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Brief report

Nonverbal, rather than verbal, functioning may predict cognitive flexibility among persons with autism spectrum disorder: A preliminary study

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ABSTRACT

Background: Cognitive flexibility may not be as impaired in persons with autism spectrum disorder (ASD) as expected by the clinical criterion of repetitive and perseverative behaviors (APA, 2013) and by their verbal abilities. In typically developing (TD) children and other groups, the development of cognitive flexibility is tightly linked to verbal development. However, nonverbal abilities may better predict cognitive flexibility in children with ASD because of their unique pattern of cognitive strengths and weaknesses.
Method: We examined the relative influences of chronological age (CA), performance mental age (PMA), and verbal mental age (VMA) on cognitive flexibility as measured by performance on the Flexible Item Selection Task (FIST) among a group of 27 individuals with ASD with a wide range of IQs. The Leiter-R and PPVT-III estimated PMA and VMA, respectively.
Results: Partial correlations indicated that PMA, but not VMA, related to switching performance on the FIST.
Conclusion: Findings highlight the potential unique role of nonverbal abilities as a contributing factor to the development of cognitive flexibility among individuals with ASD. Nonverbal abilities may better support the development of cognitive flexibility in this particular population perhaps because their limited verbal abilities cannot contribute effectively to other cognitive processes such as cognitive flexibility.

Cognitive inflexibility, or difficulties in taking multiple simultaneous perspectives and flexibly shifting among them in order to respond efficiently to task demands (Monsell, 2003), is considered a hallmark of the general autism spectrum disorder (ASD) phenotype (Kenworthy, Black, Harrison, Rosa, & Wallace, 2009; Landry & Al-Taie, 2016; Reed, Watts, & Truzoli, 2013). It is thought to be a key contributor to the manifestation of the clinical criterion of repetitive and perseverative behaviors and may contribute to a general preference for sameness (Leung, Vogan, Powell, Anagnostou, & Taylor, 2016; Maes,

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Eling, Wezenberg, Vissers, & Kan, 2010). Yet, when tested empirically, these difficulties do not seem to be as profound as might be expected, and are not even observed on some measures (for a review, see Geurts, Corbett, & Solomon, 2009).

Among typically developing (TD) children, key developmental transitions in cognitive flexibility are noted over the preschool period and are thought to result from developments in language, or more precisely, in the use of language as a mediational tool (Emerson & Miyake, 2003; Jacques & Zelazo, 2005a; Karbach & Kray, 2007; Luria, 1959). For example, labeling stimuli improves the performance of young TD children on several tasks of cognitive flexibility in nonsocial domains (e.g., Doebel & Zelazo, 2015; Kendler & Kendler, 1961; Kirkham, Cruess, & Diamond, 2003; Loewenstein & Gentner, 2005; Luria, 1961; for a review, see Jacques & Zelazo, 2005b). Moreover, correlational and experimental links between language and performance on false-belief tasks, purported to assess cognitive flexibility in the social domain (Jacques & Zelazo, 2005a; Low & Simpson, 2012), have been observed both concurrently (Jenkins & Astington, 1996; Low & Simpson, 2012) and longitudinally (Astington & Jenkins, 1999; Watson, Painter, & Bornstein, 2001). However, these findings alone do not inform about the extent to which children and adults actually *depend on* verbal abilities to reason flexibly.

One way to assess the dependency of flexible reasoning on verbal abilities is to prevent (or limit) children or adults from labeling stimuli by using *articulatory suppression*, which requires that participants continuously talk aloud about something irrelevant to the task to prevent (or at least limit) the verbal encoding and processing of stimuli in a primary task. The rationale is that if limiting verbal labeling in the primary task by requiring participants to label something else leads to a decrement in performance on the primary task then verbal processes are likely important for success on that task. In order to ensure that decreased performance on the primary task does not merely result from limiting general cognitive resources a second condition is sometimes included (e.g., finger tapping; Baddeley, Chincotta, & Adlam, 2001). In this context finding a *selective* decrease in the verbal secondary task condition supports the claim that verbal processing is implicated in task performance. Using articulatory suppression, Baddeley et al. (2001) and others found increased difficulty in adults on task-switching paradigms (e.g., Emerson & Miyake, 2003; Goschke, 2000; Miyake, Emerson, Padilla, & Ahn, 2004; Saeki & Saito, 2004a; Saeki & Saito, 2004b) and on the Wisconsin Card Sort Test (WCST; e.g., Baldo et al., 2005; Dunbar & Sussman, 1995), both of which are used to measure cognitive flexibility.

