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Intuitive physics and intuitive psychology ("theory of mind") in offspring of mothers with psychoses

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Abstract

Offspring of individuals with psychoses sometimes display an abnormal development of cognition, language, motor performance, social adaptation, and emotional functions. The aim of this study was to investigate the ability of children of mothers with schizophrenia (n=28) and bipolar disorder (n=23) to understand mental states of others using the Eyes Test (folk psychology or "theory of mind") and physical causal interactions of inanimate objects (folk psychics). Compared with healthy controls (n=29), the children of mothers with schizophrenia displayed significantly impaired performances on the Eyes Test but not on the folk physics test. The children of mothers with bipolar disorder did not differ from the controls and outperformed the children of mothers with schizophrenia on the folk physics test. These results suggest that the attribution of mental states, but not the interpretation of causal interaction of objects, is impaired in offspring of individuals with schizophrenia, which may contribute to social dysfunctions.

Introduction

Several studies provided evidence that offspring of individuals with schizophrenia display an abnormal development of cognition, language, motor performance, social adaptation, and emotional functions (Niemi et al., 2003). Children who later develop bipolar disorder also show developmental and behavioral abnormalities, but these are less severe than that seen in children who later develop schizophrenia (Murray et al., 2004). In spite of extensive research in the field, the basic mechanisms of social and cognitive impairments in children of individuals with psychoses are poorly understood.

To elucidate this issue, we selected the evolutionary framework of folk psychology and folk physics, which is based on the classification of objects in our environment as agents and non-agents (Dennett, 1987; Sperber, Premack, & Premack, 1995; Csibra et al., 1999; Baron-Cohen et al., 2001). Agents have intentionality and can move by self-propulsion. Non-agents have no intentionality and their movements are initiated by another object. From infancy, humans use folk or intuitive psychology to deduce the mental causes of agents` actions and use folk or intuitive physics to deduce the physical causes of non-agents` movements. The term “theory of mind” is closely related to folk psychology and refers to the ability to infer one's own and other persons' mental states. Evidence suggests that “theory of mind” is impaired in patients with schizophrenia and may contribute to language and social dysfunctions (Frith, 2004; Brune, 2005). However, “theory of mind” is also impaired in patients with bipolar disorder (Kerr, Dunbar, & Bentall, 2003; Bora et al., 2005) and depression (Lee et al., 2005), which suggests that it is not specific to schizophrenia.

The aim of this study was to investigate folk psychology (“theory of mind”) and folk physics in children of mothers with schizophrenia and psychotic bipolar disorder using the methods of Baron-Cohen et al (2001). We addressed the following questions: (i) Are folk psychology and folk physics equally affected in the offspring? (ii) Are offspring of individuals with schizophrenia and bipolar disorder equally affected?

Materials and methods

Participants

Mothers with schizophrenia and with type I bipolar disorder with psychotic features were recruited via the National Psychiatric Center. Parents of control participants were university and hospital employees and their relatives or acquaintances. Diagnoses were based on the DSM-IV criteria (American Psychiatric Association, 2004). All mothers received the MINI International Neuropsychiatric Interview Plus (Sheehan et al., 1998) and their full medical records were available. Health cards of the children were obtained from their home districts and a detailed history was obtained from the families, including the non-affected parent. The following items were taken into consideration for the general description of the sample: obstetric complications, severe childhood illness, emotional symptoms, conduct problems, and academic impairment in the school (Table 1). After a complete description of the study, all parents (including the non-affected parents) gave their written informed consent.

Folk Psychology

The modified version of the Eyes Test was used (Baron-Cohen et al., 2001). The test consists of 28 photographs of the eye region of faces. The participant is asked to choose which of 4 words best describes what the person on the photograph is thinking and feeling. The eye regions reflect complex mental states and social emotions such as surprised, friendly, sure about something, worried or joking (Fig. 1A). As a control condition, participants were asked to judge the gender of the person using information from the eye region only.

Folk Physics

The folk physics test of Baron-Cohen et al. (2001) was used. The test consists of 20 items presented on separate cards. Items comprised physical problems based on the causal interactions of inanimate non-agents. Participants were asked to choose the right answer from 4 alternatives. Examples are shown in Fig. 1B. The problems presented by the folk physics test could be solved using common experiences of the physical world and were based on causal relationships. Similar to that reported by Baron-Cohen et al. (2001), our survey revealed that these problems are not included in standard school curriculum. Both folk psychology and folk physics tests have good psychometric properties.

Data analysis

The STATISTICA 6.0 (StatSoft, Inc., Tulsa) software was used for data analysis. The normality of data distribution was checked using Kolmogorov-Smirnov tests. The percentage of correct judgments in the folk psychology and folk physics tests was entered into an analysis of variance (ANOVA), followed by Tukey HSD pot-hoc tests. The level of significance was alpha<0.05.

Results

The results are shown in Table 1. In each group, children judged the gender with a high accuracy (>90%). The ANOVA conducted on the folk psychology and folk physics performances indicated significant main effects of group ($F(2,77) = 13.65$, $p < .001$) and task type ($F(1,77) = 97.77$, $p < .001$). The two-way interaction was not significant ($p = .66$).

