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Qualitative analyses of verbal fluency in adolescents and young adults with high-functioning autism spectrum disorder

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ABSTRACT

Systematic qualitative analyses of verbal fluency might aid our understanding of the characteristic cognitive processes in individuals with autism spectrum disorder (ASD). In this study, we compared through qualitative and quantitative analyses performance on letter fluency (LF), category fluency (CF), and action fluency (AF) in adolescents and young adults with high-functioning autism spectrum disorders (HFASD) with that of an age-, gender-, and IQ-matched control group. Quantitative analyses revealed significantly fewer correct responses on category and action fluency and significantly more intrusions on category fluency in individuals with HFASD than in control participants. Qualitative analyses revealed significantly fewer semantic clusters and significantly more phonemic clusters during action fluency in individuals with HFASD compared to control participants. With respect to action fluency, the number of correct responses and clusters were related to verbal IQ for individuals with HFASD but not for control participants. We discuss these results in terms of abnormalities in semantic/phonemic strategy choice, cognitive flexibility, and generativity in ASD.

1. Introduction

Autism spectrum disorder (ASD) is one of the neurodevelopmental disorders characterized by social and communication deficits and repetitive/stereotyped behavior. Evidence suggests that higher-order brain dysfunctions, including executive dysfunction, in ASD might be attributable to atypical neural development of the frontal lobe, possibly starting early in life and persisting over a long period (Ben Bashat et al., 2007; Carper & Courchesne, 2000; Courchesne, Campbell, & Solso, 2011; Hazlett et al., 2011; Noriuchi et al., 2010). Executive dysfunction in ASD involves aspects of planning and monitoring, the inhibition of prepotent behaviors (Hughes, Russell, & Robbins, 1994; Ozonoff, Pennington, & Rogers, 1991; Prior & Hoffmann, 1990), cognitive flexibility (Hughes et al., 1994; Ozonoff & Jensen, 1999; Ozonoff et al., 1991), and generativity (Lopez, Lincoln, Ozonoff, & Lai, 2005; Turner, 1997) among other functions.

Verbal fluency tests are widely used to assess executive function, especially cognitive flexibility and generativity (Tröster et al., 1998; Troyer, Moscovitch, & Winocur, 1997; Troyer, Moscovitch, Winocur, Alexander, & Stuss, 1998). The three kinds of verbal fluency tests are letter fluency (LF), category fluency (CF), and action fluency (AF). LF requires a search for words beginning with a particular letter to inhibit recall by semantic association (Crowford, Parker, & McKinlay, 1992); CF requires a search for words belonging to a particular semantic category; and AF requires generation of verbs in the

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absence of prompting stimuli (Piatt, Fields, Paolo, Koller, & Tröster, 1999). The latter test is considered more sensitive to executive function than the LF or CF tests (Woods et al., 2005; Woods, Weinborn, Posada, & O'Grady, 2007).

Previous research on verbal fluency in individuals with autism appears somewhat inconsistent. As for LF, some studies have reported that children and adults with ASD can produce as many words as verbal ability-matched controls using the letters F, A, and S (Barnard, Muldoon, Hasan, O'Brien, & Stewart, 2008; Minshew, Goldstein, Muenz, & Payton, 1992; Minshew, Goldstein, & Siegel, 1995; Rumsey & Hamburger, 1988). However, Spek, Schatorjé, Scholte, and van Berckelaer-Onnes (2009) have found that adults with high-functioning autism spectrum disorder (HFASD) performed worse than controls using the letter M. As for CF, some studies demonstrated that children and adults with ASD generated fewer correct responses than verbal ability-matched controls (Dichter, Lam, Turner-Brown, Holtzclaw, & Bodfish, 2009; Minshew et al., 1992; Spek et al., 2009), whereas other studies reported that they produced as many words as their controls using the "animal" category (Dunn, Gomes, & Sebastian, 1996; Minshew et al., 1995). However, Dunn et al. (1996) found that children with ASD produced fewer prototypical nouns than did control children. To our knowledge, there have been no studies reporting on ASD and AF.

