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Published in:
Brain and Cognition

Publication date:
2003

ACADEMIC PRESS

Available online at www.sciencedirect.com
SCIENCE DIRECT®

Brain and Cognition 52 (2003) 285–294

Brain and Cognition

www.elsevier.com/locate/b&c

Face processing in adolescents with autistic disorder: The inversion and composite effects

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Accepted 19 February 2003

Abstract

Two experiments with upright and inverted face and object images were carried out to investigate whether face processing in autism is more feature-based than in individuals with typical development. Participants were 17 high-ability adolescents with autistic disorder (16–24 years), 24 typically developing children (9–10 years) and 16 adults (18–33 years). In Experiment 1, a normal inversion effect was found for the adolescents with autism in a standard face recognition paradigm with reduced memory demands, except for a subgroup with low social intelligence who were not better in recognizing upright relative to inverted photographs of faces. In Experiment 2, the group with autism did not show the composite effect like the adult group did: they recognized face halves as well in aligned composite faces as in non-aligned composite faces. The results on the inversion task suggest that most adolescents with autism form a normal configuration-based face representation, but the absence of the composite effect indicates that they are less prone to use the contextual information of the face in a visual-search task.

Keywords: Autism; Face perception; Inversion effect; Composite effect

1. Introduction

One of the most intriguing findings in the study of face perception in people with autism is their relatively good performance on tasks with inverted photographs of faces (Hobson, Ouston, & Lee, 1988; Langdell, 1978; Tantam, Monagham, Nicholson, & Stirling, 1989). However, comparison and interpretation of these findings is rather complicated, because different tasks were used. In the study of Langdell (1978), children with autism (mean age 14.1 years) were better than a control group in recognizing peers from inverted photographs, although also for the children with autism recognition in the inverted condition was more difficult than in the upright condition. Hobson et al. (1988) found that adolescents with autism were superior to controls in both expression and identity matching when photographs were presented upside-down. The children with autism (mean age 12.1 years) in the Tantam et al. (1989) study were as good as controls in labeling inverted photographs of expressions, but they were less successful than controls at labeling upright facial expressions.

In the numerous studies with adults and children with typical development, the so-called 'inversion effect' is defined as the difference in performance between upright and inverted photographs of faces (see Farah, Tanaka, & Drain, 1995; Valentine, 1988, for reviews). In most experiments, the inversion effect on faces is compared to effects of inversion on other classes of stimuli. It appears that faces, compared to other stimuli, are disproportionately sensitive to inversion (e.g., Dallett, Wilcox, & D'Andrea, 1968; Yin, 1969). It would be interesting, in view of the previous findings with children and adolescents with autism, to examine whether people with autism show a smaller inversion effect than controls in this frequently used paradigm. The use of such a paradigm facilitates the application of current theories of face

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doi:10.1016/S0278-2626(03)00042-3

processing on task performance of people with autism. This may help us understand a little more about the way they perceive and process faces.

Diamond and Carey (1986) suggest that there are some critical conditions that have to be met for a large inversion effect. In the first place, the stimulus must be member of a class with a shared configuration. Secondly, these members should be identifiable on the basis of second-order relational features (distinctive relations among the elements of this configuration). And finally, the individuals must be experts on the stimulus class. They found that these criteria were met with face stimuli, but also when dog experts had to recognize inverted photographs of dogs (Diamond & Carey, 1986). For faces this expertise is acquired from infancy on and reaches its adult level in puberty. For other stimulus classes like birds, dogs etc. expertise can still be acquired in adulthood (Diamond & Carey, 1986; Gauthier & Tarr, 1997). This notion of expertise dependency of configural face recognition was supported by studies of the development of face processing. Younger children process and recognize a face by attending to a greater degree to parts and their ability to attend to the overall configuration is not fully developed till about age 12 (Carey, Diamond, & Woods, 1980). The dependence of configural encoding on age is explained by the hypothesis of norm-based coding of faces, which proposes that the facial relations may be stored as a set of norms that represents the central tendency of faces (Rhodes & McLean, 1990). As the representation of the norm gets more completely specified with experience, face encoding becomes more efficient (Ellis, 1992). The relational features are less accessible in the inverted mode, resulting in different, more feature-based encoding of inverted faces.

