

Autistic Children have Difficulty Perceiving a Face as the Global Feature of a Compound Stimulus

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Autistic persons in adolescence or older are likely to have difficulty processing the global features of compound visual stimuli. In this study, a naming task using Navon-type compound stimuli was presented to three groups of Japanese children, namely, (1) six children with autism (6:0-10:9), (2) six children with Asperger's syndrome (6:4-11:4), and (3) six normal children as a control group (6:4-10:8), in order to determine whether autistic children demonstrate difficulty in processing the global features of compound visual stimuli. Our findings were as follows. Normal children demonstrated global precedence when presented with all types of compound stimuli. Autistic children exhibited a tendency to perceive global stimuli preferentially when presented with compound stimuli containing simple geometrical forms or numerals. However, in the case of a compound stimulus composed of numerals arranged to form a human face, autistic children tended to experience difficulty in perceiving the face on a global level. In comparison, children with Asperger's syndrome made reference to and excessively elaborated on both local and global features, but showed no difficulty in facial perception.

Key words: autism, Asperger's syndrome, Navon-type compound stimuli, facial perception

Introduction

Humans, by virtue of their nature as primates, are believed to have a tendency to respond sensitively to faces (Gross, 2002). Individuals can normally discern a face when they see an appropriate stimulus configuration in the environment, even if it does not actually represent the face of a person (Figure 1).

Autistic persons, however, are reported to have difficulty with a number of aspects of facial perception, including recognition of facial expressions, facial identification, and matching facial expressions among different persons (Baron-Cohen, Wheelwright, Hill, Raste, and Plumb, 2001; Lahaie, Mottron, Arguin, Berthiaume, Jemrl, and Saumier, 2006). In this study, we aimed to prove that autistic children have a fundamental difficulty in recognizing any object as a face.

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Figure 1. Humans can easily identify faces in stimulus configurations in the environment.

It has also been reported that autistic persons exhibit unique cognitive tendencies with respect to stimuli other than faces. Navon (1977) reported in his groundbreaking paper titled *Forest before Trees* that in general, individuals tend to identify global aspects more readily when they are presented with compound visual stimuli, based on analysis of reaction times. In contrast, a case study by Mottron & Belleville (1993) found that an autistic adult did not show global precedence in processing the tasks associated with Navon-type compound stimuli. If this finding is generalizable, it may be hypothesized that autistic children have a tendency to respond to the local features of compound stimuli. For example, when an autistic child is presented with a large Arabic figure “three” composed of multiple instances of the small Arabic figure “four” as shown in Figure 3-b, the child will identify the stimulus as “four.” In other words, this exemplifies “trees (Arabic figure ‘four’) before forest (Arabic figure ‘three’),” or local precedence, as opposed to “Forest before trees,” or global precedence.

Furthermore, based on the above reports that autistic persons have difficulty recognizing various aspects of a face and that they do not show bias towards the global features of compound stimuli, we made a second hypothesis as follows: when shown a compound stimulus consisting of numerals as the local features and a face as the global feature (Figure 4), normal children will identify the stimulus as a face while autistic children will have difficulty perceiving the face.

In order to verify these hypotheses, we presented compound stimuli composed of simple geometrical forms, numerals, and a face to autistic children as well as normal children in the same age bracket as a control group, and compared their reactions.

We expected the normal children to demonstrate global precedence while the autistic children would respond to the local aspects of the compound stimuli. If the global feature was a face, the normal children would react to it more readily than the autistic children.

In addition, children with Asperger’s syndrome in the same age bracket were included in the experiments for comparison with the autistic children.

Methods

Stimuli

We prepared five hierarchical compound stimuli. All were incongruent on the global and local levels. Figures 2-a and 2-b depict large geometrical forms made up of multiple small geometrical forms of different kinds (figure-figure stimuli), namely, a large triangle made up of 21 small circles and a large circle composed of 20 small triangles. Figures 3-a and 3-b shows a large-sized numeral made up of many small-sized numerals (numeral-numeral stimuli), namely, a large Arabic “two” composed of 17 small Arabic “threes” and a large Arabic “three” composed of 19 small Arabic “fours.” Figure 4 illustrates a large face composed of multiple Arabic figure “fives”. The small geometrical forms and the small-sized numerals are no larger than 5 mm×5mm, while all of the global patterns are no larger than 75 mm×75 mm. These compound stimuli were printed on sheets of B5 paper (185 mm × 257 mm).