The argument that cognitive flexibility may be verbally mediated is further supported by evidence of a unique relation between verbal abilities and cognitive flexibility among persons with Down syndrome (DS; Campbell et al., 2013) and those with Williams syndrome (Landry, Russo, Dawkins, Zelazo, & Burack, 2012), two populations with intellectual disability but with distinct verbal/nonverbal profiles. In both populations and across tasks, a unique relation with cognitive flexibility was found for verbal development but not for nonverbal development. This essential role of verbal development in cognitive flexibility across various populations is consistent with Yerys, Wolff, Moody, Pennington, and Hepburn's (2012) findings that children with ASD were less flexible than TD children on the Flexible Item Selection Task (FIST; Jacques & Zelazo, 2001; Jacques & Zelazo, 2005b), a paradigm commonly used to study cognitive flexibility (e.g., Blair, Granger, & Razza, 2005; Dick, 2014), and that the flexibility that was demonstrated was associated with verbal mental age. However, Yerys et al. did not consider relations with nonverbal mental age, so whether verbal or nonverbal abilities uniquely predict flexibility in this population above and beyond their shared variance remains to be determined.

Despite compelling evidence that verbal abilities support the development and maintenance of cognitive flexibility in other populations, verbal abilities may not directly support cognitive flexibility in ASD. One, individuals with ASD rely on visual abilities more than verbal abilities in solving other complex tasks (e.g., Russo, Mottron, Burack, & Jemel, 2012; Soulieres et al., 2009; see Kunda & Goel, 2011, for a review). Two, verbal IQ predicted non-perseverative errors on the WCST committed by individuals with ASD, but not perseverative errors, which were predicted by nonverbal IQ and chronological age (CA; Landry & Al-Taie, 2016). Three, children with ASD do not appear to show the verbal-stimuli advantage on a working memory task as seen among TD children (Joseph, McGrath, & Tager-Flusberg, 2005). Four, children with ASD do not appear to show the decrease in task-switching performance during articulatory suppression that is typically displayed by TD children (see Williams, Peng, & Wallace, 2016, for a recent review). Five, planning performance has been found to be significantly correlated with nonverbal abilities as assessed by the block design subtest of the WAIS for persons with ASD but not their TD peers (Williams, Bowler, & Jarrold, 2012). These disparate pieces of evidence suggest that ASD participants may not ordinarily use verbal mediation on cognitive tasks as evidenced by the lack of articulatory suppression effects.

However, as noted by Geurts et al. (2009), children with ASD paradoxically often succeed on measures of cognitive flexibility despite noted behavioral inflexibility and relative weaknesses in verbal abilities. Perhaps individuals with ASD, who disproportionately show uneven verbal and nonverbal skills (Akbar, Loomis, & Paul, 2013; Ankenman, Elgin, Sullivan, Vincent, & Bernier, 2014; Happé, 1994; Joseph, Tager-Flusberg, & Lord, 2002; Kuriakose, 2013; Lincoln, Allen, & Kilman, 1995; Lincoln, Courchesne, Allen, Hanson, & Ene, 1998), solve tasks of cognitive flexibility by capitalizing instead on their relatively strong nonverbal abilities. In other words, they may compensate for their lack of verbal mediation by engaging other nonverbal processes.

In an attempt to understand potential contributors to cognitive flexibility in ASD, we examined performance of a heterogeneous group of participants with ASD on the FIST (Jacques & Zelazo, 2001; Jacques & Zelazo, 2005b) in relation to both verbal and nonverbal mental age. Like Yerys et al. (2012), we selected the FIST as our measure of cognitive flexibility since it is thought to place fewer demands on other cognitive processes, including working memory or learning from feedback, than other measures (Geurts et al., 2009; Jacques & Zelazo, 2001; Jacques & Zelazo, 2005b), such as the WCST (Gioia & Isquith, 2004), while providing a broader developmental scale of performance than other measures, such as the Dimensional Change Card Sort (Zelazo, 2006). On the FIST, children are shown three images (e.g., a large yellow shoe, a large