Carey and Diamond (1977) and Carey et al. (1980) found exactly the same pattern of results in a study with children as Tantam et al. (1989) found with people with autism; upside-down faces were recognized as well as upright faces. Flin (1985) however, showed that this was due to floor effects. When she reduced task demands by decreasing the number of test items and prolonging the exposure duration of the inspection stimuli, she found that even 7-year-olds were more accurate on upright faces than on inverted faces. Furthermore, she found that recognition of inverted faces improved between 7 and 16 years of age, but not as much as the recognition of upright faces. This confirms that experience with the stimulus is important for the inversion effect.

Two experiments were carried out in the present study. In Experiment 1, the hypothesis was that floor effects might have influenced the inversion effect found by Tantam et al. (1989) and that people with autism will show an inversion effect under different task demands. To reduce the likelihood of floor effects in our study, the inversion effect of faces in high-functioning adolescents with autism was explored with a relatively easy recognition task. A two-alternative forced-choice test for recognition was presented directly after each inspection item, instead of first learning an inspection list and then testing. This paradigm reduces memory demands, and therefore adolescents with autism and children have a better chance of showing effects. If adolescents with autism still did not show a decline in performance on inverted faces and/or a higher recognition accuracy on inverted faces than typically developed adults or children, the claim that people with autism do not show an inversion effect would receive stronger support. In the second experiment, a multiple choice version of the composite task developed by Young, Hellawell, and Hay (1987) was administered to study in more detail the processing style of people with autism. In this task, top and bottom halves of different faces are fused to form a new facial configuration. In typically developed adults and children, recognition of the upper face half is more difficult when it is aligned with the bottom half, thereby forming a new facial configuration, then when the face halves are not aligned. This 'composite effect' is only found in the upright orientation. It is hypothesized that if people with autism have a more feature-based instead of configuration-based processing style for faces, they will not show the composite effect.

2. Experiment 1: The inversion task

2.1. Method

2.1.1. Participants

The participants were 17 adolescents with autism, 24 typically developing children, and 16 typically developed adults. The children (12 males and 12 females) were 9 and 10 years old. They attended primary school in Tilburg. The adults (8 males and 8 females; mean age 23;1 years) were undergraduate students at Tilburg University.

The adolescents with autism (13 males and 4 females) were drawn from an institute for high-functioning adolescents with autism, the Dr. Leo Kannerhuis in Oosterbeek. The age range was 16–24 years (mean 19;5 years; SD 2;2 years). They satisfied the diagnostic criteria for the autistic disorder according to DSM-IV (1994). Only individuals with a total IQ score in the normal range (above 85) were included to ensure that they were able to understand the test instructions, and that performance was specific to autism rather than mental retardation. Verbal IQ (mean 90,0; SD 11,6) was prorated from Vocabulary and Similarities of the WAIS-R. Visuoperceptual IQ (mean 115,6; SD 18,5) was prorated from Block Design of the WAIS-R and Form Board of the GIT, a Dutch test asking the participant to draw lines showing how pieces fit into outline (similar to Visualization 1 in the manual kit of factor-referenced cognitive tests: Ekstrom, French, & Harman, 1976).

Social intelligence (mean 92,9; SD 17,1) was assessed with two tests. WAIS-Picture Arrangement asks participants to put a series of pictures in the right order so that they make a sensible story. Sipps, Berry, and Lynch (1987) found substantial evidence that supports the use of Picture Arrangement as a measure of social intelligence distinct from general intelligence as measured by WAIS Vocabulary. In correlational analyses Picture Arrangement loads most heavily on the factor referred to as social understanding (Berger et al., 1993; Lincoln, Courchesne, Kilman, Elmasian, & Allen, 1988; Muris et al., 1999). The Social Interpretation Test, SIT (Berger et al., 1993; Muris et al., 1999), consists of a picture, depicting a snapshot of daily life: A slight collision without people being wounded, people discussing it, and people apparently not at all bothered about it. The instruction consists of a standard number of open questions, such as: "Tell me something about it." "Do you think there is something striking or strange in the picture?" "What have these people got to do with it?" A results table has been developed for the purpose of numeric scoring. By means of an iterative cluster analysis a cluster was identified consisting of 24 categorical statements. The SIT scores range from *none of the statements were mentioned* (0) to *all the statements were mentioned* (24). The SIT has proved its reliability and factorial and construct validity as a measure of social intelligence (Evers, van Vliet-Mulder, & ter Laak, 1992). Social IQ was prorated from Picture Arrangement and SIT by calculating age weighted percentiles and corresponding IQ equivalents on the basis of the index norms given in both test manuals. Higher social IQ's reflected greater ability to interpret social situations.

