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Research in Autism Spectrum Disorders

Journal homepage: <http://ees.elsevier.com/RASD/default.asp>

Inflectional morphology in high-functioning autism: Evidence for speeded grammatical processing



Matthew Walenski^{a,*}, Stewart H. Mostofsky^{b,c}, Michael T. Ullman^d

^a San Diego State University, United States

^b Kennedy Krieger Institute, United States

^c Johns Hopkins University School of Medicine, United States

^d Georgetown University, United States

ARTICLE INFO

Article history:

Received 29 May 2014

Received in revised form 21 August 2014

Accepted 25 August 2014

Available online 19 September 2014

Keywords:

Autism

Language

Morphology

Past tense

Procedural memory

Basal-ganglia

ABSTRACT

Autism is characterized by language and communication deficits. We investigated grammatical and lexical processes in high-functioning autism by contrasting the production of regular and irregular past-tense forms. Boys with autism and typically developing control boys did not differ in accuracy or error rates. However, boys with autism were significantly faster than controls at producing rule-governed past-tenses (*slip-slipped*, *plim-plimmed*, *bring-bringed*), though not lexically dependent past-tenses (*bring-brought*, *squeeze-squeezed*, *splim-splam*). This pattern mirrors previous findings from Tourette syndrome attributed to abnormalities of frontal/basal-ganglia circuits that underlie grammar. We suggest a similar abnormality underlying language in autism. Importantly, even when children with autism show apparently normal language (e.g., in accuracy or with diagnostic instruments), processes and/or brain structures subserving language may be atypical in the disorder.

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1. Introduction

Autism is a developmental disorder of the brain that is strongly associated with deficits in language and communication (APA, 1994). Language impairments are consistently found in pragmatics (the knowledge required to use and interpret language appropriately in social and real world contexts), even in high functioning individuals. In contrast, performance at tasks involving single words, in both receptive and expressive domains, does not show consistent impairments, and in some individuals may be spared or even enhanced in some respects relative to typically developing controls (Lord & Paul, 1997; Luyster and Lord, 2009; Minshew, Goldstein, & Siegel, 1997; Norbury, Griffiths, & Nation, 2010; Walenski, Mostofsky, Gidley-Larson, & Ullman, 2008; Walenski, Tager-Flusberg, & Ullman, 2006).

The status of grammar is less clear. Grammar subsumes the knowledge required to combine words (i.e., syntax) and parts of words (i.e., morphology) into sequentially and hierarchically rule-governed structured units. Performance consistent with deficits in these areas has been widely reported in autism, for both expressive and receptive language tasks, in both auditory and visual (i.e., reading) domains (see below and Boucher, 2012; Eigsti & Bennetto, 2009; Eigsti, Bennetto, & Dadlani, 2007; Perovic, Modyanova, & Wexler, 2012; Walenski et al., 2006; Williams, Botting, & Boucher, 2008). However, not all individuals

* Corresponding author at: Language and Neuroscience Group, San Diego State University, 6505 Alvarado Road, Suite 204, San Diego, CA 92120, United States. Tel.: +1 619 594 0280.

E-mail addresses: mwalenski@ucsd.edu, mwalenski@gmail.com (M. Walenski).

show these deficits, and some show no apparent grammatical impairments at all, at least with standardized assessments (Kjelgaard & Tager-Flusberg, 2001; Minshew et al., 1997).

Consistent with this heterogeneity, a structural MRI study reported atypical volumes of language areas in the brains of individuals with autism who have language impairments, but not in those who do not (De Fossé et al., 2004). Nevertheless, functional imaging studies of sentence comprehension have revealed atypical activation patterns in autism relative to control participants, even when the groups did not differ in accuracy (Just, Cherkassky, Keller, & Minshew, 2004; Kana, Keller, Cherkassky, Minshew, & Just, 2006; Müller et al., 1998, 1999). In addition, in one such study with typical accuracy but atypical activation patterns in autism, the adults with autism also responded more quickly than their matched controls (Just et al., 2004).

