



Effects of labeling and pointing on object gaze in boys with fragile X syndrome: An eye-tracking study



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ABSTRACT

We examined the visual processing of a social learning stimulus and the ways in which visual attention was distributed to objects as well as to the examiner's face during word learning under conditions that varied only in the presence or absence of a label. The goal of the current study, then, was to evaluate the effects of differentially providing pointing and labeling during exposure to a novel target object in males with fragile X syndrome (FXS) ($n = 14$, ages 4.33–10.02), autism spectrum disorder (ASD) ($n = 17$, ages 4.04–10.4), or typical development (TD) ($n = 18$, ages 2.05–5.33). In particular, the present study examined attention to the examiner's face as well as target and distracter objects that were presented as video stimuli. An eye-tracker captured gaze to the video stimuli as they were shown in order to examine the way in which children with FXS, ASD, or TD distributed their gaze toward the examiner and the objects. Results indicated that no group showed increased gaze toward the target object compared to the distracter object. However, results revealed that participants with FXS showed significantly increased face gaze compared to the novel objects, whereas children with ASD and TD both showed similar amounts of relative gaze toward the face and objects. Furthermore, the act of pointing at the target object was found to increase gaze toward the target objects compared to when there was no pointing in all groups. Together, these findings suggest that social cues like those employed in a word-learning task, when presented with video, may relate to gaze in FXS in context- or task-dependent ways that are distinct from those expected during live interaction.

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1. Introduction

Over the course of development, children attend to and gather information from a large variety of social cues when learning new words (Hollich et al., 2000). A conversational partner's direction of gaze, indicating gestures, speech prosody, facial expression, and labels inform the child's understanding of the association between a novel label and an intended

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referent (Baldwin & Moses, 2001). Previous research has shown that the attentional abilities supporting word learning are established relatively early in typical development as children learn to notice and respond to adult social cues that provide referential information (Carpenter, Nagell, & Tomasello, 1998; Scaife & Bruner, 1975; Striano & Stahl, 2005). By 20 months of age, for example, typically developing children will avoid making a mapping based upon temporal contiguity between label and object unless the label is accompanied by some social indication that the conversational partner intends to name that particular object (Baldwin et al., 1996). The present study examined the way in which the social cues of labeling and pointing affected attention toward novel objects in children with neurodevelopmental disorders.

Given their unique phenotypic characteristics, attention to the types of social cues that facilitate word learning is likely to be a challenge for children with neurodevelopmental disorders, such as fragile X syndrome (FXS) (Brady, Warren, Keller, Fleming, & Sterling, 2014; Warren, Brady, Sterling, Fleming, & Marquis, 2010). In the present study, we focused on fast mapping by children with FXS. The term “fast mapping” refers to the initial associative learning process by which a novel label is paired with an object referent during word learning (cf. Carey & Bartlett, 1978; Dollaghan, 1987; Heibeck & Markman, 1987). Adult social cues provided within a word-learning context serve the function of directing the child’s attention to the novel object while the novel label is being presented, thereby providing an opportunity for accurate associative learning to take place. The current study was designed to examine, within the context of an experimental fast mapping paradigm, the responsiveness of children with FXS to two specific types of adult social cues, pointing gestures and verbal labeling.

1.1. Pointing

Numerous findings demonstrate the importance of pointing gestures in directing children’s attentional resources during word learning (Baldwin & Markman, 1989; Briganti & Cohen, 2011; Deak, Flom, & Pick, 2000). For example, evidence has indicated that adult pointing toward an object results in more attention toward the object than when the adult merely looks at the object without pointing (Deak et al., 2000; Doherty & Anderson, 1999). There is a convergence of evidence to suggest that pointing gestures are important in directing young children’s attention toward objects within referential contexts (Grassmann & Tomasello, 2010; Leibal, Behne, Carpenter, & Tomasello, 2009). The phenotypic characteristics of young males with FXS, including gaze aversion (Garrett, Menon, MacKenzie, & Reiss, 2004; Hessler, Glaser, Dyer-Friedman, & Reiss, 2006), social anxiety (Cordiero, Ballinger, Hagerman, & Hessler, 2011), inattention (Cornish & Wilding, 2010) and symptoms of ASD (Roberts, Weisenfeld, Hatton, Heath, & Kauffman, 2007), can be expected to negatively affect their ability to attend to, and understand, the relevance of pointing gestures in supporting the word learning process.

1.2. Verbal labeling of novel objects

Another critical social cue that facilitates children’s attention to an adult’s intended referent is the presence of a verbal label within an interactive context that includes a novel (i.e., nameless) object (see Baldwin & Moses, 2001 for review). The presence of labels has been shown to support attention following in TD children (Moore, Angelopoulos & Bennett, 1999; Pruden, Hirsh-Pasek, Golinkoff, & Hennon, 2006) and children with ASD (McDuffie, Yoder, & Stone, 2006). That is, young children direct a greater proportion of their visual attention to an object that is accompanied by a verbal label from a speaker than to an object that is accompanied by other types of cues designed to increase the salience of a novel object (e.g., object movement, handling of the object, talking without labeling). Presumably, the presence of a verbal label carries privileged information about a speaker’s intention to name the novel object. Little is known about whether the presence of verbal labels increases the salience of a novel object for children with FXS; that is, whether these children will attend more to a novel object that is labeled than to one that is merely talked about without labeling. The phenotypic characteristics of young males with FXS, however, can be expected to negatively impact their ability to attend to and understand the relevance of verbal labels in supporting the acquisition of new words.

1.3. Fragile X syndrome

FXS, the most common inherited cause of intellectual disability (Crawford, Acuna, & Sherman, 2001), is caused by a CGG trinucleotide expansion on the *FMR1* gene on the X-chromosome. This expansion results in the lack or reduction of FMRP, a protein critical for synaptic development and experience-dependent learning (Bassell & Warren, 2008). Although FXS affects both males and females, it is more common in males, and males are more severely affected on average. Over 95% of males with FXS have cognitive abilities within the intellectual disability range (IQ of < 70; Hessler et al., 2009). In addition, males with FXS often display a behavioral phenotype that includes gaze avoidance, repetitive behaviors, inattention, hyperarousal, and social anxiety (Hessler et al., 2006; Wolff et al., 2012).

Language is generally delayed relative to age-expectations in males with FXS (Abbeduto, Brady, & Kover, 2007; Brady, Skinner, Roberts, & Hennon, 2006). There is recent evidence, however, that boys with FXS are less impaired, on average, in the process of learning new words than age-matched boys with ASD despite the former having lower levels of nonverbal cognitive functioning (McDuffie, Kover, Hagerman, & Abbeduto, 2013). These findings raise the possibility that the social skills necessary for word learning are less impaired in FXS than in boys with ASD. The current study was designed to examine specific aspects of the social and behavioral phenotypes of males with FXS that might shed light on their word learning.

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