

The impact of TBI on the use of referential context in syntactic ambiguity resolution

Patrick Sherlock¹, Melissa Duff², & Sarah Brown-Schmidt¹

1. Vanderbilt University, 2. Vanderbilt University Medical Center

Introduction: The referential context shapes interpretation of prepositional phrase attachment ambiguities¹. For globally ambiguous sentences, e.g., “*Feel the duck with the hat*”, contexts with multiple candidate referents support the modifier interpretation (NP-attach), as the modifier is necessary to resolve the referential ambiguity, whereas contexts with a single candidate referent support the instrument interpretation (VP-attach)². Unlike adults, preschoolers show weaker use of referential context, a finding attributed to memory and executive function^{2,3,4}. Yet children are not the only demographic for whom memory and executive function challenge cognition. Traumatic brain injury (TBI) affects ~ 1.7 million Americans annually and is a leading cause of long-term disability⁵. TBI is associated with a range of cognitive-communicative deficits that interfere with everyday communication^{6,7}, but the underlying mechanisms of impairment are understudied. We examine the impact of TBI on integration of referential context cues during the processing of global syntactic ambiguities.

Methods: Participants (Ps) were individuals with moderate-severe TBI in the chronic phase (6+ months post-injury), and demographically matched non-injured comparison participants (NC). Using a version of a previously-vetted paradigm⁸, eye-tracked Ps followed globally ambiguous instructions in English on a computer to, e.g., “*Feel the duck with the hat*”. Verbs were normed to be equi-biased between modifier and instrument interpretations. Contexts contained 2 potential instruments which could be used to carry out the action on-screen (e.g., a net and a hat could both be used to act out the ‘feel’ event), and two animals (**Fig1**). The critical manipulation was whether the referential context supported the modifier interpretation (2-referent: duck with hat; duck with net), or the instrument interpretation (1-referent: duck with a hat; bird with sponge). The pre-registered sample size is N=40 in each group, and the final analysis awaits the full sample. Here we present a preliminary analysis (**Fig2**) of the effect of the referential context (1- vs. 2- ref) on the rate of instrument (VP-attach) interpretations (picking up the critical instrument and using it to act out the action on the critical animal) vs. modifier interpretations (NP-attach, using the mouse to act out the action directly on the critical animal). Preliminary visualization of gaze during interpretation of the sentences is presented in **Fig3**.

Results: Preliminary analysis of the offline data for 47 Ps (23 TBI; 24 NC) used *glmm* in R and random effects structure determined by *buildmer*. The TBI group was treated as the reference level in the analysis which revealed a significant context effect in TBI with more instrument interpretations in the 1-ref vs. 2-ref context ($b = -0.29$, $p = .032$); the interaction with group was not significant ($b = -0.10$, $p = .52$) indicating the magnitude of the context effect in the NC group was not significantly different. A separate planned analysis with the NC group as a reference level revealed a similarly sized context effect ($b = -0.40$, $p = .005$), consistent with a context effect in both groups in the ultimate interpretation of the ambiguous sentences. Quantitative analysis of gaze awaits the full dataset and will reveal if online processing differed across groups.

Discussion: We examined the use of referential context in syntactic ambiguity resolution in persons with and without moderate-severe TBI. The preliminary data focused on *offline* interpretation and revealed the successful use of context in TBI, similar to non-injured comparison Ps. This notable preservation of function in TBI speaks to the importance of examining language in context when attempting to understand how brain injury impacts communication. The findings advance mechanistic accounts of cognitive-communication disorder by revealing that, when isolated for experimental study, Ps with moderate-severe TBI are sensitive to contextual cues that guide syntactic processing. We speculate some aspects of cognitive-communication disorders may not emerge from an inability to perceive and use individual cues, but rather from disruptions in managing multiple cognitive, communicative, and social cues in complex and dynamic interactions. This hypothesis warrants further investigation.

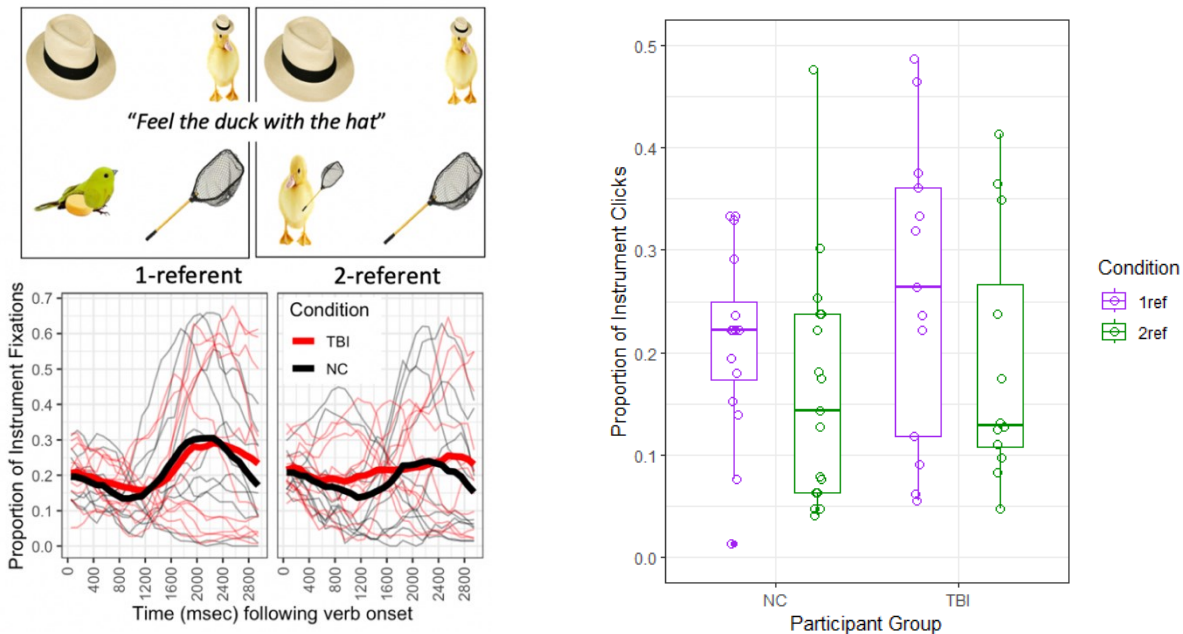


Figure 1 (top left): Example displays in 1-referent (left) and 2-referent (right) conditions for the instruction “Feel the duck with the hat”. The Target Instrument (TI) is the larger hat; the Target Animal (TA) is the duck wearing the hat. In the 2-referent condition, the second duck (with a net) encourages a modifier interpretation of the ambiguous PP (with the hat). **Figure 2 (right):** Preliminary analysis of the offline data from a subset of participants, plotted as the proportion of instrument interpretations across groups in the 1 referent (1ref) and 2 referent (2ref) conditions. **Figure 3 (bottom left):** Preliminary eye-tracking data from a subset of participants, plotted as the average proportion of fixations over time to the target instrument in the 1-referent (left) and 2-referent (right) conditions (final analysis of gaze based on the full sample will use dGLMM⁹).

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