Understanding real-time syntactic parsing in typical development and developmental language disorder: A visual-world study

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Developmental language disorder (DLD) affects ~7% of the population and leads to persistent difficulties with language learning and use (Bishop, 2017). Children with DLD are less accurate than peers with typical language development (TD) at sentence comprehension, but most work relies on offline tools (Marinis & van der Lely, 2007; Montgomery et al., 2017). In contrast, prior eye-tracking studies reveal surprising precocity with lexical processing in children with DLD, e.g., hearing "eat," looking to sandwich (Andreu et al., 2016; Borovsky, et al., 2013). This raises questions of whether documented challenges instead reflect: 1) *later interpretative processes* that unfold after sentence offset, or 2) *parsing demands* that may vary from sentence to sentence. Here, we examine the time course of processing for three sentence types: a) 1-argument intransitives, which disambiguate with noun or verb semantics, b) 2-argument transitives, which vary the ordering of agent-patient roles, and c) 2-argument relative clauses, which deviate from canonical SVO word order. If DLD challenges reflect only later interpretative processes, children with DLD should rapidly converge on referents for all sentences in an eye-tracking task. If children with DLD have particular difficulty with syntactic parsing, they may be slower to restrict reference for non-canonical word orders compared to TD peers.

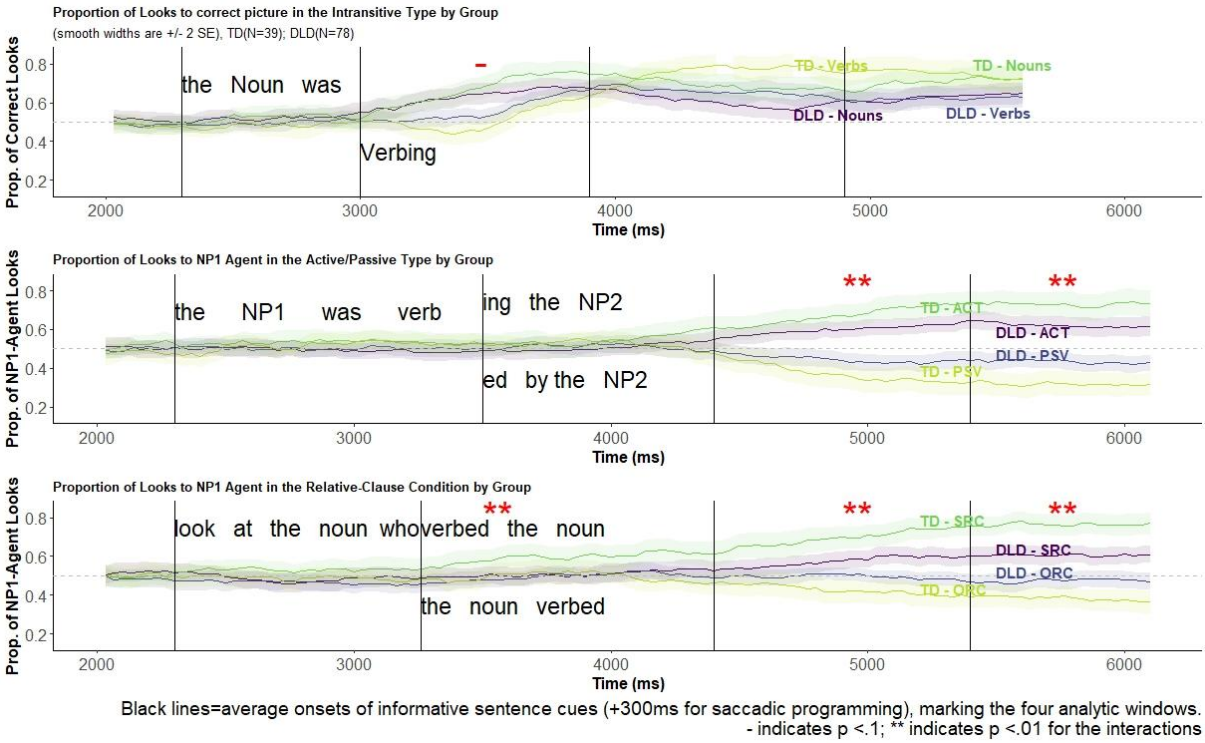
To explore sentence processing patterns in both DLD (N = 78 Age Years M = 5.90 SD = 1.43) and TD groups (N = 39, Age Years M = 6.33 SD = 1.64; data collection is ongoing), we examined children's understanding of intransitives, passives/actives, and SRC/ORC (n = 12 trials each). Children listened to audio recordings while looking at pairs of pictures that show possible interpretations of the words heard in the sentence (Fig 1). After each sentence, they were prompted to click the picture on the screen that corresponds with the sentence they heard. Looks to the left/right/away were coded frame by frame by coders blind to group and sentence target. Data were analyzed with linear mixed effect models (LMMs), which inform us whether proportions of looks differ between conditions and groups and whether they interact. LMMs were separately run for 4 different time windows (pre-, post-disambiguating cue, 1s post sentence, and 2 s post sentence), shifted by 300 ms to account for saccadic programming. Random subject and item effects were included when converging.

