

This paper appeared in Autism, 1998, 2, 296-301.

**Autism occurs more often in families of
physicists, engineers, and mathematicians.**

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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 3 subjects, were screened for cases of autism in their families. Relative to a control group of students studying literature, autism occurred significantly more often in families of students in the fields of physics, engineering, and mathematics.

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 (APA, 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 & Hammer, 1997; Bolton et al., 1994). One model proposes that the broader phenotype might be characterised as involving deficits in ‘folk psychology’ (social understanding) in the presence of intact or superior abilities in ‘folk physics’ (understanding inanimate objects) (Baron-Cohen, in press).

This study builds on the notion that cognition has a domain-specific structure (Barkow, Cosmides & Tooby, 1992; Gelman & Hirschfield, 1994), i.e., that cognitive domains exist in the human brain, as a result of natural selection. Two such basic cognitive domains are folk psychology (Baron-Cohen, 1995; Gergely, Nadasdy, Gergely & Biro, 1995) and folk physics (Baillargeon, Kotovsky & Needham, 1995; Leslie & Keeble, 1987). These domains are thought to reflect inborn attentional biases in the infant brain to particular classes of information (social vs inanimate events, respectively). 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, Leslie & Frith, 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, Jolliffe, Mortimore & Robertson, 1997). For this reason, autism has been characterised 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, Leslie & Frith, 1986); they understand mechanisms such as cameras (Leekam & Perner, 1991; Leslie & 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, in press).

Evidence that the broader phenotype of autism may be characterised 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% had either a father or grandfather who was an engineer, vs only 15% of control group families (Baron-Cohen, Wheelwright, Stott, Bolton & Goodyer, 1997). 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 3 subjects (maths, $n = 275$, engineering, $n = 266$, or 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 6 conditions in their family: autism, anorexia, schizophrenia, language delay, manic-depression, and Down's Syndrome. Family was defined as siblings, parents (these both being 1st degree relatives), parents' siblings (2nd degree relatives), or first cousins (3rd degree relatives). More distant relatives were not considered.

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 of first: autism (predicted to be more common in the engineers/maths/physics families); and manic depression (predicted to be more common in the English/French families, based on earlier findings (Andreasen, 1987; Claridge, Pryor & Watkins, 1990). Both predictions were confirmed. Only 1 case of autism was found in the English/French (E-F) group (this individual being

a 3rd degree relative), whereas 6 cases of autism were found in the Maths/Physics/Engineering (M-P-E) group (of whom 2 were a 1st degree, 3 were a 2nd degree, and 1 was a 3rd 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, 1df, $p = 0.0002$). A subsequent analysis confirmed that the two types of students did not differ in incidence rates of the other 4 conditions, or in terms of how many 1st, 2nd, or 3rd degree relatives they had (all $p > 0.7$).

insert Table 1 here

Discussion

This shows that, as predicted, there is a significant association between individuals whose cognitive strengths lie in the domain of folk physics (indexed by working in the fields of mathematics, engineering, and physics) and having a biological relative with autism. This result could reflect reporting biases between the two groups, but this is far-fetched.

Rather, the association fits the prediction derived from a theory of the broader cognitive phenotype of autism. Future work should validate this by verifying diagnosis of relatives rather than relying solely on report.

Table 1: Number of students with an affected relative

Subject studied	Autism	Lang Delay	Schizophrenia	Manic Depress	Anorexia	Down's	No. of 1st deg relatives	No of 2nd deg relatives	No of 3rd deg relatives	Total No of relatives
Maths, Engineer or Physics (n=641)	6*	32	17	50	24	6	2238	2880	4310	9428
English or French Literature (n=652)	1	43	20	100**	21	4	2401	3007	4421	9829

* Maths/Engineering/Physics significantly higher than English/French

** Maths/Engineering/Physics significantly lower than English/French

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