Available online at www.sciencedirect.com
ScienceDirect
Brain and Cognition 65 (2007) 107–111
Brain and Cognition
www.elsevier.com/locate/b&c

Effects of object complexity and type on the gaze behavior of children with pervasive developmental disorder

C. Kemner [a,*], J.N. van der Geest [b], M.N. Verbaten [c], H. van Engeland [a]

[a] *Department of Child and Adolescent Psychiatry, University Medical Center Utrecht and Rudolf Magnus Institute for Neurosciences, Utrecht University, Utrecht, The Netherlands*
[b] *Department of Neuroscience, Erasmus MC, Rotterdam, The Netherlands*
[c] *Department of Psychopharmacology and Rudolf Magnus Institute for Neurosciences, Utrecht University, Utrecht, The Netherlands*

Accepted 27 May 2006
Available online 12 July 2007

Abstract

The looking behavior of children with pervasive developmental disorder (PDD) and age- and IQ-matched normal control children was studied using infrared oculography. Stimuli varying in complexity and topic were presented to test whether children with PDD have specific abnormalities in looking behavior to complex stimuli and/or to faces. All children showed more and longer fixations on the complex objects than on the simple objects, especially the complex nonsense figure, but group differences were not found. The results show no evidence for specific abnormalities in looking behavior to either faces or to complex stimuli in high functioning children with PDD.

Keywords: PDD; Autism; Looking behavior; Face; Stimulus complexity

1. Introduction

Pervasive developmental disorder (PDD) is the general category of a spectrum of several serious child-psychiatric disorders, of which autism is the archetype. A characteristic deficit of individuals with PDD is their impaired ability to interact socially (Rutter, 1978), and deficits in gaze behavior are often among the first clinical indications of social dysfunction in children with PDD (Adrien et al., 1993). However, laboratory studies on gaze frequency in social situations in participants with PDD are not unequivocal. Some studies report lower frequencies of looking at other people (Hutt & Ounsted, 1966; Pedersen, Livoir-Petersen, & Schelde, 1989; Volkmar & Mayes, 1990), but others show normal behavior in this respect (Dawson, Hill, Spencer, Galpert, & Watson, 1990; Sigman, Mundy, Sherman, & Ungerer, 1986). Additionally, some studies show that children with PDD do look at the other person's face when their attention is drawn (Cohen, Vietze, Sudhalter, Jenkins, & Brown, 1989; Hobson & Lee, 1998; Willemsen-Swinkels, Buitelaar, Weijnen, & van Engeland, 1998). However, a common problem of the above-mentioned studies is that the methods (e.g., scoring from videotape) do not allow for a precise analysis of the looking behavior. To study looking behavior more precisely, two recent studies have used infrared oculography (i.e. using video images of the eye to estimate the point of gaze, to determine scanning patterns of faces in participants with PDD). In their study, Van der Geest and colleagues tested whether children with PDD show the normal looking preference for the eyes and mouths of human faces by studying fixation patterns in response to neutral and emotional static faces (photographs) (Van der Geest, Kemner, Verbaten, & van Engeland, 2002). No differences were found between the PDD group and an age- and IQ-matched normal control group. In a study by Klin, Jones, Schultz, Volkmar, and Cohen (2002), fixation patterns were studied in participants with PDD and controls in response to dynamic stimuli, namely to video clips rich on social interaction. Indeed differences

* Corresponding author.
E-mail address: C.Kemner@umcutrecht.nl (C. Kemner).

0278-2626/$ - see front matter © 2007 Elsevier Inc. All rights reserved.
doi:10.1016/j.bandc.2006.05.006

between the clinical and the control group were found in this study. Participants with PDD looked longer to the mouth region than to the eyes when watching video clips. The different findings in a static and a dynamic task have been interpreted as the result of differences in complexity level of the stimuli, with the dynamic stimuli containing more information than the static stimuli (Loddo, 2004). It has been suggested that the complexity of the information in social interaction exceeds the processing capacity of autistic individuals (Dawson & Lewy, 1989) and that autistic participants have a special problem in the processing of complex information (Minshew, Goldstein, & Siegel, 1997; Minshew, Sweeney, & Luna, 2002).

