Chapter 2

More Than Meets the Eye: Blindness, Talent and Autism

We have all come across blindness and for the most part think of it as a sensory-perceptual loss for which the remaining functional sensory channels like hearing or touch can provide some compensation. However, in the case of autism the impairments in communication, in social understanding and imagination, as well as the ritualistic and obsessional behaviours seem to be features of a developmental disorder that cannot easily be compensated for. In certain respects these individuals are “blind” to some aspects of the world around them, and this has consequences for their behaviour. In the first part of this chapter we explore some of the associations between autism and blindness by focusing on early childhood behaviour. Three single case studies are presented that illustrate important features discussed in the theoretical considerations. In the second part of the chapter the impact of blindness beyond the early developmental years, is considered in the context of memory performance. One suggestion given prominence concerns the role of musical pitch memory and this links with the final section where talent is considered. Research with artists and musicians both with and without autism is used to illustrate a cognitive style that may be associated with the development of talents. The connections, with reference to the development of talent, autism and blindness, are examined. In the early 1980’s there seemed no direct association between these, but as we will describe in this chapter it may be that there is more to this than meets the eye.

RESEARCH IN EARLY CHILDHOOD BEHAVIOURS

Theory of mind: Theoretical considerations

Visual experience provides children and infants with a rich source of information about themselves and their surroundings. Through vision children are able to observe connections among other people’s expressions of emotion and witness the context within which various feelings arise. For such reasons vision can be seen to play a critical role in the development of Theory of Mind.

Theory of Mind refers to the “every day” ability to understand other people’s beliefs, thoughts and desires in order to explain and predict their behaviour. With the ability to infer mental states, like the true and false beliefs of one-self and others, children become more capable of participating in a wide range of conversational and social interactions. Many studies now indicate that in almost all normally developing children theory of mind develops by the age 4-5 (Perner, Leekam & Wimmer, 1987).

With his modular account of mind Baron-Cohen (1995) has argued that the monitoring of others eye direction and subsequent integration of this with a “shared visual attention mechanism” plays a key role in establishing a Theory of Mind module in the developing infant. Similarly, in the “theory-theory” account originally offered by Meltzoff & Gopnik (1993), visual imitation provides the starting point for Theory of Mind development, requiring the child to map the seen movements of others onto the felt movements of self in order to produce an imitation. Furthermore, Hobson (1993) described foundations of Theory of Mind and interpersonal understanding in terms of a child taking part in triadic interactions, mainly visually based. Through joint attention behaviours (i.e. gaze monitoring, following points and producing proto-declarative points) that involve the child, an object or event and another person, the child is able to comprehend the attitude of the other person towards the object. These joint attention behaviours, that involve triadic co-ordination or sharing of attention, emerge in typical development between 6 and 12 months (Leekam & Moore, 2001) and are usually carried out in the visual modality (Hobson, 1993).

Significantly, disruption of joint attention behaviours has been given a central role in autism. More specifically, typical disturbances in social and communicative development seen in autism has been linked with impairment of Theory of Mind abilities, which is seen as the core deficit in autism (Happé, 1993). It is not surprising then that children who are autistic have consistently been found to perform poorly on so-called false belief tasks (e.g. Baron-Cohen, Lesly & Frith, 1985). Such tasks specifically require children to use their ability to infer mental states in order to predict other people’s behaviours and beliefs.

Hobson (1993) was amongst the first to suggest a functional overlap in the developmental psychopathology of children who are congenitally blind and children who are autistic. In the case of children who are blind this is likely to be associated with the fact that without vision (and joint attention) they are denied the chance to associate emotional and mental states with their behavioural correlates. Brown, Hobson, Lee and Stevenson (1997) found that a lower ability group of children with visual impairment (verbal IQ<70) could not be distinguished from children with autism by their scores on checklists of autistic-like behaviours whereas a higher ability group (verbal IQ>70) showed a higher level of these behaviours than normally developing children. Similarly, some children with profound congenital visual impairment (and no other impairments) have been found to have problems with false belief tasks at chronological and verbal mental ages older than 4 years therefore demonstrating a delay in Theory of Mind development (Peterson, Peterson & Webb, 2000; Green, Pring & Swettenham, 2003;).

