DOCUMENT SUMMARY

This 2009 paper by Simon Baron-Cohen and colleagues argues that **hyper-systemizing**—the drive to analyze systems and identify 'if-then' rules—is the core cognitive style that predisposes individuals with **Autism Spectrum Conditions (ASC)** to develop special talents. The authors contrast this theory with Weak Central Coherence and Executive Dysfunction, positing that excellent attention to detail in ASC is not random but is purposefully driven by systemizing. They further trace this excellent attention to detail back to a biological foundation of **sensory hypersensitivity**.

FILENAME

`baron-cohen_2009_research_report_autism_talent_hyper-systemizing`

METADATA

Category: RESEARCH **Type:** report **Relevance:** Core **Update Frequency:** Static **Tags:** #autism #talent #hyper-systemizing #attention-to-detail #sensory-hypersensitivity #weak-central-coherence #savant #baron-cohen **Related Docs:**

- happe_2009_research_report_autism_talent_detail_focus
- murray_2005_research_report_monotropism_autism_attention
- white_2020_research_report_adhd_creativity_conceptual_expansion **Supersedes:** N/A

FORMATTED CONTENT

Talent in autism: hyper-systemizing, hyper-attention to detail and sensory hypersensitivity

Abstract

We argue that **hyper-systemizing** predisposes individuals to show talent, and review evidence that hyper-systemizing is part of the cognitive style of people with **autism spectrum conditions (ASC)**. We then clarify the hyper-systemizing theory, contrasting it to the **weak central coherence (WCC)** and **executive dysfunction (ED)** theories. The ED theory has difficulty explaining the existence of talent in ASC. While both hyper-systemizing and WCC theories postulate excellent attention to detail, by itself excellent attention to detail will not produce talent. By contrast, the hyper-systemizing theory argues that the excellent attention to detail is directed

towards detecting 'if p, then q' rules (or [input-operation-output] reasoning). Such law-based pattern recognition systems can produce talent in systemizable domains. Finally, we argue that the excellent attention to detail in ASC is itself a consequence of **sensory hypersensitivity**. We review an experiment from our laboratory demonstrating sensory hypersensitivity detection thresholds in vision. We conclude that the origins of the association between autism and talent begin at the sensory level, include excellent attention to detail and end with hyper-systemizing.

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1. Introduction

Savantism is found more commonly in **autism spectrum conditions (ASC)** than in any other neurological group, and the majority of those with savantism have an ASC. This forces us to ask: why the link between talent and autism?

In this paper, we argue that while savantism (defined as prodigious talent) is only seen in a subgroup of people with ASC, a universal feature of the autistic brain is **excellent attention to detail**. Furthermore, we argue that excellent attention to detail exists in ASC because of evolutionary forces positively selecting brains for strong systemizing, a highly adaptive human ability.

Strong systemizing requires excellent attention to detail, and in our view the latter is in the service of the former. Next, we argue that one can trace excellent attention to detail to its basis in **sensory hypersensitivity** in ASC.

2. Systemizing

Talent in autism comes in many forms, but a common characteristic is that the individual becomes an expert in recognizing repeating patterns in stimuli. We call this **systemizing**, defined as the drive to analyse or construct systems. These might be any kind of system. What defines a system is that it follows rules, and when we systemize we are trying to identify the rules that govern the system, in order to predict how that system will behave.

When we think about the kinds of domains in which savants typically excel, it is those domains that are highly systemizable. Examples might be from numbers (e.g. spotting if a number is a prime number), calendrical calculation, drawing, music, memory, or even learning foreign languages.

3. Systemizing the Rubik's Cube

Let us take a cardinal example of savantism: a non-conversational child with autism who can solve the Rubik's Cube 'problem' in 1 min and 7 s. This is a nice example because it illustrates several things. First, that the child's non-verbal ability with the Rubik's Cube is at a much higher level than either his communication or social skills. Second, it prompts us to ask: what are the processes involved in solving the Rubik's Cube? At a minimum, it involves analysing or memorizing the sequence of moves to produce the correct outcome. It is a series of 'if p, then q' steps.

4. Systemizing in Autism Spectrum Conditions

What is the evidence for intact or even unusually strong systemizing in ASC?

- First, such children perform above the level that one would expect on a physics test.
- Second, using the **Systemizing Quotient (SQ)**, people with high-functioning autism or AS score higher on the SQ compared with general population controls.
- Third, children with classic autism perform better than controls on the picture-sequencing test where the stories can be sequenced using physical-causal concepts.

Strong systemizing is a way of explaining the non-social features of autism: narrow interests; repetitive behaviour; and resistance to change/need for sameness. This is because when one systemizes, it is best to keep everything constant, and to only vary one thing at a time. That way, one can see what might be causing what, and with repetition one can verify that one gets the very same pattern or sequence (if p, then q) every time, rendering the world predictable.

5. Systemizing and Weak Central Coherence

As with the **weak central coherence (WCC)** theory, the **hyper-systemizing** theory is about a different cognitive style. Similar to that theory, it also posits excellent attention to detail (in perception and memory), since when one systemizes one has to pay attention to the tiny details.

One difference between these two theories is that the WCC theory sees people with ASC as drawn to detailed information either for negative reasons (an inability to integrate) or because of stronger local processing. By contrast, the hyper-systemizing theory sees this same quality (excellent attention to detail) as being highly purposeful: it exists in order to understand a system.

> In earlier formulations of systemizing, the key cognitive process was held to be in terms of **[input-operation-output]** processing (Baron-Cohen 2006). In mathematics, if the input = 3, and the operation = cubing, then the output = 27... Note that WCC makes no mention of the key part of this that is noting the consequences of an operation. Simply seeing the parts in greater detail would not by itself lead to understanding the operations (the moves) needed to solve the Rubik's Cube.

Another difference is that the hyper-systemizing theory (but not WCC) predicts that over time, the person may achieve an excellent understanding of a whole system. WCC would predict that the individual will be forever lost in the detail.

6. Hyper-Systemizing: Implications for Education

Teachers need to take into account that hyper-systemizing will affect not only how people with ASC learn but also how they should be assessed. A man with Asperger's syndrome reported recently that 'I see all information in terms of links... If I am asked a question in an exam I have great difficulty in completing my answer within the allocated 45 min... because every fact I include has thousands of links to other facts, and I feel my answer would be incorrect if I didn't report all of the linked facts.'

For the hyper-systemizer, getting these details correct matters, because the concept and the classification system linking concepts is a system for predicting how this specific entity will behave or will differ from all other entities.

7. Hyper-Systemizing Theory versus Executive Dysfunction Theory

The **executive dysfunction (ED)** theory has attempted to explain the non-social features of ASC, particularly the repetitive behaviour and narrow interests. According to this theory, aspects of executive function involved in flexible switching of attention and planning are impaired, leading to perseveration. The ED theory has difficulty in explaining instances of good understanding of a whole system, such as calendrical calculation. It also does not explain why in autism these "obsessions" should centre on systems.

> ...while the ED theory sees this as perseveration arising from some neural dysfunction... the hyper-systemizing theory sees the same behaviour as a sign that the individual 'understands' the physics (i.e. recognizes the patterns) behind the movement of that piece of string.

8. Sensory Hypersensitivity

Rather than assuming that the strong systemizing in ASC is ultimately reducible to excellent attention to detail, in this section we pursue the idea that the excellent attention to detail is itself reducible to **sensory hypersensitivity**.

Studies using questionnaires have revealed sensory abnormalities in over 90 per cent of children with ASC.

- **Vision:** Individuals with ASC are more accurate at detecting the orientation of first-order gratings.
- **Auditory:** Superior pitch processing has been found in ASC.
- **Tactile:** Hypersensitivity to vibrotactile stimulation has been shown.

In an experiment from our laboratory looking at vision, participants were administered the Freiburg Visual Acuity and Contrast Test.

- The ASC group scored a mean acuity measure of 2.79, which was significantly better than the control group mean of 1.44.
- The Snellen score of 2.79 for the ASC group represents acuity 2.79 times better than normal, and translates to vision of 20:7. This approaches the range reported for birds of prey.

Results from this and other experiments demonstrated greater sensory perception in ASC across multiple modalities. In the context of the earlier discussion of hyper-systemizing and excellent attention to detail, we surmise that these sensory differences in functioning may be affecting information processing at an early stage in ways that could both cause distress but also predispose to unusual talent.

> We conclude that the search for the association between autism and talent should start with the **sensory hypersensitivity**, which gives rise to the **excellent attention to detail**, and which is a prerequisite for **hyper-systemizing**.