Autism, mathematics, and logic: is there a link?

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Introduction

This paper serves to answer if those (particularly adolescents) with Autism Spectrum Disorder have influenced logical ability, and mathematical ability, given in the form of proof-based, formal mathematics, as in what a pure mathematics specialization would concentrate on. Mathematics is not about mindless computation, which is what G.H. Hardy would call "school math", but much more about proofs, logical arguments, and problem solving. The focus on "actual" or "authentic" mathematics is a key motivation for this paper. As a remark, many studies on the subject of Autism Spectrum Disorder and mathematical ability use standardized tests and often involve word problems, which are generally ambigous to autistics, and generally score lower on. (Bae et al. 2015, Irene Polo-Blanco et al. 2024) Also, said studies do not include what I would call "authentic" mathematics, using rigorous proof. Many pure mathematicians were autistic, including Kurt Goedel, Paul Erdos, Alan Turing, amongst others not examined, generally because they were too obscure or did not have many accounts of their personality, although Cantor is also described as "very erratic" (I. Grattan-Guinness, 2006). Also, autism is highly overrepresented in mathematicians, mathematics majors, and those in mathematics competitions. Even those without a formal ASD diagnosis may show higher amounts of traits relating to ASD; this is shown in Baron-Cohen's "Autism Quotient". (Simon

Baron-Cohen 2001, Simon Baron-Cohen et al. 2007.) As for on logical abilities in general, this has yet to be explored further, but my hypothesis is thus this:

Hypothesis. Those with Autism Spectrum Disorder have a higher ability to do proof-based, formal, rigorous mathematics, and also logical abilities, such as spotting logical fallacies.

This is somewhat motivated from the fact that (i) autistics are better "systemizers" (Simon Baron-Cohen et al. 2017), (ii) autistics, especially adolescent ones, can detect the "conjunction fallacy" better than neurotypicals (Morsanyi et al. 2010), and that (iii) autistics have a slightly superior ability to detect and recognize fake content (Djaouat 2017). Also, autistics may speak in a very formal tone, which could add to their desire for formal argumentation, such as in a mathematics proof. Additionally, autism is a disorder of high intelligence (Crespi 2016), and the gifted perform better at mathematics and logic (Myers et al. 2017).

Method

Four questions are given, three on mathematics (which focus on logic and proof-writing skills) and one on detecting an informal logical fallacy, which is the red herring fallacy. They are evaluated based on the quality, depth, and validity of the answers. Several neurotypical participants and several autistic participants are recruited. The autistic participants are recruited from the social media website Reddit, in which a "post" is made, and then the autistic participants answer a "form" to answer the questions, whereas the neurotypical participants are volunteers from a Christian middle school. These are the questions:

Problem 1: Cantor

The number of numbers made by counting from 1,2,3... is more than the number of numbers between 0 and 1. This proceeds because one can show that a collection of objects has the same amount of objects as another collection of objects by showing that someone can correspond each object from one collection to another collection. (As an example, one can show that 5 = 5 by demonstrating that five objects can correspond with five objects) How do you think such an argument may proceed, or how could you show that you cannot correspond each object from 1,2,3... to the numbers between 0 and 1 (think 0.125245, 0.12232355, etc.)?

Problem 2: A mathematical fallacy

Take this ”proof” that 2 = 1.

- a = b = 1.
- a2 = ab.
- a2 - b2 = ab - b2.
- Factoring the above, we have (a + b)(a - b) = b(a - b).
- Canceling both sides, (more specifically, (a - b) on both sides), we have a + b = b.
- 2 = 1.

Which step went wrong?

Problem 3: A logical fallacy

Take this prompt on Senate Bill 47:

Will the new tax in Senate Bill 47 unfairly hurt business? I notice that the main provision of the bill is that the tax is higher for large employers (fifty or more employees) as opposed to small employers (six to forty-nine employees). To decide on the fairness of the bill, we must first determine whether employees who work for large employers have better working conditions than employees who work for small employers. I am ready to volunteer for a new committee to study this question. How do you suppose the committee should go about collecting the data we need?

What went wrong, and what errors are present arguing about the fairness of the bill?

Problem 4: Prove that 2 even numbers always add to an even number.

Do not proceed the argument as: 2 + 2 = 4, 2 + 4 = 6, and as every number that I have checked satisfies the argument, then Problem 4 is true. Instead, prove logically, from the definition of even numbers (as 2k, in which k is any integer, like 2(3) = 6, or 2(5)= 10), that Problem 4 proceeds. (Hint: Use algebra)

Results

The autistic participants showed better ability in (a) detecting fallacies, particularly in Question 3, (b) gave better, deeper explanations or “proofs” of problems, for which they were more rigorous, and (c) better validity in answers. These characteristics are very important in order to do actual, rigorous, and proof-based mathematics, and are also present in many philosophers.

Citations

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