To explore the cognitive processes underlying verbal fluency, Troyer et al. (1997) focused on clustering and switching. They defined clustering as the ability to generate words in a certain semantic or phonemic subcategory, which is considered more efficient for word generation than a disorganized search. They defined switching as the ability to shift from one cluster to another to avoid slowing down (Troyer et al., 1997). Clustering in terms of cluster size (i.e., the number of words within one cluster) reflects word storage (Abwender, Swan, Bowerman, & Connolly, 2001; Raskin, Sliwinski, & Borod, 1992; Troyer et al., 1997). Switching in terms of the number of clusters reflects cognitive flexibility (Abwender et al., 2001; Tröster et al., 1998; Troyer et al., 1997, 1998). In a study on LF and CF in children with HFASD, Turner (1999) suggested that the poorer performance of these children relative to control children might be attributable to a failure to use phonemic or semantic strategies to improve performance, rather than an inability to produce multiple responses per se. On the other hand, Spek et al. (2009) found that adults with HFASD exhibited significantly impaired performance on both LF and CF tasks. They reasoned that because these adults and their verbal ability-matched controls exhibited similar frequency of clustering or switching during LF and CF, their poorer performance on verbal fluency tests was not attributed to insufficient use of strategies or to difficulties switching between strategies, but rather to the relatively low processing speed found in adults with HFASD.

Currently, insufficient evidence exists to draw any conclusions about the utility of verbal fluency tests for individuals with ASD. However, systematic qualitative analyses of verbal fluency might contribute to our current understanding of the characteristic cognitive processes in individuals with ASD. Therefore, the aim of this study was to determine whether adolescents and young adults with HFASD exhibit impaired performance on the LF, CF, and AF verbal fluency tests, and if they do, to determine which test is more sensitive and whether the atypical cognitive strategies identified, such as clustering or switching, are associated with such impairments in these individuals. Here we conducted LF, CF, and AF tests, determined cluster-related indices, and compared conventional quantitative scores (e.g., number of total responses or errors) between adolescents and young adults with HFASD and control participants matched by gender, age, verbal IQ (VIQ), performance IQ (PIQ), and full scale IQ. We also examined the relationship between verbal fluency performance and age or IQ to explore possible developmental plasticity and compensation.

2. Material and methods

2.1. Participants

We recruited participants from psychiatric clinics and local schools. Both authors, who are experienced child psychiatrists, diagnosed participants in the HFASD group ($n = 30$; 8 with autistic disorder, 14 with Asperger's disorder, 8 with pervasive developmental disorder-not otherwise specified) based on clinical information according to the DSM-IV-TR (American Psychiatric Association, 2000). We confirmed that control participants ($n = 18$) had no history of head injury, neurological disorder, or severe psychiatric disorder, although two control participants were diagnosed with social anxiety disorder, two with generalized anxiety disorder, one with an adjustment disorder, and one with a manic episode that had occurred 3 years earlier but was in remission at the time of participation. Diagnostic agreement was obtained for all participants ($n = 48$).

Some participants were receiving medication, although the amount was small (14/30 participants with HFASD, specifically 4 atypical antipsychotics, 6 selective serotonin reuptake inhibitors, 4 mood stabilizers; and 10/18 control participants, specifically 2 atypical antipsychotics, 5 selective serotonin reuptake inhibitors, and 3 mood stabilizers). The proportion of participants taking medication did not significantly differ between the two groups (χ^2 test). The mental conditions of all participants were stable at the time of participation. All participants had sufficient verbal and cognitive abilities as measured by the Japanese version of the WAIS-R, with no significant group differences (full scale IQ: $t = .59$; VIQ: $t = .40$; PIQ: $t = .74$). The gender ratio (5:1) was identical and mean chronological age (CA) did not significantly differ between groups ($t = 1.23$) (Table 1).

The protocol of this study was approved by the Ethics Committee of the National Center of Neurology and Psychiatry, Japan and was performed in accordance with the Helsinki Declaration of 1975, as revised in 2000. Informed consent was obtained from the parent of each minor participant and each adult participant.