Overall, the data suggest that accuracy alone may be too crude to detect atypical language processing in many individuals with autism – that is, even if language output appears normal, the underlying processes that created that output may be different in autism, for example in speed (e.g., processes used by individuals with autism may be slower or even faster than in typical individuals), or perhaps in kind (i.e., different processes may be used altogether).

The main aim of the current study is to investigate language in autism using a paradigm that allows us to examine both the accuracy and timing of both grammatical and lexical processes, while holding other factors constant: that is, the production of regular and irregular inflected forms. This fills an important gap, since little research has examined regular and irregular morphology in autism, despite the theoretical importance of this distinction.

1.1. Inflectional morphology

Few studies have investigated the production of inflectional morphology (changes or additions to a word to reflect its correct use in context) in autism, including in the contrast between regular and irregular inflected forms (e.g., *walked* vs. *dig* in English past tense), which may reflect different underlying processes (see below).

First of all, several studies of elicited verb production in children with autism have reported an increased number of incorrect verb forms in contexts that require the past tense (e.g., saying *play* instead of *played*) (Bartolucci & Albers, 1974; Botting & Conti-Ramsden, 2003; Seung, 2007), as well as in contexts that require the present tense (e.g., saying *walk* instead of *walks*) (Roberts, Rice, & Tager-Flusberg, 2004). In addition, in samples of spontaneous speech produced while children interacted with a parent, children with autism aged 8–10 years old have produced correct regular and irregular inflectional morphemes (past tense and present tense) at different rates than typically developing individuals or mental-age-matched control participants with intellectual disability (Bartolucci, Pierce, & Streiner, 1980; Howlin, 1984).

Only one study we are aware of has separately reported performance on regular and irregular forms in autism. This study, which included children with autism across a wide age range (5–15 years) and IQ range (42–141), examined verb forms elicited in response to pictures (Roberts et al., 2004). Language-impaired children with autism – defined as those individuals scoring below 70 on the Peabody Picture Vocabulary Test (PPVT-III; Dunn & Dunn, 1997), a test of receptive vocabulary – were compared against age-matched groups of children with autism who were either unimpaired or borderline impaired on the PPVT. The language-impaired group produced fewer correct regular and fewer correct irregular past tense forms, with more unmarked errors on both (*walk-walk*; *dig-dig*), relative to both the unimpaired and borderline-impaired language groups. However, it is not clear whether the regular and irregular deficits in the language-impaired group reflect a single dysfunction affecting both types of forms (e.g., a deficit of morphosyntax) or two distinct areas of dysfunction, one affecting regulars and one irregulars. Moreover, performance at regulars and irregulars was not statistically compared, and no non-autistic control participants were included, so it is not clear if either of the latter groups might have also had some impairment at either or both regular and irregular forms. Note also that the task included only a small number of regular and irregular test items (11 regular, 8 irregular), which were not reported to be matched on length, frequency, or any other factors which may influence how difficult the forms are to produce.

Impairments have thus consistently been reported at the production of inflected forms, though several factors potentially limit the interpretation of these findings. First, all prior production studies collected data in contexts that required social interaction (e.g., with a parent for collecting spontaneous speech samples or an experimenter for elicited production). It may be that this social context contributed to their poor performance (Ozonoff & Strayer, 2001). Second, rigorous diagnostic measures of autism were not developed until the late 1980s and early 1990s (Eigsti et al., 2007), making older studies difficult to evaluate in comparison to more recent findings. Third, no prior study has examined production response times, so more subtle abnormalities at producing either regular or irregular forms may be present even if all forms are ultimately produced correctly. Finally, only one study reported results for regular and irregular forms separately, but these forms were not matched, were not statistically compared, and moreover the individuals with autism were not compared with a typically developing control group.

1.2. Theories and predictions

The dearth of studies contrasting regular and irregular inflected forms in autism is a particularly important lacuna, as these forms are posited by various theoretical perspectives to rely on different cognitive processes and on different brain structures, underscoring the need to examine their production separately. Indeed, the regular/irregular distinction lies at the heart of a long-standing debate in the study of language and cognition (Bird, Lambon Ralph, Seidenberg, McClelland, &

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