Indeed, some children with profound visual impairment have been found to resemble sighted children who are autistic in various aspects. The similarities include abnormalities in social-communicative competence (Fraiberg, 1977), difficulty in emotional expressiveness and emotional recognition (Minter, Hobson & Pring, 1991; Rogers & Puchalski, 1986), a characteristic pattern in use of creative symbolic play and language (e.g. echolalia and pronoun reversal) (Andersen, Dunlea & Kekelis, 1984), mannerisms and stereotypical ritualistic behaviour (Chess, 1971) and impairments in cognitive abilities such as abstract thinking (Wills, 1981).

The development of social cognition in children who are blind

Sarah Cupples (now Green) as a postgraduate student of Pring and Swettenham's adopted the approach taken by Hobson (1993). Children with profound visual impairment were presented with standard false-belief tasks, such as the Sally-Anne Task (Wimmer & Perner, 1983), Containers Task and Boxes Task (Minter et al., 1998), as well as other tasks assessing the understanding of more advanced tests of Theory of Mind (e.g. Strange Stories Task by Happé, 1994; also see Pring, Dewart & Brockbank, 1999). These tasks involve second-order false-belief understanding, such as “I know that you know that I am not telling the truth” as well as the understanding of sarcasm and irony. Overall Cupples/Green's research (2001) supported of Hobson’s findings that children without vision appear to be at a significant disadvantage in understanding Theory of Mind, even when they are several years older than their sighted counterparts. On the other hand, even though the majority of children who are blind experience difficulties with false belief understanding and more advanced aspects of social cognition (Cupples, Pring and Swettenham, 1999; Minter et al., 1998) Cupples et al. observed that some children without vision show little or no difficulty at all in this area. More interestingly, those children with profound visual impairment who pass first-order false belief tasks have been found to be no different from sighted children in their performance on second-order false beliefs (Cupples et al., 1999). It seems that once children who are visually impaired understood first-order false beliefs, their advanced understanding seems to “catch up” with that of sighted children. On some occasions however, a more profound deficit can be observed and such children will not be able to make up for this deficit (Cupples et al., 1999). Researchers in the area (e.g. Brown et al. 1997; Hobson, Lee & Brown,1999; Cupples et al., 1999) agree that it is likely that verbal ability plays a very significant role in this process and subsequent outcome.

Three case studies - Katy, Robert and John

Some of the characteristics described above can perhaps best be illustrated by referring to individual case studies. The data was originally collected by Cupples and we present our interpretation of it below.

The three children described here were chosen because they exemplified 3 different ways in which Theory of Mind development may proceed in children with congenital and total sight loss. They were matched by chronological and mental age, which in all three children was within normal range (as assessed by WISC-R, 1976 and WPPSI, 1967). The children were assessed on two occasions with approximately a year in between.

Katy was first assessed at 6 years and 8 months and was 7 years and 11 months at the time of the second session. Her visual impairment is the result of Leber’s Amaurosis, a congenital retinal disorder (Good, 1993). Katy had been in a mainstream school setting since pre-school. Her verbal skills were extremely good (IQ=145) and she showed a consistently high ability pattern across the five WISC-R verbal sub-tests (see Table 2.1). Katy was responsive and chatty during the testing sessions and told the researcher that she enjoyed activities such as playing ‘schools’ with her friends, playing hide and seek, making collages and pictures and sometimes pretending to be other people.

The youngest of the children, Robert was first assessed at the age of 6 years and 6 months and was 7 years and 9 months at the time of the second session. His visual impairment is a result of an inherited syndrome called Norrie's Dissease (Webster & Roe, 1998). Robert, like Katy, attended a mainstream school at the time of the testing. His verbal IQ was found to fall within a normal range (IQ=90) even though there were some inconsistencies in his verbal ability, with relative weakness on the Information and Comprehension sub-tests but strength on the Vocabulary sub-tests (WPPSI, 1967). At an informal interview Robert proved to be very good at imitating voices and said that he liked using cassette machines and making his friends laugh by telling them jokes. He also reported that he never pretended to be another person because he did not "have any favourite characters".

The oldest of the children, John, was 8 years and 1 month at the time of the first session and was 9 years old at the second session. His visual impairment was congenital but without a specific diagnosis. He attended a mainstream school at the time of the testing and even though his verbal IQ was within a normal range (IQ=95) he showed an inconsistent pattern of verbal abilities with relative strength on Digit Span and weakness on Comprehension (WISC-R, 1976). John told the researcher that he likes playing on his computer and brailler and making Lego/Duplo models with his friends but that he never engaged in pretend play.