Social IQ was positively correlated with verbal IQ ($r = .49$, $p < .05$). No other correlations were significant.

2.1.2. Stimuli

Forty-two adult faces (26 females and 16 males) and 32 pairs of shoes were photographed with a Canon Still Video Camera RC-560 on a Video Floppy Disc VF-50, in frontal and 3/4 orientation. These photographs were then prepared as greyscale pictures with an image processing and production program (Aldus PhotoStyler) for presentation on a monitor. For every trial, 1 photograph in frontal view was used as target stimulus, and 2 photographs in 3/4 view for test stimuli. Pairs of faces were put together on the basis of comparable hair style. The stimuli were presented in upright and in inverted orientation.

2.1.3. Procedure

Pilot studies revealed that most of the children performed at chance level when inspection time of the first stimulus (1 s) and the time out period (3 s) were the same as for adults. An inspection time of 3 s and a time out period of 5 s proved to be more appropriate. Because we learned from comparable tasks that the adolescents with autism perform at about the same level as 10-year-old children, these changes were made for the adolescents with autism as well.

Adult participants were tested in a sound-attenuated test cabin in the laboratory. Stimuli were presented on a monitor at a distance of 1.5 m. Before starting the experiment, the participants read the instructions for the task, and then were given a short training with 8 (4 upright and 4 inverted) randomized test trials.

Adolescents with autism and children were tested in a quiet room at the institute or school. The experimenter was in the same room as the participant during the entire experiment. Instructions were given both verbally and visually, with the help of photographs of faces. Then 8 training trails were administered on the computer. The above chance performance on these trails indicated that the instructions were understood.

Following the training block, every subject completed 4 experimental blocks of randomized trials. One condition was tested in every block: face/upright (21 trials), face/inverted (21 trials), shoe/upright (16 trials), and shoe/inverted (16 trials). The order was counterbalanced within each group. The same test pairs were used in the upright and in the inverted condition, but the photographs were reversed in half of the trials.

Five hundred milliseconds after an auditory warning signal, the first stimulus, the target photograph in frontal view, was shown. After a 2-second interval, the second stimulus, consisting of 2 photographs in 3/4 view labeled "A" and "B," was shown. Participants were instructed to indicate as rapidly as possible which photograph depicted the same face or shoe as in stimulus 1, by pressing one of the two response buttons (also labeled "A" and "B"). The stimuli disappeared when a response was given or when the time out period was exceeded. The intertrial interval was 3 s.

2.2. Results

Results were analyzed for correct responses (Fig. 1a) and for RT of correct responses (Fig. 1b). Individuals with a z-score below 1.65 (60% correct) were considered to respond at chance level and were excluded from analyses. One male participant with autism was excluded for this reason.

Because the forced-choice recognition task was somewhat different from the standard inversion paradigm, the first analysis served to replicate the selective inversion effect for faces in normal adults, using repeated measures ANOVA with Orientation (upright versus inverted) and Type of Stimulus (face versus shoe) as within-subject factors. Post hoc paired-samples t tests were used to explore significant interactions. Then, using the same

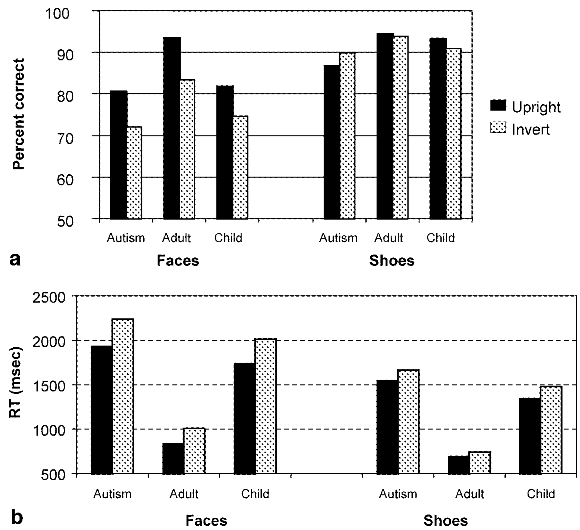


Fig. 1. Experiment 1: Inversion task. (a) Mean percentage correct scores of the groups of adolescents with autism and adults and children with typical development. (b) Mean RT scores of the groups of adolescents with autism and adults and children with typical development.

statistical analyses, the results of the children and the adolescents with autism were analyzed separately.

