



Unsupervised Categorization in a sample of children with autism spectrum disorders

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ABSTRACT

Studies of supervised Categorization have demonstrated limited Categorization performance in participants with autism spectrum disorders (ASD), however little research has been conducted regarding unsupervised Categorization in this population. This study explored unsupervised Categorization using two stimulus sets that differed in their difficulty of Categorization according to the simplicity model. ASD participants displayed a greater tendency to categorise according to one dimension as compared with mental-aged matched participants in the easily categorised sets, but both ASD and Control groups became more prone to one-dimensional sorting as the difficulty of the Categorization task increased. These results are discussed in terms of the processes underlying over-selective responding.

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The ability to categorise items can be regarded as fundamental to many aspects of functioning, and disruptions to this ability may have profound impacts on a person's ability to understand their environment (e.g., Bott, Brock, Brockdorff, Boucher, & Lamberts, 2006; Demetras, Post, & Snow, 1986). Thus, it is important to investigate Categorization abilities across a variety of populations, including in individuals with autism spectrum disorders (ASD). There are many forms of Categorization behaviour, which can be based on quite different mechanisms and principles, and it is important to explore each of these in the context of ASD. For example, some Categorization may be achieved on the basis of learning which items belong to which categories (supervised Categorization), and some categories are the result of intuitive groupings of items (unsupervised Categorization). To date, there have been no investigations of the latter form of Categorization for individuals with ASD, and the primary aim the current report is to document these abilities in individuals with ASD over a variety of circumstances. To make clear, it is important to study Categorisation in this context (i.e., with an ASD population) because there are several quite different explanations which try to explain the cognitive deficits behind ASD (e.g., such as Dube et al., 1999, for attentional deficits or Leader, Loughnane, Mc Moreland, & Reed, 2009, for retrieval deficits). For this reason, Categorization offers a useful means to experimentally assess the ability of this population to perform decisions which have not previously been explored (i.e., unsupervised decisions), thus this has real world applications. To this end, these methods could further our understanding of these cognitive deficits, and potentially lead to more refined screening methods.

Supervised Categorization concerns learning pre-specified categories, where the experimenter determines which items belong to particular categories, and the participant must then learn to which category a new item belongs. In most cases, this is done by trial and error learning, with the participant receiving corrective feedback (e.g., Demetras, Post, & Snow, 1986). Reduced supervised Categorization ability has been noted in children with ASD (e.g., Klinger & Dawson, 2001). This is the difficulty in developing categories when feedback is given (i.e., supervised). In such a case, participants are given corrective

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feedback in terms of the item and its associated category label, which refers to the category to which it belongs. In this study, autistic people had greater difficulty (i.e., it took longer to learn the category labels) as compared with a control population. The study concluded by suggesting that greater over-selectivity in autism was responsible for the reduced ability to learn the category labels associations with the item structures. This over-selectivity was attributed to the cognitive deficits in the ability to learn the category structures, which supported the learning deficits theories.

Similarly, Bott et al. (2006) reported reduced Categorization ability in adults with ASD, even when they ensured that the participants attended to multiple dimensions when learning the category structure. In this study, adults with high-functioning ASD required more time to learn the category structures, and did not display high performance during generalisation. It could be noted that this process of trial and error Categorization learning is rather akin to the simple discrimination learning procedures used in over-selectivity procedures, in which individuals with ASD also display reduced ability to correctly identify all members of a reinforced complex stimulus (e.g., Leader et al., 2009).

In contrast to the work directed at exploring supervised Categorization, little research has been conducted into unsupervised Categorization in individuals with ASD. Unsupervised Categorization refers to the spontaneous Categorization of stimuli where no corrective feedback is given. Participants are given a range of stimuli, and then simply categorise them on the basis of what they feel to be most intuitive; thus, unsupervised Categorization deals with unlearned category coherence (Murphy & Medin, 1985). Thus, an unsupervised Categorization task directly explores intuitive Categorization of items comprising a number of dimensions to which attention must be paid (e.g., Pothos & Chater, 2002; Pothos et al., 2008). The simplicity model (e.g., Pothos & Chater, 2002), is one model of unsupervised Categorization, and assumes that a Categorization can simplify the description (via encoding information, in the simplest of ways) of the objects to be categorised. The prediction is that the greater the simplification, the more intuitive the category structure. In brief, a definition is provided for the information content of the uncategorised items, and for how a Categorization can reduce this information content. The model has been validated in terms of presenting groups of items to naïve participants (in control and dyslexic participants; Nikolopoulos & Pothos, 2009), and asking them to divide the items in a way that seems intuitive (Pothos, Perlman, et al., 2011; Pothos et al., 2008). Also, it is interesting to note that both supervised and unsupervised learning have shared properties, such as, it has been demonstrated that the most intuitive category structures in an unsupervised task are also the most easy to learn in a supervised learning task (Pothos, Edwards, & Perlman, 2011).

However, there have been no investigations of unsupervised Categorization in individuals with ASD, and exploration of these abilities would increase understanding of Categorization abilities for this population as well as the underlying deficits in the cognitive mechanisms of over-selectivity. Most theoretical views of ASD would predict (e.g., the attentional deficit theory, Dube et al., 1999; or encoding, Boucher & Warrington, 1976) that there would be a deficit in unsupervised Categorization. Such an assumption would lead to the hypothesis that, if attention (Dube et al., 1999; Lovaas, Schreibman, & Koegel, 1971), and encoding (Boucher & Warrington, 1976; Reed & Gibson, 2005), deficit views of ASD are correct, then those with ASD would not be able to attend or encode the multiple stimulus dimensions, and, therefore, would perform worse on a two-dimensional unsupervised Categorization task (i.e., there would be a greater number of one-dimensional sorts), compared to a Control group who could attend to both dimensions. Additionally, work from the over-selectivity field has also suggested that, as the task becomes harder, greater levels of over-selectivity would be noted (e.g., Reed & Gibson, 2005). Given this, more one-dimensional sorts would be expected for harder tasks than for easier tasks, and this would be expected to be seen in a more pronounced form in individuals with ASD.

1. Method

1.1. Participants

Twenty-two children (11 with ASD and 11 mental-aged matched typically developing children) were employed. All of these participants had verbal ability. The group with ASD was all diagnosed as having childhood autism by a paediatrician who was independent from the study. The diagnosis was made using a combination of DSM-IV criteria for these disorders and clinical judgment.

The participants with ASD were recruited through specialist educational provisions for young people with ASD, which were attached to mainstream provision, and from those mainstream educational settings for the Control group. Consent for participation was sought from the parents of the children, who completed an ABC questionnaire and returned it if they consented for their child to participate. Participants were not rewarded in monetary terms for participating in the research, and the study was fully approved by the Universities ethical board.

To gauge the approximate severity of the ASD in the sample, the ABC (Autism Behaviour Checklist) was employed (parent-rated). This was conducted for the ASD group only. The ABC measure showed that the mean (standard deviation) of the overall ABC score for this sample was 81.91 (33.33), indicating that this sample was of a higher than average autistic severity (the ABC has a cut off of 67 for probably autism).

The mental age of the group with ASD was matched to the chronological age of the Control group by use of the British Picture Vocabulary Scale (BPVS). The mean chronological age for ASD group was 10.71 (± 1.6 ; range = 8.1–13.6) years, but the mean verbal mental age of the group with ASD, measured by the BPVS, was 10.0 (± 2.23 ; range 7.4–13.8) years. The chronological

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