Fig 2 plots the proportion of correct/NP1-as-agent looks, with the average onsets of informative sentence cues (+300ms adjusted for saccadic programming) marked by dark lines. For intransitives, all children showed sensitivity to lexical meanings in the post-disambiguating window (i.e., after the noun offset). Critically, there was only a marginal interaction indicating a slightly bigger sentence-effect for TD children, with no significant interactions found in any other windows. For transitives, all children distinguished active vs. passives in the first post-sentence window (although visually it can be seen the ACT/PSV curves started to diverge a few hundred milliseconds before the sentence ended). Critically, for both post-sentence windows, there was a significant interaction indicating a much bigger sentence-effect for TD children. Finally, for relative clauses, only TD children—not DLD children—distinguished SRCs and ORCs in the post-disambiguating window (i.e., after the offset of *who*), with an interaction observed. DLD children started to differentiate SRC and ORCs in the next window, yet the interaction persisted. These patterns align with the offline 2AFC accuracy data (Fig 3): the more interactions observed during processing, the bigger the difference between the two groups in the accuracy difference between the sentence types was. Together, this reveals similarities and differences in sentence processing across populations, and suggests that school-aged children with DLD may have particular difficulty assigning roles for 2-argument sentences with non-canonical word order.

By examining real-time processing across multiple sentence types, we show that children with DLD adopt parsing strategies that overlap with TD peers, but may lack effective procedures for high-demand contexts (e.g., RCs). These findings provide crucial links between the information-processing requirements imposed by sentences and children's strategies for extracting meaning, and offer a powerful framework for understanding the contribution of sentence parsing as a mediator of learning in children with DLD.

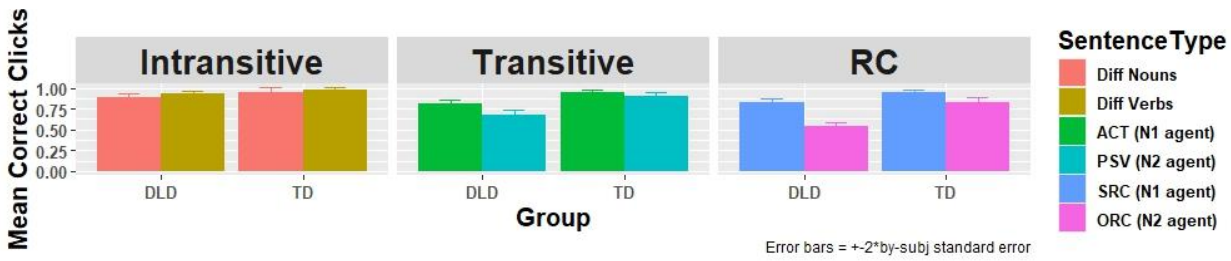
Figure 1

Figure 2



Black lines=average onsets of informative sentence cues (+300ms for saccadic programming), marking the four analytic windows.
- indicates p <.1; ** indicates p <.01 for the interactions

Figure 3



Andreu, et al (2016). *Frontiers in Psychology;* Bishop et al., (2017). *IJLCD;* Borovsky et al., (2013), *JCD*; Cho et al. (2022). *Psych Methods*; Marinis & van der Lely (2007). *IJLCD*; Montgomery, et al. (2017). *JSLHR*