2.2.1. Adults

The selective inversion effect for faces (interaction Orientation × Type of Stimulus) was found in the adult group, both in accuracy [$F(1,15) = 18.20$, $p < .001$] and in RTs [$F(1,15) = 5.26$, $p < .05$]. Upright faces were recognized more accurate [$t(15) = 4.98$, $p < .001$] and faster [$t(15) = 3.29$, $p < .005$] than inverted faces, while there were no differences in accuracy [$t(15) = 0.62$, n.s.] and RT [$t(15) = 1.83$, n.s.] between upright and inverted shoes.

2.2.2. Children

For children, the Orientation × Type of Stimulus interaction was only significant in the accuracy data [$F(1,23) = 4.52$, $p < .05$] and not in RTs [$F(1,23) = 3.29$, n.s.]. Faces were recognized better in the upright than in the inverted mode [$t(23) = 4.34$, $p < .001$], while shoes were not recognized better upright [$t(23) = 1.30$, n.s.]. Both main effects in the RTs were highly significant for children: faces were recognized faster than shoes [$F(1,23) = 100.19$, $p < .001$] and upright stimuli were recognized faster than inverted stimuli [$F(1,23) = 63.18$, $p < .001$].

2.2.3. Adolescents with autism

In this relatively easy forced-choice recognition test, adolescents with autism also showed the face inversion effect like the adults and children; the interaction Orientation × Type of Stimulus was significant both in accurateness [$F(1,15) = 12.00$, $p < .005$] and in RTs [$F(1,15) = 4.80$, $p < .05$]. Faces were recognized better [$t(15) = 2.86$, $p < .05$] and faster [$t(15) = 3.57$, $p < .01$] when presented upright, while performance on shoes was not sensitive to orientation [accuracy: $t(15) = 1.14$, n.s; RT: $t(15) = 2.04$, n.s.].

Significant correlations of social IQ on accuracy with the upright condition ($r = .70$, $p < .005$) but not with the inverted condition ($r = .34$, n.s.) suggest that individuals with autism with a higher social IQ were specifically more accurate in recognizing upright stimuli.

2.3. Discussion

The first experiment was conducted to determine whether the previous findings that people with autism show no inversion effect for faces (Hobson et al., 1988; Langdell, 1978; Tantam et al., 1989) could be replicated with reduced task demands. We found that this was not the case. The response pattern of the adolescents with autism was very similar to that of the adults and the typically developing children in this task. Thus, in contrast to the studies by Hobson et al. (1988) and Langdell (1978), the individuals with autism in this experiment were not superior to the controls in recognizing upside-down faces, nor did the present results confirm the finding of Tantam et al. (1989) that they were as accurate on inverted faces as on upright faces. Like the children and adults, they recognized upright faces more accurately and faster than inverted faces. Furthermore, for the individuals with autism the inversion effect was also larger for faces than for shoes. Various aspects of this general pattern of results require comment.

A first comment concerns the results obtained here with the adult group. The primary use of an adult control group is to establish a baseline concerning typical performance with the specific materials and task used with the clinical population. It is clear from the present adult data that the classical inversion effect obtains here for faces but not for objects.

Secondly, our data show that typically developing children do show an inversion effect. This finding is inconsistent with earlier reports by Carey and Diamond (1994) but it is entirely compatible with more recent studies (Tanaka, Kay, Grinnel, Stansfield, & Szechter, 1998). It must be noted, however, that exposure times of the stimuli were prolonged for children and adolescents with autism. Although both groups still made more errors than the adult group, it is conceivable that the prolonged exposure time allows the inversion effect to emerge to the same extent in children and adolescents with autism as in adults. On the other hand, one might argue that longer exposure times encourage a feature-based strategy. However, we have seen in two earlier studies that this is not the case for adult populations (de Gelder, Bachoud-Levy, & Degos, 1998; de Gelder & Rouw, 2000). In these studies adults without neuropsychological disorders were compared to patients with prosopagnosia on inverted photographs. It turned out that with prolonged exposure of the target stimuli still significantly better results were obtained in the upright face condition than in the inverted condition, suggesting that even with unlimited exposure times a configuration-based strategy was used. Our present results indicate that this is true for the children too.