Place Table 2.1 about here

The three children were initially assessed on first-order false belief tasks (i.e. Sally-Anne Task, Containers Task and Boxes Task) and some advanced Theory of Mind tasks (a modified version of Strange Stories Task by Happé, 1994). Based on tasks devised by Baron-Cohen (1989), they were additionally assessed on second-order Theory of Mind understanding. Finally we (Cupples, Pring, Swettenham & Tadic) examined the relationship between performance on assessments of Theory of Mind development and everyday social skills. We were interested to find out what patterns of ‘real life’ social competence could be found in children who are congenitally blind, regardless of their performance on standard Theory of Mind assessments.

Katy, Robert and John clearly exhibited a different pattern of performance on standardized assessments of Theory of Mind understanding as illustrated in Table 2.2. Katy showed extremely good understanding of Theory of Mind overall. Her performance on the assessment of false belief of first and second order is in line with the performance of sighted children of the same age (Cupples et al. 1999). Robert on the other hand showed a clear initial delay in Theory of Mind development relative to his verbal and mental age and the sighted pattern of development but over a period of 15 months had shown a dramatic improvement passing the first and second-order false belief tasks. John however showed an inconsistent pattern in Theory of Mind development in that he showed some understanding of first-order false belief tasks initially but failed to pass the Theory of Mind tasks overall when assessed again 11 months later, suggesting a longer-term delay in this area of development.

<u>Place Table 2.2 about here</u>

The heterogeneity in development illustrated here confirms earlier findings that while some children with profound sight loss show good understanding of Theory of Mind, as shown in a false-belief paradigm, some children who are blind experience a delay and some even a regression in this area of development (Cupples, et al. 1999). This picture is in line with Fraiberg (1977) and many other clinicians who feel that children who are profoundly visually impaired are more heterogeneous in their developmental patterns than other groups of children with and without impairments. This may be related to the special role of the development of language in such children.

We suggest that the patterns in Theory of Mind development seen in our study may in turn reflect the patterns in language development in children who are blind. Indeed the development of Theory of Mind has been closely linked to language development, the implicit understanding being that a child’s developing knowledge and appreciation of their own and other’s mental states must be facilitated by language (Baron-Cohen, Tager-Flusberg & Cohen, 1993). A relationship between verbal IQ and Theory of Mind ability has already been observed in children with autism in whom language competence was found to make a significant, positive impact on their performance of Theory of Mind tasks (Happé, 1995). Can the performance of the children described here shed light on these issues?

Even though all three children had a verbal IQ within a normal range Katy, who showed a very good overall understanding of Theory of Mind, had a particularly high verbal IQ. More specifically, her verbal mental age at the time when she was 6 years and 8 months old was 9 years and 8 months (154 on the Williams scale). It seems plausible to suggest that such high verbal ability may have helped Katy pass false belief and advanced Theory of Mind tasks all along. But what about children like Robert and John?

A number of developmental studies have shown that there are deviations and delays in language development and vocabulary acquisition in children who are blind (e.g. Andersen, Dunlea & Kekelis, 1984; Landau & Gleitman, 1985). These deviations and delays may be a consequence of a parent/child communication style where attention in a child without vision cannot be caught and directed by eye-contact, leading to a more restricted and less rich language input (Andersen et al., 1984). However, it seems that this can, in the long run be overcome and during the school years the language of children who are blind “catches up” (Landau & Gleitman, 1985). Once a child with profound visual impairment achieves a certain competence in verbal ability they make a big leap in their social cognitive development. This might explain the initial delay in Theory of Mind development in children like Robert at the age when he was first tested.

However, the question remains why some children fail to progress, and in John’s case, even regress in this area of development. Some clinicians (e.g. Dale & Sonksen, 2002) describe a phenomenon of serious developmental disruption or “setback” which seems to occur between 15 and 27 months of age. One explanation for the setback occurring in the children with profound visual impairment is the notion of a sensitive or critical period of brain development in the first to second year of life that is dependent on the visual experience that would be expected at this age (see Dale & Sonksen, 2002). Another explanation is that development had not been "normal" before the setback but that a change seems more apparent in older children because the tests and batteries assessing social and cognitive abilities may detect such changes better at this age.

