, 2006) software and segmented into C-units (i.e., an independent clause and its modifiers). Participants’ narrative transcripts were coded for the use of different types of verbs (Lexical: Action, Mental State, Metalinguistic, or Other; Grammatical; Semi-Auxiliary). For each verb type, a density score (proportion of C-units containing type of verb) and diversity score (number of different verbs used) were calculated.

**Results:** Addressing Aim 1, an average of 58.8% of participants’ C-units contained a lexical verb, 32.3% contained a grammatical verb, and only 1.6% contained a semi-auxiliary verb. Of the lexical verbs used, 82.2% were action verbs, 6.3% mental state verbs, 5.1% metalinguistic verbs, and 6.4% were categorized as other verb types. Importantly, there was a wide range of verb use across the participants; thus, Aim 2 focused on explaining this inter-individual variation. To address Aim 2, multiple regression was used to investigate the contribution of chronological age, nonverbal cognitive ability (Leiter-R Brief IQ scores), expressive syntax (mean length utterance, MLU), and receptive vocabulary (PPVT-4 standard scores) to verb density and diversity for both grammatical and lexical verb types. The combined predictor variables explained 61% of the variance in lexical verb density, 67% in grammatical verb density, 75% in lexical verb diversity and 44% in grammatical verb diversity. Expressive syntax was a significant predictor of each dependent variable, but receptive vocabulary emerged as the strongest predictor of lexical verb diversity. Table 1 reports total variance explained by the model, as well as unique contributions of each predictor.

**Table 1.** Effect of age, IQ, receptive vocabulary and expressive syntax on each outcome variable.

<table>
<thead>
<tr>
<th></th>
<th>Age</th>
<th>IQ</th>
<th>PPVT-4</th>
<th>MLU</th>
<th>Total Variance ($R^2$)</th>
<th>F</th>
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</thead>
<tbody>
<tr>
<td>Lexical density</td>
<td>.02</td>
<td>&lt;.01</td>
<td>.21***</td>
<td>.61</td>
<td>14.10***</td>
<td></td>
</tr>
<tr>
<td>Grammatical density</td>
<td>&lt;.01</td>
<td>.04</td>
<td>&lt;.01</td>
<td>.41**</td>
<td>.67</td>
<td>18.63***</td>
</tr>
<tr>
<td>Lexical diversity</td>
<td>.04*</td>
<td>&lt;.01</td>
<td>.15**</td>
<td>.08**</td>
<td>.75</td>
<td>26.93***</td>
</tr>
<tr>
<td>Grammatical diversity</td>
<td>&lt;.01</td>
<td>&lt;.01</td>
<td>&lt;.01</td>
<td>.13**</td>
<td>.44</td>
<td>6.95***</td>
</tr>
</tbody>
</table>

*p = .05, *p < .05, **p < .01, ***p < .001, (df 4, 36)

**Discussion:** These findings are consistent with previous research suggesting a distinction between verb density and verb diversity in DS. Not surprisingly, expressive syntax emerged as a strong predictor of verb production overall. Lexical verb diversity was further predicted by age and receptive vocabulary. Stronger receptive vocabulary abilities may help participants produce a greater variety of verbs, though it does not appear to increase the overall number of verbs produced. Knowledge of concurrent correlates of verb use allows for the identification of possible predictors of verb learning over time, which in turn can aid interventions to promote language development, especially in syntax, a noted area of difficulty for individuals with DS. Future work will add comparison groups to examine the syndrome specificity of this profile.

**References/Citations:**
Paper 3 of 4

Paper Title: Inference Generation in Narrative Retells by Youth with Down Syndrome

Authors: Shealyn Ashby1, Marie Moore Channell1, & Leonard Abbeduto5

Introduction: Individuals with Down Syndrome (DS) struggle with narrative storytelling—an important aspect of communicative competence that requires complex coordination of cognitive and linguistic abilities to communicate event sequences, character actions, and reactions. Although several studies have documented the syntactic impairments of individuals with DS relative to nonverbal cognition in the context of narrative storytelling, much less research has investigated other aspects of narration that require perspective-taking and other social-cognitive abilities. In particular, inference generation requires the speaker to integrate information that is not explicitly provided in the story, generate logical conclusions (i.e., draw inferences), and use language to communicate these inferences to a social partner. The inclusion of inferences during storytelling is crucial to conveying details about events and characters (e.g., cause and effect; character motivations, intentions, actions, and emotions) as well as broader evaluative information (e.g., character roles, dialogue, and other descriptive language). To date, no study has systematically investigated the use of inferences by individuals with DS. The present study aimed to characterize inference generation in youth with DS in the context of narrative storytelling relative to typically developing (TD) children matched on nonverbal cognitive ability level.

Methods: Participants were 23 youth with DS, 10.28-15.54 years old (M = 12.80, SD = 1.59), and 23 TD children, 3.11-6.19 years old (M = 12.33, SD = 1.74). Participants with DS or TD were matched on nonverbal cognitive ability level using Leiter-R growth scores (DS: M = 462.09, SD = 7.66; TD M = 462.22, SD = 7.58; p = .95). During the Narrative Task (Abbeduto et al., 1995), participants produced oral narrative retells in response to a wordless picture book. Systematic Analysis of Language Transcripts (SALT; Miller & Iglesias, 2006) software was used to transcribe the participants’ narratives. Utterances were segmented into C-units (i.e., an independent clause and its modifiers). A systematic coding scheme was developed, adapted from the work of Tompkins et al. (2013) in TD children, to capture instances of inferential language in the narrative retell transcripts. Each utterance was coded for the presence of inferential language, and inferences were categorized by subtype (Character actions/attempts, Internal state references, References to causality, Use of character dialogue, and Other inferences). Point-by-point inter-coder agreement was established at least 85%.