Our data show a normal inversion effect with most high-ability adolescents with autism when the task demands in a recognition task for unfamiliar faces are reduced, suggesting that the findings of Tantam et al. (1989) may be due to floor effects. However, there are also indications in the present study that at least some individuals with autism perform relatively poor with upright presentation. Accuracy in this mode of presentation was correlated with social IQ in this group, suggesting that adolescents with a low social IQ do not profit as much from upright presentation of the stimuli as the individuals with higher social IQ's. Therefore, the present results do not replicate the results that people with autism are *better* in recognizing inverted faces as is suggested by the studies by Langdell (1978) and Hobson et al. (1988), but suggest that some people with autism—those with a low social IQ—are *worse* in recognizing normal upright stimuli. Note that this poor recognition not only concerns faces but also objects in the present study, a result that is not consistent with other findings (e.g., Boucher & Lewis, 1992; Tantam et al., 1989). However, impaired recognition of unfamiliar faces in people with autism was reported in other studies (Boucher & Lewis, 1992; de Gelder, Vroomen, & van der Heide, 1991). Boucher, Lewis, and Collis (1998) also demonstrated impaired familiar face recognition in children with autism, but in Langdell's study no such impairment was found. A possible explanation for a relatively good recognition of familiar faces might be that some individuals with autism encode faces in a qualitatively different way that is less sensitive to inversion. This other processing style is less efficient when new, unfamiliar faces have to be encoded, but is accurate enough to perform well on familiar face recognition tasks.

If we follow Diamond and Carey (1986), the remarkable absence of an inversion effect in previous studies suggests that people with autism rely less on configural information in face encoding. Our results indicate that this might only be true for individuals with low social intelligence. If there is a subgroup of adolescents with autism that indeed encode faces in a non-configural way, then other tasks where configural information is critical should also show a deviant response pattern. Young et al. (1987) developed a task in which they fused top and bottom halves of different familiar faces to form a new facial configuration. Participants were then asked to name the upper part of these composite faces. They found that recognition is more impaired when the top and bottom halves were aligned to form a new configuration than when they were not, but only when the stimuli were presented upright. This 'composite effect' was also found with unfamiliar faces, both in the same paradigm (Young et al., 1987), and in a matching task paradigm (Hole, 1994). Carey and Diamond (1994) obtained the composite effect for 6- and 10-year-old children.

In Experiment 2 an adapted version of the composite task was administered to determine if adolescents with autism, especially those with low social IQ scores, are less affected by manipulations of the facial configuration. As in Experiment 1, memory demands were reduced by presenting a two-alternative forced-choice test directly after presentation of each target stimulus.

3. Experiment 2: The composite task

3.1. Method

3.1.1. Participants

The same adolescents with autism and children who participated in Experiment 1 completed the task. There were at least 2 and at most 7 days between Experiments 1 and 2 for each participant of these groups. For the adult group, a new group of 24 undergraduates (12 females and 12 males; mean age 22;4 years) was recruited.

3.1.2. Stimuli

Still video photographs of faces in frontal view were used to prepare the composite stimuli. The images were split into top and bottom halves using an image program (Aldus PhotoStyler). Test stimuli consisted of aligned and non-aligned composites of top and bottom halves of different faces, in inverted and upright orientation. The target faces were upright and inverted photographs of the same individuals in 3/4 view (Appendix B).

3.1.3. Procedure

Inspection time of the first stimulus and time out period were longer for children and adolescents with autism than for adults for reasons given in Experiment 1.

Participants were tested in the same circumstances and with the same equipment as in Experiment 1. Adults received written instructions. Children and adolescents with autism were instructed both verbally and visually, with the use of photographs of the stimuli. Before every experimental block, a training block of 9 randomized trials for that condition was given. Four experimental blocks of 20 randomized trials were administered. The conditions were upright/aligned, upright/non-aligned, inverted/aligned, and inverted/non-aligned. The conditions were counterbalanced within each group.

