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Generalization of content and emotional prosody across speakers varying in gender in youth with Autism Spectrum Disorder

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ABSTRACT

Aims: We employed a discrimination-choice procedure, embedded in a custom-made videogame, to evaluate whether youth with Autism Spectrum Disorder (ASD), including nonverbal individuals, distinguish sentences on the basis of emotional tone-of-voice and generalize linguistic information across speaker gender.

Methods and procedures: Thirteen youth with ASD (7–21 years) and 13 age-matched typical controls heard pairs of pre-recorded sentences varying in lexical content and prosody (e.g., enthusiastic "Dave rode a bike" vs. grouchy "Mark held a key"). After training to select a target sentence, participants heard test probes comprising re-combinations of the content and prosodic features of the sentences. Interspersed generalization trials used a voice opposite in gender to the voice used in training.

Outcomes and results: Youth with ASD were less accurate than controls in discriminating sentences based on emotional tone-of-voice. Nonverbal and verbal youth did not differ in this regard. The ASD group showed only slight decrements in generalizing to the opposite-gender voice.

Conclusions and implications: The finding of intact generalization of linguistic information across male/female speakers contrasts with the widely held view that autism is characterized by deficits in generalization. This suggests the need to test generalization under varying task demands to identify limits on performance.

What this paper adds?

Individuals with Autism Spectrum Disorder (ASD) often exhibit impairments in discriminating and interpreting emotional tone-of-voice. Although poor generalization has been viewed as characteristic of ASD, research has not directly explored whether individuals with ASD are impaired in generalizing linguistic information across speakers. The current study embedded a discrimination-choice procedure in a custom-made videogame that allowed youth with ASD—including nonverbal individuals who are typically excluded from language research—to learn through trial-and-error to select a target sentence. After reaching a training criterion, interspersed test trials examined discrimination of sentences on the basis of emotional tone-of-voice and content while testing for generalization of linguistic information across speakers varying in gender. Youth with ASD generalized to almost typical levels, but had difficulties selecting the target sentence on the basis of emotional tone-of-voice. The success of nonverbal individuals in playing the videogame suggests potential therapeutic applications as a means of rewarding attention to emotional prosody.

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1. Introduction

Proficiency in spoken language processing requires individuals to pay attention (1) to *what* is said (content) and *how* it is said (prosody), and (2) to generalize linguistic knowledge across different speakers. With regard to (1), Wagner and Watson (2010, p. 905) include "emphasis, pitch accenting, intonational breaks, rhythm, and intonation" as aspects of prosody defined by form as well as function (how words relate to each other semantically and syntactically). The behavior-analytic view on spoken language is similar in that it also considers discrimination and interpretation. *Discrimination* requires that the listener come under the stimulus control of prosodic features such as pitch, timbre, rate, intensity, intonation, and rhythm. In contrast, *interpretation* addresses the "meaning" of an expression, requiring the listener to be sensitive to higher-order contingencies embedded in the spoken words and their context of use (Lowenkron, 2004). In general, discrimination requires attention to the form of an utterance, without necessarily recognizing how forms relate to specific communicative functions, whereas interpretation requires attention to information embedded in a larger communicative context. For example, "Good job!" can be said with enthusiasm or sarcasm, and can only be understood properly by attending to its form, including any distinguishing prosodic features, *and* function (praise or reprimand).

With regard to (2), generalization is the ability to correctly apply what was previously learned to novel situations. Deficits in generalization have serious implications. For example, with a lack of generalization, even if a child learns to respond appropriately to a parent's emotional state, he/she may not respond appropriately to an unfamiliar person even if an identical emotion is expressed. Such a deficit in generalization would result in severe deficits in social skills. Lack of generalization due to "stimulus overselectivity" (Lovaas, Koegel, & Schreibman, 1979) has been studied extensively with behavior-analytic approaches (Ploog, 2010).