In the present study, we used infrared oculography in a modified preferential looking task to test the hypothesis that stimulus complexity influences looking behavior in children with PDD. An alternative hypothesis was also tested, namely that participants with PDD lack a natural preference for faces. In a preferential looking task, a child is shown two images, and the difference in looking time between the two images is used as a measure for (visual) preference for the object. Using the preferential looking technique, the gaze behavior of normally developing human infants towards facial configurations of elements and non-facial configurations of the same elements has been investigated in several studies (Haaf & Brown, 1976; Valenza, Simion, Cassia, & Umilta, 1996). The natural preference for faces shown by normally developing humans is reflected by their visual fixation patterns (e.g., Morton & Johnson, 1991). Infants look longer at face-like stimuli than at nonsense stimuli and at complex stimuli. The longer fixation times for both kinds of stimuli probably reflect the amount of potentially interesting information that is provided by the stimulus. In the present study, the time spent looking at objects and faces under conditions of different complexity was studied in children with PDD and age-, sex-, and IQ-matched controls.

2. Method

2.1. Participants

Informed consent was obtained from the parents of 17 children with PDD (mean age of 10.4; $SD = 2.2$ years; Total IQ of 93.6; $SD = 18.2$) and 16 age- and IQ-matched, normal children (10.3 ; $SD = 1.3$ years, Total IQ of 96.5; $SD = 10.4$). IQ scores were estimated by the full Wechsler Intelligence Scale for Children Revised, Dutch version. All children with PDD were boys, as were all but one of the control children. All diagnoses of PDD were based on the DSM-IV criteria and the Autism Diagnostic Interview-Revised (ADI-R; Lord, Rutter, & Le Couteur, 1994). The children were diagnosed as having Autistic Disorder (AD; $N = 10$) or Pervasive Developmental Disorder- Not Otherwise Specified (PDD-NOS; $N = 7$). All children had normal vision without glasses or contact lenses.

2.2. Apparatus

The participant sat upright in a dentist-chair with his head fixed using a vacuum-cushion, which reduced head movements. Stimuli were displayed on a 21″ computer screen that was positioned approximately 1 m in front of the participant's eyes. The display size was 640×480 pixels. Eye movements were recorded by means of the Iview Remote Eye Tracking device (SensoMotoric Instruments), with a sample rate of 50 Hz and an accuracy of about 1° of visual angle. This device was positioned in front of the subject just below the monitor. The field of view for the eye tracker was more than 60° horizontally and 40° vertically.

2.3. Stimulus material

Each stimulus consisted of six small objects, drawn in black on a white background, covering the total area of the screen. The position of these six objects differed for each stimulus. The size of the whole stimulus was $23° \times 17°$ of visual angle. The size of each of the six objects was 3.6° in diameter. The objects were roughly arranged in an ellipse/rectangle in a random order. The distance between two neighbouring objects was minimally 8° of visual angle. Two objects represented a human face, two objects represented a clock, and the remaining two objects did not represent anything realistic. Thus, there were three levels of meaning: 'face', 'clock', and 'nonsense'. For each level of meaning, there were two levels of complexity. Within each level of complexity, the number and shape of the elements that made up an object were the same (see Fig. 1). In total the participants saw ten stimuli. A single stimulus consisted of six objects (clock, face and nonsense; all in a simple and a complex form). In each of the ten stimuli all six objects were present. So, the fixation time of each single object was calculated over 10 trials of 5 s each.

2.4. Procedure

The participant was instructed that he would be shown cartoon-like drawings and was to look at the TV screen carefully. Before the experiment started, each participant's eye movements were calibrated using a 9-point calibration routine. Before each stimulus, a small fixation cross was shown at the center of the screen for 2 s. After the fixation cross disappeared, each stimulus was displayed for 5 s. Then the fixation cross was shown again. Following this session, the participant was shown the six objects drawn on paper and asked to name them. This task was not announced beforehand, to avoid interference of task requirements on looking behavior. All children could easily name the face-like and clock-like objects.

2.5. Analysis

The raw data were analyzed for fixation points. A fixation was defined as the group of 5 or more consecutive