Five hundred milliseconds after the audio warning signal the target face was presented on the monitor for 1 (adults) or 3 (children and adolescents with autism) s. After an ISI of 3 s the two probes were shown: the top half of the target face and the top half of a distracter face, each in combination with the same bottom half of a third face. The task was to indicate as quickly as possible which of the 2 top halves belonged to the target face by pressing one of 2 buttons (also labelled "A" and "B"). The stimulus disappeared when a response was given. The inter-trial interval was 3 s.

3.2. Results

The results were analyzed for correct responses (Fig. 2a) and for RT of correct responses (Fig. 2b). It was assumed that individuals with a *z*-score below 1.65 (58% correct) had responded at chance level, and they were excluded from analyses. One male participant with autism was excluded for this reason.

The same analyses as in Experiment 1 were carried out, but this time using Orientation (upright versus inverted) and Composition (aligned versus non-aligned) as within-subject factors.

3.2.1. Adults

The composite effect is defined as better performance on non-aligned relative to aligned photographs and is strengthened by the finding that the pattern is found only in the upright condition. This interaction was significant in the RT analysis [$F(1,23) = 6.12, p < .05$] but not in the accuracy data [$F(1,23) = 2.04$, n.s.]: in the upright mode, non-aligned faces were recognized faster than aligned faces [$t(23) = 4.55$, $p < .001$], while there was no composite effect in the inverted mode [$t(23) = 0.18$, n.s.].

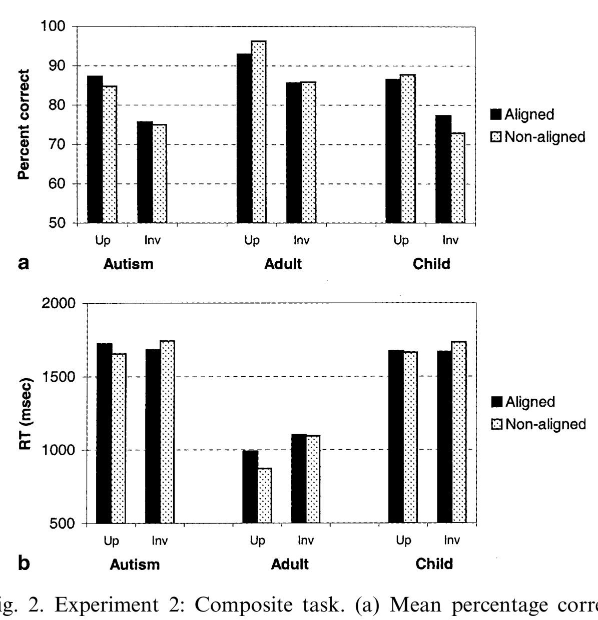


Fig. 2. Experiment 2: Composite task. (a) Mean percentage correct scores of the groups of adolescents with autism and adults and children with typical development. (b) Mean RT scores of the groups of adolescents with autism and adults and children with typical development.

A main effect on Orientation showed that photographs were recognized far more accurately in the upright condition [$F(1,23) = 73.69$, $p < .001$].

3.2.2. Children

In the children group, only a main effect of Orientation was found: upright photographs were recognized more accurately than inverted photographs [$F(1,23) = 53.71$, $p < .001$]. The crucial Orientation × Composite interaction was not found in the RT data [$F(1,23) = 0.54$, n.s.] and just failed to reach significance on accuracy [$F(1,23) = 4.05$, $p < .6$].

3.2.3. Adolescents with autism

The adolescents with autism showed no composite effects in RTs [$F(1,15) = 0.62$, n.s.] or accuracy [$F(1,15) = 0.28$, n.s.]. Only a main effect on orientation was significant: they were more accurate in the upright than in the inverted condition [$F(1,15) = 15.10$, $p < .001$].

Task performance in general was correlated with social IQ ($r = .55$, $p < .05$) and age ($r = .58$, $p < .05$).

3.3. Discussion

The goal of Experiment 2 was to obtain evidence about the importance of overall configuration from a different task. Results would also allow us to assess whether the deviant performance of some of the adolescents with autism on the inversion tasks in Experiment 1 could be attributed to the use of a non-configural processing style. The data show some correspondences and some deviations with configuration-based processing as measured in the inversion task.

A first comment concerns the adult results which are consistent with previous studies by Young et al. (1987) and Carey and Diamond (1994): non-aligned composites were recognized faster than aligned composites in the upright presentation mode. The results of the children with typical development were also compatible with the findings of the Carey and Diamond (1994) study with 10-year-old children, although the composite effect in our study was only marginal. The Composite × Orientation interaction in the present experiment just failed to reach significance.

