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Some difficulties behind the concept of the 'Extreme male brain' in autism research. A theoretical review

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ABSTRACT

The idea that autistic symptoms are produced by an 'extreme male brain' warrants further examination. The concept of the 'extreme male brain' derives from scores on the Autism Spectrum Questionnaire (AQ) i.e. it is defined behaviourally rather than anatomically. But if the concept of the 'extreme male brain' is to *explain* rather than *describe* autistic behaviour then evidence must come from a non-behavioural (e.g. physiological, biochemical or anatomical) source to avoid circularity of argument. The lack of a cognitive *intervening variable* linking autistic behavioural traits to brain activity casts doubt on the existence of a uni-dimensional spectrum of 'brain gender' for which autism is to be found at the 'extreme male' end. The inappropriate conflation of the *dependent variable* (score on the AQ) and the *independent variable* (brain anatomy of respondent) has led to the claim that a person with autism, even if female, has an 'extreme male brain'. This is comparable to the claim that, because on average men are taller than women, extremely tall women have 'extreme male height'. This stereotypical view of gender fails to recognize the overlapping diversity of cognitive styles found in males and females.

1. Introduction

In this article I want to explore the concept of the 'extreme male brain' and its usefulness in describing people with symptoms of autism. I will also consider the assumptions behind, and implications of, describing a person of either sex who displays supposedly male-typical behaviour, as having a 'male brain'. I will argue that the concept of the 'extreme male brain' raises complex issues about the meaning of 'extreme' in this context, about the meaning of 'male' when applied to persons, tissues or chemicals, and about whether there is any explanatory power in labelling 'behaviour' as 'brain'. It is only when we are clear about what the 'extreme male brain' is that we can evaluate the evidence intended to support or disprove the relationship of this 'extreme male brain' to autistic behaviour.[1]

Autism, Asperger's syndrome and the autism spectrum are important concepts in modern clinical and cognitive psychology. Starting from descriptions by Kanner (1943) and Asperger (1944) of children with social isolation and restricted cognitive interests, there have been many descriptions of people who exhibit this type of behaviour, and many hypotheses about the origins of this condition. Asperger (1944) was the first person to suggest that there is a relationship between autism and male-typical behaviour. This idea has been developed into the proposal that people with autism or Asperger's syndrome have an 'extreme male brain' (Baron-

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[1] I do not wish to consider here the evidence for or against sex differences in brain structure or function in the general (i.e. unselected) population since this is a substantial topic in its own right (e.g. Fine, 2010) or to consider in detail the evidence that the clinical features of autism arise from environmental effects on, or developmental changes in, brain and body structure since this has also been reviewed elsewhere (e.g. Teatero & Netley, 2013).

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Cohen & Hammer, 1997), that is to say, a brain which is both functionally and structurally male irrespective of the sex of the person concerned.

In order to assess the cognitive style in the general population that is associated with clinical autism, Baron-Cohen, Wheelwright, Skinner, Martin, and Clubley, (2001) developed the Autism Spectrum Quotient questionnaire (AQ) comprising 50 questions based on 5 cognitive domains: social skills, communication skills, imaginative flexibility, attention to detail and attention switching. These cognitive domains were chosen because of the cognitive features of autism (but excluding the motor abnormalities) that were described by Rutter (1978) and Wing and Gould (1979), although Baron-Cohen et al. (2001) stressed that the AQ is not an instrument for clinical assessment. Baron-Cohen et al. (2001) predicted and found that people with a diagnosis of high-functioning autism or Asperger's syndrome tended to score 'poor' in the domains of social and communication skills and imaginative flexibility, and 'good' in the domains of attention to detail and attentional focus. Subsequently, data on two separate questionnaires, the systemising quotient (SQ) (Baron-Cohen, Richler, Bisarya, Gurunathan, & Wheelwright, 2003) and the empathising quotient (EQ) (Baron-Cohen & Wheelwright, 2004) were published as independent psychometric instruments which showed that people with high-functioning autism or Asperger's Syndrome tended to be high systemisers and low empathisers. These data, taken together, indicate a relationship between social and communication skills and imaginative flexibility in the AQ to the empathising skills of the EQ, and a relationship between attention to detail and attentional focus in the AQ to the systemizing skills of the SQ, although the overlap is neither theoretically or functionally total.