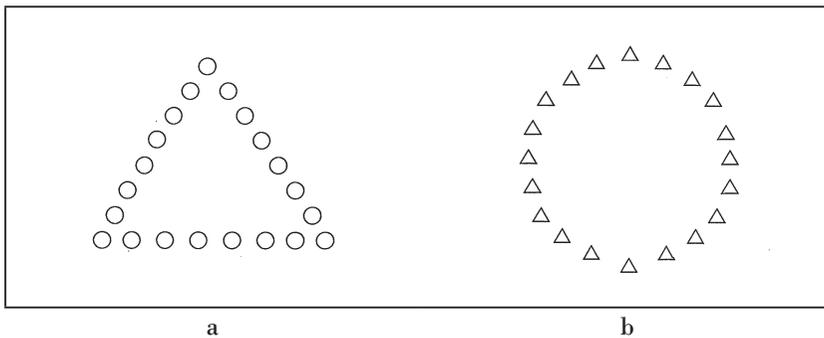


Figure 2-a and -b. Hierarchical compound stimuli consisting of simple geometrical forms

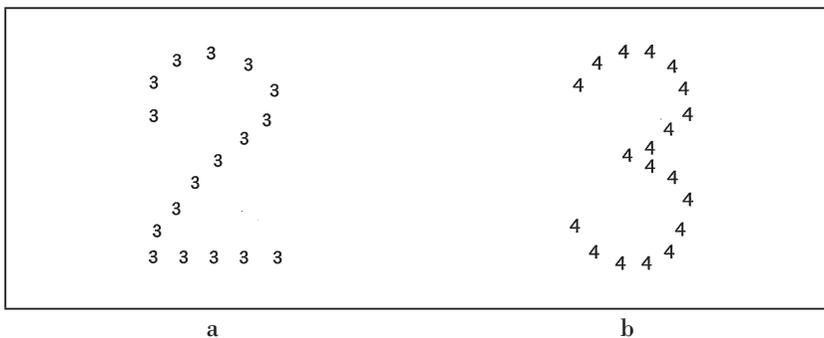


Figure 3-a and -b. Hierarchical compound stimuli consisting of large-sized numerals composed of multiple small-sized numerals

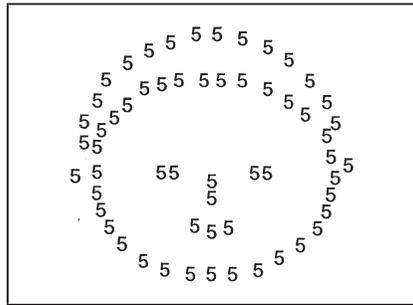


Figure 4. A hierarchical compound stimulus containing a large face composed of multiple small-sized Arabic figure “fives”

Participants

Participants consisted of three groups of Japanese children: (1) six children with autism (6:0-10:9), (2) six children with Asperger’s syndrome (6:4-11:4), and (3) six normal children as the control group (6:4-10:8). The children in groups (1) and (2) were elementary school pupils who visited a child consultation center. These children underwent developmental tests and interviews conducted by a clinical psychologist. They were then examined and diagnosed with autism or Asperger’s syndrome by psychiatrists based on ICD-10 diagnostic criteria. The naming task was administered by the clinical psychologist following parental consent. The normal children were chosen by an elementary school teacher with experience teaching pupils with developmental disorders, who determined them to be free from any developmental disorders. All participants were boys except for one girl with Asperger’s syndrome.

Procedure

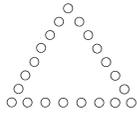
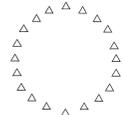
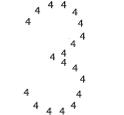
The naming task was implemented as follows. Children were presented with five stimulus cards one-by-one and asked, “What is this?” For all participants, the five stimulus cards were presented in order from Figure 2 to 3 to 4. After their first response, additional inquiries were made regarding their perception of the drawings to confirm whether their response was global or local. After all the naming tasks were completed, we showed one-by-one the small-sized numerals and geometric forms used to form the larger patterns and asked the children to name them. They were able to identify them, indicating that their size was not an issue.

Results

The different groups of children demonstrated different characteristics. All of the normal children in the control group demonstrated a global response to all five stimuli (Table 1). All of them reported that Figure 4 looked like a face (N=4) or a man (N=2).

All of the autistic children demonstrated a global response to the two stimuli composed of figures and the two composed of numerals. However, regarding Figure 4, in which small Arabic figure “fives” represented a face on a global level, only one child reported that it looked like “a head”. Of the remaining five, two responded globally though they stated it looked like the number “six”. One demonstrated a local response, saying it looked like the number “five”. Finally, two children reported that they did not know what the figure resembled. Thus, five of the six children with autism did not identify a face when they saw Figure 4.

