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# Research in brief

## Does autism occur more often in families of physicists, engineers, and mathematicians? by Simon Baron-Cohen, Patrick Bolton, Sally Wheelwright, Vicky Scahill, Liz Short, Genevieve Mead and Alex Smith

ABSTRACT The study reported here tests a prediction that autism should occur more often in families of individuals whose occupation requires advanced folk physics but with no requirement of good folk psychology. Physics, engineering, and mathematics are paradigm examples of such occupations. Students in Cambridge University, studying one of these three subjects, were screened anonymously for cases of autism in their families. Relative to a control group of students studying literature, autism was reported to occur significantly more often in families of students in the fields of physics, engineering, and mathematics. Such results are consistent with the prediction. This study necessarily involved anonymous self-report methods, so the reliability and validity of diagnoses are unknown. Future replications should attempt a non-anonymous study so as to establish if this association is robust.

KEYWORDS
*autism;*
*folk physics;*
*genetics;*
*occupation*

Autism is considered to be the most severe of the childhood psychiatric disorders. It is strongly heritable (Bailey et al., 1995) and is diagnosed on the basis of abnormalities in social development, communication, and imagination (American Psychiatric Association, 1994). First-degree relatives of children with autism are at raised risk not only of autism itself, but also of a lesser variant (or broader phenotype) of autism (Baron-Cohen and Hammer, 1997; Bolton et al., 1994). One model proposes that the broader phenotype might be characterized as involving deficits in 'folk psychology' (social understanding) in the presence of intact or superior abilities in 'folk physics' (understanding inanimate objects) (Baron-Cohen, 1997).

This study builds on the notion that cognition has a domain-specific structure (Barkow et al., 1992; Gelman and Hirschfield, 1994), i.e. that a small number of cognitive domains exist in the human infant brain, in an elementary form, as a result of natural selection. Two such basic cognitive domains are folk psychology (Baron-Cohen, 1995; Gergely et al., 1995) and folk physics (Baillargeon et al., 1995; Leslie and Keeble, 1987). These domains are thought to reflect inborn attentional biases in the infant brain to particular classes of information (social versus inanimate events,

respectively). Thus, normal infants show a preference for looking at faces (and eyes) over other objects (see Baron-Cohen, 1995 for a review), and expect there to be 3D objects which conform to a small number of laws of physics (Baillargeon et al., 1995). Such attentional biases facilitate the infant brain learning about these specific aspects of the environment.

The evidence that children with autism are impaired in the development of folk psychology is plentiful (Baron-Cohen, 1995; Baron-Cohen et al., 1985). This impaired folk psychology appears to be universal in autism, even amongst adults with autism who have otherwise normal intelligence, though subtle tests of mind-reading are needed to reveal this (Baron-Cohen et al., 1997a). For this reason, autism has been characterized as involving degrees of 'mindblindness' (Baron-Cohen, 1995).

Evidence that in such children folk physics is intact or superior comes from the following sources: they have a good understanding of object properties and physical causality (Baron-Cohen et al., 1986); they understand mechanisms such as cameras (Leekam and Perner, 1991; Leslie and Thaiss, 1992); and their obsessional interests often centre on machines, other physical systems (such as the planets), or systems with mathematical/spatial regularities (such as transport networks and calendars) (Baron-Cohen, 1997).

Evidence that the broader phenotype of autism may be characterized in terms of folk physics being more advanced than folk psychology comes from a recent study of the occupations of the first- and second-degree relatives of children with autism. Both fathers and grandfathers of such children were disproportionately represented in occupations linked to engineering. In a sample of 919 families with a child with autism, 28.4 percent had either a father or a grandfather who was an engineer, versus only 15 percent of control group families (Baron-Cohen et al., 1997b).

In the present study, we investigated if autism was more common in the families of those people who work in fields which demand good folk physics but which do not necessarily demand good folk psychology. Specifically, we tested the prediction that autism would be more common in the families of those working in the object-centred fields of engineering, physics, and mathematics, relative to those working in the humanities.

## Method

We sampled students in Cambridge University who work in these fields. We compared 641 students studying one of the three subjects (maths $n = 275$; engineering $n = 266$; physics $n = 100$) with 652 students studying literature (English $n = 480$; French $n = 172$). We asked them to report, by

questionnaire, on the incidence of the following six conditions (severe enough to have merited treatment or clinical diagnosis) in their family: autism, anorexia, schizophrenia, language delay, manic depression, and Down's syndrome.

The decision to embed autism among five other conditions was so as to camouflage the condition that was central in this study (autism), to avoid biasing the responses, as well as to check that any increased familial association with a disorder was a specific one. These six conditions were selected because they all involve psychological or psychiatric symptoms, many with a genetic and/or a developmental component. Finally, manic depression was included because unipolar depression might be interpreted too loosely by respondents, and because earlier studies had suggested a link between this and creative artists (Andreasen, 1987; Claridge et al., 1990). In this respect, it allowed an opposite prediction to be made, relative to autism (see below). Family was defined as siblings and parents (these both being first-degree relatives), parents' siblings (second-degree relatives), and first cousins (third-degree relatives). More distant relatives were not considered. In order to maximize the response rate, given that the informants were young, in a peer group (university setting), and divulging information about potentially stigmatizing conditions, we used an anonymous method.

## Results

Results are shown in Table 1. To minimize the risk of statistically significant results occurring due to multiple testing, two tests were carried out: first of autism, predicted to be more common in the engineering/maths/physics families; and second of manic depression, predicted to be more common in the English/French families based on earlier findings (Andreasen, 1987; Claridge et al., 1990). Both predictions were confirmed. Only 1 case of autism was found in the English/French (E-F) group (this individual being a third-degree relative), whereas 6 cases of autism were found in the maths/physics/engineering (M-P-E) group (of whom 2 were a first-degree, 3 were a second-degree, and 1 was a third-degree relative). Comparing 6 in 9428 (relatives of the M-P-E students) to 1 in 9829 (E-F students) is significantly different (Fisher's exact probability test, $p = 0.049$). Regarding manic depression, twice as many cases were found in the families of those students studying literature. Comparing 50 in 9428 (M-P-E group) with 100 in 9829 (E-F group) is also significant (chi-square = 14.15, 1 d.f., $p = 0.0002$). A subsequent analysis confirmed that the two types of students did not differ in

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