In the present experiment, no composite effect was found for the adolescents with autism. Unlike suggested by Experiment 1, it was not the case that a non-configural processing style might be shown selectively by a subgroup of individuals with autism with a low social IQ. The results of the composite task are in line with the hypothesis that individuals with autism make less use of the configural information of a face, but are not in accordance with the results of the inversion task. Apparently, some other factor is involved in the composite task.

4. General discussion

The objective of this study was to examine the existence of an inversion and a composite effect in typically developing children and to determine whether the previously reported absence of an inversion effect in adolescents with autism on tasks where photographs of faces were presented upside-down (Hobson et al., 1988; Langdell, 1978; Tantam et al., 1989) was related to a deficit in the use of the configural information of the face. The first experiment re-examined the inversion effect and avoided floor effects by administering a recognition task of inverted faces with reduced memory demands. Adolescents with autism performed normally under these circumstances and showed an inversion effect for faces with only a subgroup with a low social IQ score being less sensitive to orientation. To the extent that the inversion effect results from configural processing (Diamond & Carey, 1986; Scapinello & Yarmey, 1970; Yin, 1969), this suggests that the majority of the individuals with autism is able to process a face on the basis of its configuration.

In a second Experiment where the configural processing was tested using composite faces we did not observe evidence of a normal composite effect in the group with autism. This suggests that either they were not processing faces as configurations at least not in this task, or that besides configural processing, another factor is involved in performing the composite task. We discuss these two alternatives in turn.

First we would like to point out that the results obtained with the adult group establishes that the inversion and the composite effects can be found with unfamiliar faces using a paradigm that does not involve training but involves recognition of personal identity across a difference in viewing angle. However, the composite effect was not as solid in the children group, for it did not reach significance. Apparently, the specific task demands were less advantageous for this group to find a reliable Composite × Orientation interaction. A major difference between the study by Carey and Diamond (1994) and the present one concerns the degree of familiarity with the faces. Their studies concerned a composite effect for familiar faces. They also claim that the effect holds for unfamiliar faces, but as there was extensive learning of the face halves and a requirement to name them, it is questionable whether these face halves were processed as unfamiliar faces. Furthermore, since the learned face halves were exactly identical to the face halves in the composite faces, task performance on the basis of overall similarity was very likely. This criticism was formulated by Hole (1994), whose study tackled this problem by using a matching paradigm. The results showed that in this paradigm the composite effect also holds for unfamiliar faces. However, Hole only compared upright composites with inverted composites, but did not compare aligned composite faces with non-aligned composites. This makes a definite conclusion about the existence of a composite effect for unfamiliar faces difficult. In the present experiment, a more standard paradigm for unfamiliar face processing was used that did not require learning of the faces. The target faces were presented as a whole (instead of only showing the upper part as in the other studies) in 3/4 orientations. To reduce memory demands, the two composite faces in frontal orientation immediately followed the target face. This paradigm prevented recognition purely based on similarity, since the top halves of the target and composite faces were not identical as was the case in the studies just mentioned. Instead, the target faces in our study had to be encoded specifically as faces and not as patterns. However, the composite task not only requires face encoding, as in the inversion task, but also detection of a target in an embedding context.

Some of the most relevant studies on configurable encoding were conducted in the seventies and concern the object and face superiority effects, the notion that array goodness or good context helps in detection of a part. In a convincing paper in which normal and scrambled faces were used as stimuli, Mermelstein, Banks, and Prinzmetal (1979) demonstrated that figures of good form lead to face superiority effects, but only when the context stimulus has to be kept in memory (the context stimulus is presented first, followed by the part to be recognized). If the part is presented first, followed by the context stimulus (and thus no memory for the context stimulus is needed), it becomes a perceptual task and then a face inferiority effect is found. Mermelstein et al. looked at face processing, but addressed the issue of context effects in such a way that the generalization to objects is clear and they integrated the existing studies about the phenomena that have used objects (Weisstein & Harris, 1974) or faces (Homa, Haver, & Schwartz, 1976).

