

**Title:** Mental state terms and linguistic synchrony among boys with fragile X syndrome and autism spectrum disorder.

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**Introduction:** Fragile X syndrome (FXS) is the most common inherited, monogenic cause of autism spectrum disorder (ASD; Oostra & Willemson, 2003). Individuals with comorbid FXS and ASD (FXS+ASD) and idiopathic ASD (i.e., no known genetic cause) demonstrate similar global impairments in pragmatic language (Klusek et al., 2014; Lee et al., 2016; Losh et al., 2012), which may be influenced by reduced social cognition (i.e., the understanding that others have different thoughts and feelings from our own) (Losh et al., 2012). Differences in social cognition may affect aspects of pragmatic language, such as the use of mental state terms (e.g., “happy”, “want”; Byom & Turkstra, 2012; Stronach & Turskstra, 2008) and linguistic synchrony (Gonzalez et al., 2010). Linguistic synchrony is a metric of similarity in language use between two speakers, which may be indicative of social mimicry and the quality of an interaction (Gonzalez et al., 2010). Thus, the present study had the following aims: 1) Characterize the use of mental state terms and linguistic synchrony among boys with ASD and FXS+ASD, and 2) Evaluate associations between mental state terms, linguistic synchrony, and ASD symptoms across groups. Evaluating these aspects of pragmatic language may provide insight into how ASD symptoms manifest within etiologically distinct disorders, which in turn has important implications for treatment.

**Methods:** Participants included 25 boys with FXS+ASD and 22 boys with idiopathic ASD, drawn from a larger study (Sterling, 2018). Boys were matched on ASD severity ( $t(53) = -.49, p=.627$ ), as measured by the Autism Diagnostic Observation Schedule (ADOS), modules 2 and 3. Groups differed in chronological age ( $p=.035$ ), nonverbal IQ ( $p<.001$ ), and mean length of utterance in morphemes (MLU;  $p<.001$ ); only MLU was retained as a covariate in analyses due to associations with outcome measures. ASD symptoms were measured using the Childhood Autism Rating Scale (CARS) and the ADOS Social Affect total. Ten-minute semi-structured conversations with an examiner were completed following standard procedures (Abbeduto et al., 2020). Language samples were transcribed using the Systematic Analysis of Language Transcripts software. Mental state terms (MSTs) were coded from transcripts of conversations by trained coders blind to diagnostic group. To control for talkativeness, we computed the proportion of utterances containing MSTs (i.e., cognitive, desire, or emotional terms). Linguistic synchrony was measured using an algorithm to evaluate the relative similarity in the words used by the two speakers (i.e., participant and examiner) from a range of categories (Gonzalez et al., 2010). Categories included pronouns, function words, affect terms, cognitive process terms, and an overall score. Scores ranged from 0-1, with scores closer to 1 indicative of greater linguistic synchrony between speakers. Analyses of covariance (ANCOVAs) were used to examine group differences in the use of mental state terms and linguistic synchrony. Pearson partial correlations were used to assess relationships between the use of mental state terms, linguistic synchrony, and ASD symptoms.

**Results:** Groups did not significantly differ in their use of MSTs after controlling for MLU ( $p$ -values  $>.152$ ). Boys with FXS+ASD demonstrated significantly greater linguistic synchrony with examiners overall ( $p=.042$ ), and specifically in pronouns ( $p<.001$ ), affect terms ( $p=.013$ ), and cognitive process terms ( $p=.031$ ) during conversations compared to boys with ASD. Greater linguistic synchrony overall was associated with higher use of mental state terms during conversations for boys with FXS+ASD ( $r=.70, p<.001$ ) and ASD ( $r=.51, p=.023$ ). In the FXS+ASD group, lower linguistic synchrony was associated with higher ADOS Social Affect scores ( $r=-.42, p=.040$ ), whereas in the ASD group, lower linguistic synchrony was related to higher CARS scores ( $r=-.51, p=.027$ ). MSTs were not significantly associated with ASD symptoms in either group ( $p$ -values  $>.077$ ).

**Discussion:** This study investigated the use of mental state terms and linguistic synchrony as metrics of social cognitive skills and pragmatics among boys with FXS+ASD and ASD. While groups did not differ in their use of MSTs, boys with FXS+ASD exhibited greater linguistic synchrony than boys with idiopathic ASD, even after accounting for differences in structural language; this suggests the possibility that linguistic synchrony is a relative strength of boys with FXS+ASD. Alternatively, examiners may have needed to align to boys with FXS+ASD in ways that were different from the ASD group. Associations with ASD symptoms across groups suggest that linguistic

synchrony may be a sensitive marker of social communication. Examination of the utility of linguistic synchrony in clinical contexts may be warranted in future work.

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