Tukey HSD revealed that the children of mothers with schizophrenia recognized fewer mental states than the controls ($p < .05$) and the children of mothers with bipolar disorder ($p < .005$). The children of mothers with bipolar disorder and the controls did not differ ($p = .9$). In the case of the folk physics test, there were no significant differences between the controls and the children at risk of schizophrenia and bipolar disorder ($p > .2$), but the children of mothers with bipolar disorder outperformed the children of mothers with schizophrenia ($p < .05$) (Table 1). There was no significant differences between boys and girls ($p > .1$).

Discussion

We found that folk psychology ("theory of mind") was significantly impaired in children of mothers with schizophrenia but not in children of mothers with bipolar disorder. This is consistent with the view that schizophrenia vulnerability is associated with more severe early impairments than vulnerability to bipolar disorder (Murray et al., 2004). Although the children of mothers with schizophrenia also achieved lower scores on the folk physics test as compared with the controls, this difference did not reach the level of statistical significance. It is important to note that the folk physics test was more difficult than the folk psychology test, which is consistent with the findings of Baron-Cohen et al (2001). Intact performances on the gender identification test are against a generalized deficit of facial processing, although the difficulty of this task was not matched to that of the folk psychology procedure. Altogether, our results may suggest that offspring of individuals with schizophrenia show more pronounced impairments in the understanding of mental states of

agents than in the understanding of physical causality. This may contribute to social dysfunctions (Fett et al., 2011).

Baron-Cohen et al. (2001) raised the possibility that folk psychology and folk physics are potentially dissociable. Children with Asperger syndrome displayed impaired performances on the Eyes Test, whereas they outperformed the healthy control group on the folk physics test. This suggests an extreme "technical brain" and a poorly functioning "social brain" in Asperger syndrome. The possible existence of extreme "social brain" and "master mindreaders" has also been suggested (Dziobek et al., 2005). Indeed, evidence from brain imaging and lesion studies indicates that several brain areas, including the dorsomedial prefrontal cortex, superior temporal cortex, and amygdala specifically participate in folk psychology and may be especially affected in psychiatric disorders such as autism-spectrum disorders and schizophrenia (Adolphs, 2003; Lee et al., 2004). This neuronal system is qualitatively different from that activated during logical reasoning (Goel & Dolan, 2001). Fahim et al. (2004) found impaired activations of cortical areas related to emotional memory in a discordant twin pair for schizophrenia. Brain structures associated with the processing of facial information, such as the fusiform gyrus, may be especially vulnerable (Onitsuka et al., 2003; Mancini-Marie et al., 2004). Platek et al. (2005) demonstrated a relationship between abnormal medial prefrontal activation, schizotypal traits, and Eyes Test performance, which raises the possibility that subclinical symptoms may be present in children at risk of schizophrenia. Indeed, well functioning adult relatives of schizophrenia patients without schizotypal traits show normal performances on the Eyes Test (Kelemen et al., 2004). Others found subtle deficits (Montag et al., 2012). The Eyes Test is not a simple emotion recognition paradigm because the words include both affective and non-affective mental state terms and brain areas specifically related to "theory of mind" are activated during the task (Calder et al., 2000).

The present findings may facilitate the delineation of cognitive foundations of developmental abnormalities in children at risk of psychosis. One of the most important aims of future research is to find specific endophenotypes that support the identification of susceptibility and modifying genes and their interactions with environmental factors (Gottesman & Gould, 2003; Kéri & Janka, 2004).

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Table 1. General characteristics of the participants and results from the folk psychology and folk physics tests

	Children of mothers with schizophrenia (n=28; 20 boys, 8 girls)	Children of mothers with bipolar disorder (n=23; 18 boys, 5 girls)	Control children (n=29; 16 boys, 13 girls)
Mean age (years)	10.6 (SD=0.8)	10.8 (SD=0.5)	10.6 (SD=0.9)
Mean IQ	96.8 (SD=12.0)	102.5 (SD=10.3)	101.7 (SD=9.7)
Folk psychology (% correct)	59.7 (SD=14.8)*	73.9 (SD=10.5)	71.4 (SD=10.3)
Folk physics (% correct)	41.6 (SD=15.8)**	52.8 (SD=15.6)	49.0 (SD=9.9)
Obstetric complications	1/28	1/23	1/29
Severe childhood illness	1/28	1/23	2/29
Emotional symptoms	6/28	4/23	0/29
Conduct problems	3/28	4/23	1/29
Academic impairment	5/28	2/23	1/29

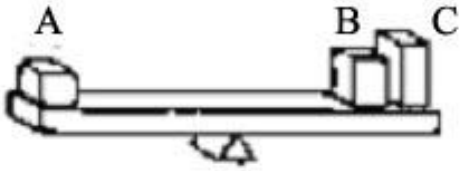
*Significant difference as compared with controls and with children of mothers with bipolar disorder ($p<0.05$ and $p<0.005$, respectively, Tukey HSD)

**Significant difference as compared with children of mothers with bipolar disorder ($p<0.05$, Tukey HSD)

Fig. 1. Examples of stimuli used in the folk psychology ("theory of mind") (A) and folk physics (B) experiments (Baron-Cohen et al., 2001)

A

B



Which box is the heaviest?
a A
b B
c C
d all equal

Where is the pendulum moving fastest?
a A
b B
c C
d D