Difficulties with language processing are common in individuals with Autism Spectrum Disorder (ASD), as noted in different versions of the *Diagnostic and Statistical Manual of Mental Disorders* (e.g., DSM-5; American Psychiatric Association, 2013), and impact social-communicative development (Paul, Augustyn, Klin, & Volkmar, 2005; Paul, Shriberg et al., 2005). Although research has explored whether individuals with ASD attend to prosody, especially with regards to emotion (Lartseva, Dijkstra, & Buitelaar, 2015; McCann & Peppé, 2003), less is known about whether they readily generalize linguistic information across speakers (de Marchena, Eigsti, & Yerys, 2015; Plaisted, 2001). Furthermore, most studies have only tested individuals with ASD who are verbal ("high-functioning") with just a few including nonverbal participants (Brooks & Ploog, 2013; Ploog, Banerjee, & Brooks, 2009; Ploog, Brooks, Scharf, & Aum, 2014; Schreibman, Kohlenberg, & Britten, 1986). The current study used a discrimination paradigm to explore whether youth with ASD, including nonverbal individuals, distinguish sentences based on lexical content and emotional tone-of-voice and whether they generalize such sentences across speakers varying in gender.

1.1. Discriminating and interpreting emotions in speech

Prior literature has explored whether discrimination and/or interpretation of prosody are impaired in individuals with ASD. Numerous studies have found evidence of impairments in interpreting emotional content expressed through prosody (Brennand, Schepman, & Rodway, 2011; Golan, Baron-Cohen, Hill, & Rutherford, 2007; Heaton et al., 2012; Korpilahti et al., 2007; Lindner & Rosén, 2006; Matsumoto et al., 2016; Mazefsky & Oswald, 2007; O'Connor, 2007; Philip et al., 2010; Rutherford, Baron-Cohen, & Wheelwright, 2002; Singh & Harrow, 2014; Van Lancker, Cornelius, & Kreiman, 1989; Wang & Tsao, 2015). In contrast, studies investigating discrimination based on prosody have yielded mixed findings. Some have reported impairments (e.g., McCann, Peppé, Gibbon, O'Hare, & Rutherford, 2007; Peppé, McCann, Gibbon, O'Hare, & Rutherford, 2007), with others reporting no impairment (Boucher, Lewis, & Collis, 2000; Brennand et al., 2011; Chevallier, Noveck, Happé, & Wilson, 2009; Doyle-Thomas, Goldberg, Szatmari, & Hall, 2013; Grossman, Bemis, Skwerer, & Tager-Flusberg, 2010; Jones et al., 2011; O'Connor, 2007; Ozonoff, Pennington, & Rogers, 1990) or even enhancement (Järvinen-Pasley, Wallace, Ramus, Happé, & Heaton, 2008). To give an impression of the mixed findings, Le Sourn-Bissaoui, Aguert, Girard, Chevreuil, and Laval (2013) reported that youth with ASD performed similar to typical controls in discriminating utterances based on prosodic cues yet had difficulties when asked to interpret positive emotions in varying situational contexts. However, McCann et al. (2007) reported impairments across task types in children with ASD using the Profiling Elements of Prosodic Systems in Children (Peppé & McCann, 2003)—a task battery encompassing form and function tests for receptive and expressive prosody. Finally, Järvinen-Pasley, Peppé, King-Smith, and Heaton (2008) reported no difficulties in form and function tasks assessing receptive prosody at the single-word level, but difficulties in sentence-level tasks.

The current study tested youth with ASD for their ability to respond to form (discrimination), not function (interpretation), and generalize information across different speakers. It represents a follow-up to a series of studies using a similar paradigm. Ploog et al. (2009) used a discrimination task embedded in a custom-made videogame to examine attention to linguistic features of prerecorded sentences varying in content (e.g., "Max ate a grape" vs. "Tom threw a ball") and prosody (i.e., statement vs. question). The task was designed so that individuals could learn through trial-and-error without verbal instructions, which allowed testing of a diverse sample that included nonverbal individuals. Even though the ASD group, compared with typical controls, did not show appreciable deficits in discriminating sentences on the basis of content or prosody, the ASD group based discrimination equally on content and prosody whereas controls had a clear preference for content. In two follow-up studies using the videogame paradigm, atypical patterns of attention to content and prosody were observed in individuals with ASD. Brooks and Ploog (2013) tested specifically for emotional prosody, and Ploog et al. (2014) tested with an unfamiliar language to remove "meaning" and thus the demands of interpretation. The current study was a further test of attention to content and prosody that was expanded to assess whether individuals with ASD would generalize what they had learned in response to a change in voice.