Results: Overall, the proportion of C-units containing inferences spoken by the participants with DS (M = .50, SD = .25) was significantly lower than that of the TD participants (M = .69, SD = .20; F[5,40] = 3.04, p = .02, partial eta squared = .28). Group comparisons by inference type revealed that youth with DS used significantly fewer references to Character Actions/Attempts (p = .03) and Internal States (p = .01) than TD children. There was no significant difference between participant groups for use of Character Dialogue (p = .99) or references to Causality (p = .86), though both groups demonstrated low rates of causal referencing. Additional analyses exploring the role of expressive syntax (mean length of C-units, MLU) in inference generation revealed that, when MLU was included as a covariate, there was no longer a significant difference between groups in overall rate of inference use (F[5,39] = 1.95, p = .11, partial eta squared = .20).
Discussion: These findings demonstrate a clear deficit in the use of inferential language by youth with DS relative to nonverbal cognitive ability levels. The analysis by subtype revealed a specific pattern of difficulty in DS for referencing character actions/attempts and internal states relative to other types of inferences. It may be that these types of inferences are particularly challenging because they require more advanced perspective-taking skills than the use of character dialogue, for example, though future work is needed to specify the mechanisms underlying these differences. Holistically, there is evidence that MLU plays an important role in inference generation in DS, suggesting one of two hypotheses for future research: (1) syntactic limitations constrain the use of inferential language, or (2) the lack of inferential language precludes the need for more complex syntax during narrative storytelling. Regardless, interventions aimed at enhancing spoken language in this population should also target inferential language, with a specific focus on discussing others’ intentions, actions, and internal states, as these abilities are critical for successful everyday communicative exchanges.

References/Citations:

Paper Title: Modeling the Relationships among Sustained Attention, Short-Term Memory, and Language in Down Syndrome

Authors: Gayle G. Faught, Frances A. Conners, Lani Shellhouse

Introduction: Youth with Down syndrome (DS) have difficulty with productive language and receptive syntax, while receptive vocabulary is a relative strength (Abbeduto, Warren, & Conners, 2007). Based on a wide variety of past research, this study sought to determine if predictors of language difficulty in DS include sustained attention (SA; e.g., Finneran et al., 2009) and short-term memory (STM; e.g., Chapman et al., 2002). Specifically, we hypothesized indirect effects of SA (auditory and visual) and language (receptive and productive vocabulary and syntax) through STM (auditory and visual) controlling for chronological age and nonverbal ability.

Methods: Thirty-five youth with DS aged 10- to 22-years-old ($M=15.94, SD=3.37$) participated in this study. To measure SA, participants completed auditory and visual SARTs in which they pressed a computer key in response to eight non-targets and resisted pressing a key in response to the target over an eight-minute continual stream of auditory or visual stimuli. Dependent variables were omissions (i.e., failing to press in response to non-targets) and commissions (i.e., pressing in response to the target). The CTOPP-2 phonological memory composite measured auditory STM, and a Corsi task measured visual STM. The PPVT-4 measured receptive vocabulary, TROG-2 measured receptive syntax, and CELF-P-2 expressive language index measured productive vocabulary and syntax. The KBIT-2 measured nonverbal ability. As exploratory measures, we included parent reports of participants’ executive function (BRIEF-2) and past language therapy. For main analyses, several simple mediation models were run with the bootstrapping method using PROCESS (Hayes, 2012).
Results: Potential indirect effects of auditory SA and language through auditory STM were supported by correlations. However, the same was not true for the visual domain, so these effects were not analyzed further. For auditory SA, omissions and commissions were unrelated, so separate models were run for each error type. All nine models considering indirect effects of auditory omissions and language through auditory STM controlling for age and nonverbal ability were significant. Specifically, the indirect effect through the mediator yielded a point estimate of -.27 (95% CI [-.57, -.05]) with general language as the outcome, -.26 (95% CI [-.52, -.06]) with receptive language as the outcome, -.29 (95% CI [-.62, -.05]) with productive language as the outcome, -.25 (95% CI [-.48, -.07]) with vocabulary as the outcome, -.29 (95% CI [-.62, -.04]) with syntax as the outcome, -.24 (95% CI [-.48, -.06]) with receptive vocabulary as the outcome, -.28 (95% CI [-.58, -.06]) with receptive syntax as the outcome, -.26 (95% CI [-.50, -.08]) with productive vocabulary as the outcome, and -.31 (95% CI [-.68, -.06] with productive syntax as the outcome. None of nine models considering auditory commissions were significant. Exploratory analyses revealed 1) parent report of executive function did not account for variance in models, and 2) indirect effects were not conditional upon past language therapy.

Discussion: SA predicts language through STM in youth with DS. Specifically, lapses in auditory SA (as indicated by increased omissions) predict poorer receptive and productive vocabulary and syntax through auditory STM regardless of youths’ executive functioning and past language therapy. The same was not true for the inhibitory component of SA (commissions) or for the visual modality more generally. Results have immediate implications for language therapy with youth with DS. That is, addressing auditory SA in addition to auditory STM in therapy could lead to improved language outcomes in DS. Thus, interventions geared toward improving auditory SA in DS should be piloted.

References/Citations: