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The beautiful otherness of the autistic mind

Francesca Happé and Uta Frith

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Introduction

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1. INTRODUCTION

Of all the features of autism, none is more widely admired than the remarkable talent found so frequently with this condition. Yet special talents are still less researched and less well understood than other features of autism. In popular accounts of autism, the existence of extraordinary talent in art, music, maths, calendar calculation or memory, often referred to as savant skills, has become a stock in trade. As a result of this fascination, it is now very likely that any eccentric scientist or artist, living or dead, will come under scrutiny for having traits of autism or Asperger syndrome. But are geniuses, such as Newton or Einstein, personifications of the association of autism and talent? In our view, this notion misrepresents both autism and talent. Nevertheless, the association of autism with special talent, sometimes at the highest level, cannot be denied and provides one of the most tantalizing mysteries of this condition.

Sacks (1985) was probably the first to raise popular awareness of people with severe brain abnormality who nonetheless showed extraordinary ability, in his famous account of 'the twins'. John and Michael, then 26, were living in an institution when Sacks met them. When a box of matches spilled on the floor, '111, they both cried simultaneously; and then, in a murmur, John said 37. Michael repeated this, John said it a third time and stopped. I counted the matches—it took me some time—and there were 111'. Amazingly, the twins could not only count the large number of matches within seconds, they were able to see the prime number 37 almost instantly, and saw it three times. While unable to communicate with John and Michael in the ordinary way, Sacks was able to engage with them by offering ever-larger prime numbers for their delight. Treffert (1989) described many more examples of staggering savant skills in his seminal book, *Extraordinary people*, in which he defined savantism as a rare condition that combines brilliance in one field with severe intellectual limitations in almost all others.

What can science tell us about autistic savants? Twenty years ago, O'Connor & Hermelin (1988) published an annotation on 'Low intelligence and special abilities'. These pioneering researchers had, for the first time, moved research on savant skills beyond the descriptive case study, through innovative experimental designs and the use of appropriate control groups. They thus paved the way for modern cognitive psychological studies of the conundrum: how can individuals with substantial impairments of intellect and social adaptation show skills that outstrip and baffle even the most intelligent 'neurotypical'?[1]

The later 1980s and 1990s were dominated by social deficit accounts of autism spectrum disorders (ASD), fired by the breakthrough finding that individuals with ASD failed simple tests of theory of mind. However, the last decade has seen a return to interest in domain-general accounts, and particularly to interest in areas in which people with ASD show special ability rather than disability—a trend started by the concept of 'weak central coherence' (Frith 1989).

There has also been a return to interest in basic sensory processes in autism, also foreshadowed by Hermelin & O'Connor's (1964) early experiments on unusual processing of sensory input. Their initial hypothesis that children with autism favoured touch and smell over vision and hearing gave way to accounts centred on the nature of the resulting representations in the mind of the autistic child. Their notion that sensory information was stored more veridically, but less adaptively, due to lack of recoding for meaning, also prefigured the theories presented by some authors in this issue.

The papers in this issue reflect the content of a joint Royal Society and British Academy Discussion Meeting, held in September 2008. In line with the remit of these institutions, the range of contributions spans humanities and sciences, to debate questions such as: does autism predispose to talents, and if so why? Can talent result from neurocognitive deficits? What is the nature of autistic creativity versus 'neurotypical' creativity? In this way, the contents reach out beyond autism and raise questions about the basis of talent and creativity more generally.

2. THE KEY PUZZLE: SPECIAL SKILLS ARE ASSOCIATED WITH AUTISTIC DISORDER

The history and origins of the savant concept are introduced by Treffert (2009), who vividly illustrates the phenomenon with case material. Treffert originally introduced and here discusses the distinction between savant skills at different levels of achievement. The very rare 'prodigious savants' are those whose abilities would be staggering in any context. 'Talented savants' and those with 'splinter skills' show striking abilities relative to their other skills and are relatively more common. While up to now the assumption has been

One contribution of 18 to a Discussion Meeting Issue 'Autism and talent'.

[1] A note on terminology: 'Neurotypical' is the term coined by people with autism spectrum conditions/disorders for those without such conditions. In this issue, we have left unedited authors' use of 'autistic' and 'with autism'. While the latter has been preferred in recent years by those working in the field, the former has been embraced in some recent writings by those on the autism spectrum.

that savantism only occurs in approximately 10 per cent of cases with ASD, Howlin and her colleagues (2009) provide evidence of much higher prevalence. In a large clinical cohort, almost 30 per cent show an outstanding skill either in terms of peak performance on intelligence subtests or parent-rated savant skills (in, for example, memory, music or calculation). The task, then, is to explain why people with ASD appear to show striking isolated talents at such a high rate, and much more often than any other group.

Several authors in this issue offer hypotheses for why autism should be associated with talent, with remarkable consensus that the ability to process local information plays a key role. Happé & Vital (2009) suggest that detail-focused attention and memory predispose to the development of talent, both in the general population and in autism. Baron-Cohen *et al.* (2009) suggest that superior sensory acuity across modalities underlies such detail focus, which in turn fosters the tendency to explore and master closed systems (e.g. the calendar). With the enhanced perceptual functioning theory, Mottron *et al.* (2009) propose that locally orientated processing and, specifically, detection of patterns in the environment, underlies the high incidence of savant skills in autism. Plaisted Grant & Davis (2009) also emphasize the qualitative differences in perceptual and cognitive processing in ASD, and make tentative links to underlying neural systems. These very different theorists share the view that an ability to attend to and process featural information plays an important part in predisposing to special skills of a savant sort. This view is upheld, for example, in a detailed case study of a prodigious mnemonist and calculator with Asperger syndrome and synaesthesia who shows a preference for local processing and an unusual pattern of brain activation while remembering digits (Bor *et al.* 2007).

3. BUT NOT EVERYONE WITH TALENT IS AUTISTIC

There is general agreement that savant skills can be found in people who are not autistic. An open question is whether such individuals share the cognitive characteristic of bias for superior featural processing. If 'eye for detail' is an important predisposing factor in talent, regardless of autism, this might perhaps help to redirect the trend for 'Asperger spotting' in geniuses current or long dead: instead this theory suggests that it is one or more of the cognitive biases/abilities characteristic of ASD, rather than the diagnosis itself, that is linked to special abilities and could usefully be identified in well-known individuals, from Newton to Bill Gates.

If savant skills can be found in individuals who do not meet the diagnostic criteria for ASD, an obvious question is whether the nature of skill is different in ASD and non-ASD savants. Drake & Winner (2009) in their paper on 'precocious realists' discuss commonalities between these young amazingly accurate drawers and artists with autism. They explore global and local processing in these children and find superior segmentation of parts and good visual memory, as in autism, but, unlike in autism, a distinct benefit from global coherence.

Cardinal (2009) discusses artists uninfluenced by current art theory or fashion and largely self-taught, who may be considered 'outsiders' for a variety of reasons. Common features across these non-autistic and autistic artists include self-motivation, self-teaching and extreme productivity. One of the thorny questions that savant art in particular raises is whether we admire the art works for their own sake or because they were produced by a savant. Would these works be worthy of the highest regard if we did not know who had produced them? As Cardinal (2009) points out: 'Outsider art earns its name not because of an association with a lurid case history or a sensational biography, but because it offers its audience a thrilling visual experience', the chance 'to savour the extreme experience of Otherness, in the form of a seductive exoticism that produces an inarticulate yet intense pleasure'. Indeed art and music, whether created by the autistic individual or by any other individual, act as 'a privileged medium of human contact'. This view resonates with Heaton's (2009) position, and her findings specifically that emotion communicated in music is apparently fully accessible to children with autism.

4. AND NOT EVERY PERSON WITH ASD SHOWS SAVANT SKILLS

The public fascination with savant skills may have the dangerous consequence that striking skills are expected of everyone on the autism spectrum. Draaisma (2009) explores the presentation of autism in fictional narrative, particularly in film, and concludes that savant skills are vastly overemphasized in this genre. For the parents of a lower-functioning child with autism who does not show a developed talent, the equation of autism with savant skills can be quite distressing. Hacking (2009) considers how the proliferation of autobiographies written by people on the autism spectrum may also inadvertently give a misleading picture of autism, since these writers are by their very nature exceptional in their ability to communicate their experience.

A key question is why some, maybe most, people with ASD do *not* develop savant skills. This puzzle is paralleled in the case of acquired skills following neurological damage or induced by repetitive transcranial magnetic stimulation (rTMS), as reported by Snyder (2009). Snyder's controversial theory proposes that it is only top-down inhibition that prevents us from being creative artists ourselves. People with autism, and neurotypicals when their left anterior temporal lobe is reversibly disabled with rTMS, can escape this inhibition. This means they have privileged access to raw forms of information, not normally accessible, that may give a new and more veridical perceptual insight, in contrast to expectation-biased interpretations. However, not every volunteer improves their savant-type skills under rTMS. Young *et al.* (2004), for example, found enhanced skills in memory, drawing, maths or calendar calculating as a result of rTMS, but only in 5 of 17 participants. What is different, cognitively or neurally, in this subgroup?

One possibility is that *all* people with autism have the potential to develop savant skills, and that chances of exposure and opportunity play a large part in determining outcome. Heaton (2009) reports data from musically untrained young people with autism and suggests that a substantial minority show potential to develop skills in music perception and performance. Better pitch and timbre discrimination appear to be widespread in ASD. Plaisted Grant & Davis (2009) make a plea for greater recognition of the value of autistic characteristics such as fine discrimination, which have currency in the workplace. While it is unlikely that every child with autism would become a maths, art or music savant, even with hours of training, we hypothesize that each could develop an identifiable special ability. For example, great facility with programming, rote memory for an area of interest, absolute pitch and superior ability to spot grammatical and typographical errors are often observed. Hyperlexia, and in some striking cases even learning to read fluently before developing speech, is moderately common in autism (Grigorenko *et al.* 2002)—and is well discussed in the contribution by Mottron *et al.* (2009). However, this is often not considered a savant skill because the absolute level of attainment does not exceed what ordinary older children eventually achieve. Similarly, distress at minute changes in the environment, insistence on taking exactly the same route to a destination or extreme reactions to apparently mild sensory stimuli are not viewed as 'talents', but might signal superior memory and discrimination. The challenge is to know how such abilities might be channelled into useful skills that could bring personal satisfaction or vocational success.

5. 10 000 HOURS OF PRACTICE

It is sometimes said that genius is 99 per cent practice, and a target article by Howe *et al.* (1998) emphasized the overwhelming role of practice in expertise across a range of skills. However, many of the commentaries to this article argued for the role of innate talent, e.g. in predisposing cognitive or physical characteristics. In addition, individual differences in commitment, endurance, concentration and motivation are widely discussed in the literature on, for example, success in sports (e.g. Ericsson *et al.* 1993). The origins of these motivational characteristics are not well understood.

Modern conceptions of gene–environment interplay render obsolete any strict dichotomy between nature and nurture. However, it is impossible to resist asking, could we all be savants if only we put in the hours of practice? Woollett *et al.* (2009) show that navigation expertise rests on years of training and even then depends on constant practice. London taxi drivers who have internalized the complex street map of London show concomitant changes in the hippocampus. Interestingly, these changes reverse once practice ceases, following retirement. However, there is also another side to the argument. Approximately two-thirds of the candidates who begin the 3-year London black-cab training drop out and never acquire 'The Knowledge'. This large attrition rate may suggest that future taxi drivers who stay the course have a preexisting talent, and it is in the context of this self-selected sample that years of practice translate into the highest level of expertise. It seems very likely, then, that the same amount of practice will have dramatically different outcomes in different people.

Neuroimaging studies in this issue by Cowan & Frith (2009) and Wallace *et al.* (2009) also suggest that practice alters brain structure and/or function in savant calendar calculators. No evidence was found of abnormal or unexpected brain areas drawn into service, also supporting perhaps continuity with non-savant maths skills. This fits well with the assertion by Hermelin & O'Connor (1986), based on the patterns of behavioural data, that calendrical calculators have extracted rules and regularities of the calendar and are not simply using rote memory.

6. WELLSPRINGS OF TALENT

Can autism reveal some important truths about all creativity and genius? Among the contributors to this issue there is a strong consensus that one of the deep sources of exceptional skill is the obsessive drive to practice. But this is not all. According to Baron-Cohen there is also an obsessive need to classify and to make systems. One of the illustrations in this issue presents an image of different species of crows by renowned savant Gregory Blackstock. This is typical of his art, which often consists of representing, in the form of a pictorial dictionary as it were, all the types of a category he knows. Other examples include turkeys, mackerel, collie dogs, carnivorous plants, hats, lighthouses, saws and knives. This type of work, which appears to reflect what Baron-Cohen has termed systemizing, exhaustively represents exemplars of a category side by side without concern for higher-level prototype.

Happé & Vital (2009) in this issue suggest that the preference for detail over prototype and generalisation underlies both talent and repetitive and restrictive behaviour in autism. Their analysis of twin data suggests a genetic basis for this association. Further exploration should shed light on whether talents in different domains spring from a common set of genetic/environmental factors. Do genetic factors predispose for talent in *any* area or for talent specifically in, say, music? Documenting the different or similar talents shown by identical twins will elucidate this question. It would also be of interest to establish whether relatives of savants—at least in cases of familial, versus de novo, autism (Abrahams & Geschwind 2008)—show special skills or cognitive characteristics that might predispose to talent.

Most of the accounts presented in this issue suggest that the predisposition to talent is to a large extent domain neutral. If this is the case, we would not be surprised to find that multiple talents develop in a single individual—time constraints allowing. Wallace *et al.* (2009) present one such case, and several more are known in the literature. Examples include: perfect pitch, calendar calculation and drawing all present in the case of Trehin (2006); perfect pitch, drawing and music in the case of Wiltshire (1989; Sacks 1995); and memory for numbers and learning languages in the case of Tammet (2006). Such cases would be very surprising if the basis for talent in, for example, calculation, were quite different from that for art or music.

Hardly anything is known as yet about the brain in autistic savants. The anatomical findings reviewed by Casanova and Trippe (2009) in their contribution to this issue suggest that minicolumnar peculiarities are seen in talented neurotypical scientists (Casanova *et al.* 2007), and are also found in ASD individuals, regardless of savant status. The evidence for atypical minicolumnar organization in autism fits well with the ideas on neural hyperconnectivity in local areas alongside hypoconnectivity over the longer range (e.g. Belmonte *et al.* 2004). A rather different approach focuses on rare single-gene disorders with a high prevalence of autism, with a recent suggestion that some molecular defects in autism may interfere with mechanisms of synaptic protein synthesis linked, theoretically, to both cognitive impairment and savant skills (Kelleher & Bear 2008).

7. THE IMPORTANCE OF FOSTERING TALENT

A theme that emerged from the Discussion Meeting was the adaptive value of fostering special interests and talents. This might seem self-evident, but stands in contrast to the tendency to see narrow and obsessive interests as maladaptive and limiting. Heaton (2009) makes a strong case in her paper that learning to play music has benefits for both social integration and personal development for young people with autism. Her work suggests untapped potential special to ASD, which makes the task of teaching children with socio-communicative impairments particularly important. For such children, music lessons should not be considered a luxury. Untapped potential in art or maths remains to be documented, but anecdotally parents or carers often discover an existing talent entirely by accident.

It may well be that the most paradoxical talent shown by some autistic individuals is the ability to tell their own story. Grandin (2009), who contributes here a paper about her own ability to think visually, is perhaps the most famous example. Hacking (2009) considers the paradox and the power of autobiographical accounts to shape our concept of autism. This, he points out, is not without danger. In particular, it is not clear to what extent we can generalize from the experiences reported by a number of high-functioning people with ASD to the experience of others who may never be able to speak for themselves. He gives the salutary warning that we really cannot know anything of what it is like 'inside the autistic mind'.

One outstanding message in Grandin's presentation at the meeting was the possibility of lifelong learning: 'I felt my brain switched on when I hit fifty'. This is discussed in her paper in this issue and raises the interesting possibility that developmental periods of exceptional brain plasticity may be extended in ASD. Lifelong learning may be of special importance in autism.

A striking feature of many talented people, whether autistic or not, is the precocious emergence of their skills. This in turn evokes a special environment, particularly in terms of the personal engagement of parents and teachers. The delight that parents feel in their child's achievement is at least as great in the case of autistic savants as neurotypical prodigies. Non-autistic maths, chess or sports prodigies also benefit from intense long-term professional coaching relationships, which deliver systematic expert feedback. By contrast, in many cases autistic talent emerges fully fledged without any systematic feedback by a trainer. In the case of calendar calculation, for instance, parents sometimes say they would not have wished to train this skill, and would have channelled their child's interest into a different direction, if only they could.

8. FUTURE RESEARCH DIRECTIONS

Paul Trehin (http://pagesperso-orange.fr/gilles.trehin.urville/accueil.html), whose comments and questions at the Discussion Meeting were enlightening, related the following anecdote about his son, Gilles, then aged 8: 'While coming back from New York City by train, in one of the cars one ceiling light was blinking, remaining longer dark than bright. As soon as our son arrived at home, he rushed to his bedroom to fetch a pencil and a page of paper to draw the ceiling of the train car with a dark ceiling light. It seems that, during early phases of talent observation at least, drawing is guided by a strong urge to draw, regardless of whether the drawing will be seen or not by someone else. There is no desire to communicate, the child draws for his own purpose, probably to fix a perception in space and time' (personal communication).

This anecdote highlights, as well as the remarkable focus on detail, the mystery of motivation in talent. Mottron *et al.* (2009) are unusual in considering explicitly the emotional aspects of savant skills. Winner (1996) coined the phrase the 'rage to learn' and argued that this is what characterizes exceptionally gifted children. For these children, learning, practice and performance are all rewarding in their own right and not a means to other rewards.

It seems to us that the single largest remaining puzzle is why repetitive practice in a narrow domain is so enormously rewarding for individuals who develop savant skills. On the one hand, we all enjoy doing things we are good at. However, most neurotypical individuals do not enjoy *getting to be good at* savant skills: when ordinary volunteers are instructed to learn calendar calculation, for example, it is notable that they stop as soon as they can.

Perhaps this contrast between meaningless repetition for the neurotypical trainee and enjoyable repetition for the ASD trainee savant can be understood through the notion of detail focus. Repetition is not repetition, for example, if you have expert levels of discrimination. Listening to different recordings of the same symphony might strike some as repetitive, but these sound entirely distinct to an expert. The child with autism who would happily spend hours spinning coins, or watching drops of water fall from his fingers, might be considered a connoisseur, seeing minute differences between events that others regard as pure repetition.

In the neuroscience of decision making, the tendencies 'to exploit' versus 'to explore' have been successfully contrasted in terms of computational models of learning (Daw *et al*. 2006). Why would you ever *not* order your usual dish at your favourite restaurant? Sameness is what people with ASD would prefer, even over decades, while for neurotypicals there is pleasure in novelty and boredom in repetition. In the natural environment, it makes sense for animals to stay and exploit a familiar and rewarding fruit tree, yet sooner or later a well-adapted animal needs to move on, and this will require exploring the unknown and finding reward in doing something different. In autism, the aversion to novelty suggests a different balance of reward value for exploiting versus exploring. Thus, reward-learning paradigms might open new avenues for investigation of savant skills. For example, is the ability to practice without boredom connected with a different balance of rewards from novelty and familiarity?

Understanding why the individual with savant skills chooses to 'practice' day and night may lead us to a better understanding of the apparently meaningless repetition and insistence on sameness seen throughout the autism spectrum. In this way, the study of savant skills could, perhaps, lead to a better appreciation of the beautiful otherness of the autistic mind.

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Francesca Happé[1,*]
Uta Frith[2,3] *January 2009*

[1]*MRC Social, Genetic and Developmental Psychiatry Centre, Institute of Psychiatry, King's College London, London SE5 8AF, UK*
E-mail address: francesca.happe@iop.kcl.ac.uk
[2]*Institute of Cognitive Neuroscience, University College London, London WC1N 3AR, UK*
[3]*CFIN, University of Aarhus, 8000 Aarhus, Denmark*
*Author for correspondence.

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