Pursuing this line, it appears that the studies on the composite effect are perception based, as the task is a visual search of the composite faces. The results of the participants with typical development are consistent with the prediction made by Mermelstein et al. (1979), that, in this case, a face inferiority effect will be found. In contrast, individuals with autism did not show a composite effect, suggesting that their visual search strategies are influenced to a much lesser degree by the embedding context. This absence of an inferiority effect in people with autism is also found in studies that used stimuli other than faces. In the Embedded Figures task, children with autism were found to be superior in finding the hidden target in a camouflaging context (Shah & Frith, 1983; Jolliffe & Baron-Cohen, 1997). People with autism also perform remarkably well on the Block Design task (Bowler, 1992; Lockeyer & Rutter, 1970; Ohta, 1987; Tymchuk, Simmons, & Neafsey, 1977; Venter, Lord, & Schopler, 1992), a task where participants have to copy a given pattern with small building blocks as quickly as possible. Shah and Frith (1993) showed, by presenting different variations of the Block Design task, that this remarkable performance is due to a more feature-based search strategy, while obliqueness and rotation did not reveal group differences. Both the findings on the Embedded Figures task and the Block Design task thus suggest that people with autism make more use of feature-based strategies in visual search tasks. The weaker composite effect in the children with typical development indicates that they also use a more feature-based search strategy.

At first sight, these findings seem in line with the theory of Frith (1989) that people with autism exhibit a weak central coherence, an inability to integrate pieces of information into coherent wholes. However, on basis of this theory it is not clear why most adolescents with autism in the present study show a normal inversion effect, since this presupposes that a normal, configuration-based, face representation had been formed (Diamond & Carey, 1986). In other words, piecemeal information of the face (eyes, nose, mouth) apparently had been integrated into the coherent whole of a face. The results indicate that if this is a valuable explanation, only a subgroup of adolescents with autism with a low social intelligence may suffer from a weak central coherence.

To conclude, our data suggest that most adolescents with autism do not suffer from an inability to form a configuration-based face representation, but that they are less prone to use contextual information in a perceptual task. This is in line with a recent study of Jolliffe and Baron-Cohen (1999), who found, in linguistic processing tasks, that individuals with autism will not use contextual information, unless they are instructed to do so or unless they make a conscious decision to do so. In individuals with typical development, this contextual information seems to activate automatically a holistic processing of the stimulus, which is why they have to suppress the tendency to perceive an embedding figure as a Gestalt in a visual search task (Witkin, Oltman, Raskin, & Karp, 1971). Individuals with autism do not need to suppress this tendency, and will use primary a feature-based strategy. This may also explain the finding that, when photographs of faces can be categorized on basis of type of hat (feature-based) or facial expression (configuration-based), typically developing children will prefer sorting by expression and children with autism prefer sorting by type of hat (Weeks & Hobson, 1987). In some exceptional situations, as in performing the Embedding Figures task, this strategy may be effective, but in most daily life situations this is not very adequate for understanding and anticipating events.

Acknowledgments

The authors would like to thank Petra Piree for assistance in testing the children. We are grateful to the staff and pupils of the Dr. Leo Kannerhuis, Oosterbeek, and of Basisschool De Helle, Tilburg. We are indebted to Paul Bertelson and Hans Berger for valuable discussion.

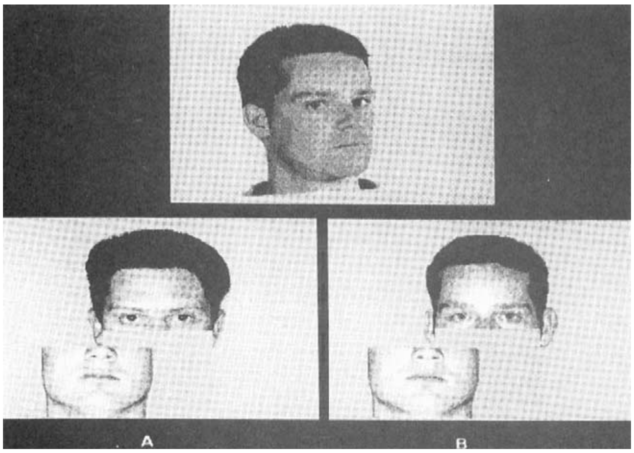
Appendix A

An example of the face stimuli used in Experiment 1.

An example of the shoe stimuli used in Experiment 1.

Appendix B

An example of the stimuli used in Experiment 2.



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