Table 1. Children’s responses to compound stimuli: Children with autism, Asperger’s syndrome, and children in a control group

Groups	Stimuli				
					
	Figure 2-a	Figure 2-b	Figure 3-a	Figure 3-b	Figure 4
Autism (N=6)	[Global]= 6 (“triangle”=6)	[Global]= 6 (“circle”=6)	[Global]= 6 (“two”= 6)	[Global]= 6 (“three”=6)	[Global]= 3 (“head”= 1, * “six” =2) [Local]=1 (“five”=1) [Don’t know]=2
Asperger’s syndrome (N=6)	[Global]= 6 (“triangle”=4, “a triangle consisting of 20 circles” =1, “a rice ball”=1)	[Global]= 6 (“circle”=4, “a circle consisting of 21 triangles” =1, “a maned lion”=1)	[Global]= 6 (“two”= 1, “figure two”= 2, “two, three”= 1, “two consisting of three” =1 , “Arabic figure two consisting of 17 Arabic figure three” =1)	[Global]= 6 (“three”= 1, “figure three”= 2, “three, four”= 1, “three consisting of four” =1 , “Arabic figure three consisting of 19 Arabic figure four” =1)	[Global]= 6 (“face”=1, “human face”=2 “face, five”=1, “a human face consisting of figure five=1”, “a face consisting of 58 Arabic figure” =1)
Control (N=6)	[Global]= 6 (“triangle”=5, “triangle consisting of circle”=1)	[Global]= 6 (“circle”=5, “circle consisting of triangle” =1)	[Global]= 6 (“two”= 5, “two consisting of triangle” =1)	[Global]= 6 (“three”= 5, “three consisting of four” =1)	[Global]= 6 (“face”=3, “man”=2, “human face”=1)

* “six”: Children reported that Figure 4 looked like a large “6”.

Though their responses differed from the children in the control group and those with autism, all children with Asperger's syndrome demonstrated a global response to all stimuli. Two of them answered "figure two" instead of just "two," "figure three" instead of just "three," and "human face" instead of just "face." One child with Asperger's syndrome gave overly elaborate responses to all stimuli, as follows: "a triangle composed of 21 circles" for Figure 2-a, "a circle formed by gathering 20 triangles" for Figure 2-b, "Arabic figure two formed by gathering 17 Arabic figure three" for Figure 3-a, "Arabic figure three formed by gathering 19 Arabic figure four" for Figure 3-b, and "a face formed by gathering 58 Arabic figure five." (The entire calculation was correct.) Finally, one child gave both global and local responses, saying "two and three" for Figure 3-a, "three and four" for Figure 3-b, and "a face and five" for Figure 4. Thus, one characteristic of the children with Asperger's syndrome was significant elaboration on an object. The ratios of children demonstrating some degree of excessive elaboration in describing the five stimuli were 5/6 children with Asperger's syndrome, 0/6 children with autism, and 2/6 normal children in the control group, resulting in significant differences among the three groups (Fisher's exact test, $p=0.018$).

In conclusion, while all normal children in the control group and children with Asperger's syndrome could identify a face or a man when they were presented with Figure 4, only one of six autistic children could do so. Fisher's exact test demonstrated a significant difference in these ratios ($p=0.002$).

Discussion

Most previous studies concerning facial recognition by autistic persons, including children, have focused on expression recognition or matching facial expressions among different persons. Little attention has been paid to whether these individuals can identify a face at all when they see an object or pattern resembling a face. In this study we succeeded in clarifying the subtle difference in their facial recognition ability by utilizing compound visual stimuli. We found that autistic children had difficulty in recognizing a face when they were presented with a compound stimulus consisting of a large face composed of multiple small-sized numerals, as in Figure 4.

Nonetheless, we cannot conclude that autistic children show bias toward local precedence. Throughout the presentation of all types of stimuli, only one autistic child demonstrated local precedence instead of global precedence by answering "five" instead of identifying a face when presented with Figure 4. However, our previous findings indicated that younger autistic children (3:7-5:10) were more likely to demonstrate a local response when presented with compound stimuli consisting of a combination of figures (figure-figure) or numerals (numeral-numeral) as well as a facial stimulus (Nihei & Nihei, 2002). The set of stimuli introduced in this study may be used as a supplementary tool in diagnosis of autistic children and children with Asperger's syndrome, especially in younger age brackets.

It is controversial whether the diagnoses of autism and Asperger's syndrome should

be classified into different categories. DSM-5 (APA, 2013), unlike the previous version, has integrated these two types of disorders into one category “Autism Spectrum Disorder”. However, in a paper titled “Asperger’s disorder will be back” , Tsai (2013) writes that the two disorders should be distinguished, based on a meta-analysis of 128 studies comparing their characteristics.

Our own previous study (Nihei & Nihei, 2008), which was included in Tsai’s meta-analysis, similarly found that some of the Rorschach test responses of persons with these disorders differ significantly. Furthermore, in the responses to compound visual stimuli used in this study, the two disorders demonstrated very different characteristics. Thus, we believe that future studies on the differences and similarities between autism and Asperger’s syndrome are warranted.

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