2. What is the 'extreme male brain'?

'The male brain is defined psychometrically as those individuals in whom systemising is significantly better than empathising, and the female brain is defined as the opposite cognitive profile. Using these definitions, autism can be considered as an extreme of the normal male profile. There is increasing psychological evidence for the extreme male brain theory of autism.' (Baron-Cohen, 2002).

Baron-Cohen (2002) defines 'systemising' as 'the drive to analyse the variables in a system, to derive the underlying rules that govern the behaviour of a system' while he defines 'empathising' as 'the drive to identify another person's emotions and thoughts, and to respond to these with an appropriate emotion'. Identification of these cognitive styles arose from the Autism Spectrum Quotient (AQ) (Baron-Cohen et al., 2001) in which answering 'agree' to questions about attentional style, which have a systemizing component (e.g. I am fascinated by dates) scores positively while answering 'disagree' scores null. Answering 'disagree' to social questions, which may be related to empathising skills, (e.g. I find social situations easy) scores positively while answering 'agree' scores null. Thus a high AQ score will be achieved by a person who has a particular interest and skill in systemizing together with a low interest in social or emotional interactions. According to the definition above (Baron-Cohen, 2002), a person with a high AQ score will have a cognitive style which can be described as 'extreme male' or 'autism-like'.

In the SQ questionnaire, 'strongly agree' and 'slightly agree' answers score 2 or 1 points respectively on pro-systemising questions and 'strongly disagree' and 'slightly disagree' answers score 2 or 1 points on negatively-couched systemising questions (e.g. I rarely read about new technology) such that a high systemizing person scores highly on this questionnaire. A comparable scoring system is used in the EQ questionnaire, which counts as positive 'agree' scores on pro-empathising questions together with 'disagree' scores on negatively-couched empathising questions (e.g. seeing people cry doesn't really upset me) such that a highly empathetic person scores highly on this questionnaire.

To ascertain whether such measurements can justify the use of the term 'extreme male brain' to describe or explain autism we need to consider the nature of the questionnaires, how a score on these scales can be linked with the brain and with sex, and finally to ask how the 'extreme male brain' theory of autism can be tested.

2.1. Problems with the AQ

First, I want to consider the theoretical relationship between any cognitive attribute and the ways in which it can be measured and so I will start with an non-specific quality which I will refer to only as a 'particular cognitive style'. This gives us the freedom to think about the relationship between a psychological variable and a psychological metric in general before applying that understanding to the relationship of the AQ to cognition.

2.2. Externally-defined and internally-validated metrics

In order to explore any 'particular cognitive style' we would need to be able to measure it - we would need a metric. Some human attributes can be measured according to an *externally-defined* metric; for example, you can measure people's height in centimetres. But we would have no externally-defined metric for a 'particular cognitive style' we would just have perceived the possible existence a particular cognitive style. We could invent a questionnaire to measure the 'particular cognitive style' in individuals and then describe the distribution of that attribute within the general population. This would be an *internally-validated* metric - one in which the questions reflect the originally perceived variable such that the people who strike us as having that particular cognitive style turn out to have higher scores on the metric than those whom we did not so regard.

As we shall see in more detail later, externally-defined and internally-validated metrics have different relationships to the thing they are measuring. For an externally-defined metric, such as height, the scores on the metric need not be normally distributed – the scores will just be whatever they are found to be, although in practice externally-defined biological variables often do form a normal distribution. The situation is different for an internally-validated metric. In making a questionnaire, we would include questions that