Testing everyday social competence

To explore "real life" social competence, we adapted the approach taken by Frith, Happé and Siddons (1994). Everyday social skills and adaptation were assessed through the reports of caregivers (i.e. teacher and/or LSA) using the Vineland Adaptive Behaviour Scales - VABS (Sparrow, Balla & Cichetti, 1984) and Active and Interactive Sociability Items (devised by Frith et al., 1994). The children's "personal and social sufficiency" (Sparrow et al., 1984) was assessed on three out of nine sub-domains of behaviour measured by VABS namely: communication, social coping skills and interpersonal relationships. The additional items on Active and Interactive sociability adapted from Frith et al. were used to assess behaviours that could be performed with (Interactive) and without (Active) ability to "mentalize".

Some of these items were of particular interest because of their possible connection to underlying Theory of Mind ability. For instance, social coping skills involve behaviours such as apologizing for mistakes and responding appropriately to meeting strangers, both of which require an awareness of other people's thoughts and feelings. Similarly, interpersonal relationships such as having friends and showing thoughtfulness in gifts also show awareness of other people's feelings and ideas.

In their study with 24 children with autism Frith et al. (1994) found a relationship between performance on false belief tasks and the scores on the VABS and interactive sociability. More specifically, those children with autism who passed first-order Theory of Mind had higher scores on VABS communication domain and Interactive Sociability items than those who failed the tasks, notably our research yielded the same pattern. Katy, who showed extremely good performance on Theory of mind assessment, received higher scores on Expressive Communication (VABS) and Interactive Sociability than Robert and John whose Theory of mind understanding was delayed (see Table 2.2 and Table 2.3).

Place Table 2.3 about here

However, on certain VABS items all three children, regardless of their IQ and Theory of Mind ability showed unusual and perhaps limited social competence skills. All three were reported to have less than adequate social coping skills as assessed by VABS. Furthermore, all scored in the low range on the assessment of Active and Interactive sociability (Table 2.3). In addition, the Active sociability scores in this group were lower than the mean score gained by two groups of children with autism (those who passed and those who did not pass Theory of Mind tasks) studied by Frith and colleagues. We speculate that one explanation for this discrepancy is that specific Active sociability items may assess behaviours that are likely to be particularly affected by lack of vision, in particular sharing of toys, initiating social contact and showing appropriate table manners. Nevertheless the low scores were somewhat surprising and provide some insight into the way the parents and caregivers viewed the children (e.g. Robert's parents refer to his behaviour as 'being a bit of a handful').

The pattern of findings seen here reiterates the association between autism and blindness and ability level. Brown et al. (1997), for example, found that the children who were blind and obtained low IQ scores showed a tendency to score higher on the Childhood Autism Rating Scale - CARS (Schopler, Reichler & Renner, 1988) than those with high IQ scores, indicating a link between low mental ability and autistic-like features in children who are congenitally blind. Even though Katy, Robert and John were within the normal IQ range and none of the children were assessed for autistic-like features per se, some aspects of their everyday social skills bear resemblance to behaviours exhibited by children who are on the autistic spectrum. This is particularly true in the case of John whose assessments of both Theory of Mind understanding and everyday social competence were at a low level. John's difficulty in concentrating may have had an adverse effects on his false-belief task performance. Nevertheless, even though his real life social competence is better than his scores on Theory of Mind tasks, it still falls below the range expected for the sighted children and closely resembles that of children with autism who can master the first-order false belief. Similarly, in the case of Robert, catching up on delayed Theory of Mind development does not seem to lead to improvement in everyday skills and on the contrary, his social competence seems to be on a level with children who are autistic.

In many respects Robert and John resemble sighted children who are autistic. But if we are to draw comparison between autism and blindness based on these three cases where does Katie fit in? Katy certainly provides a singular example of a very bright child with profound visual impairments. She has a robust understanding of Theory of Mind, at an equivalent level to that of older sighted children. Looking at her real life social competence we observed earlier that some of her scores (i.e. Active Sociability and Social Coping) bore a resemblance to the scores of sighted children with autism studied by Frith et al. However, we think that a more rigorous assessment developed with children who do not have access to vision is essential in this regard. If a child that is blind resembles a child with autism on a measure not specifically devised with sightedness as a factor, assessing the cause of the child's performance is subsequently confounded.

Screening for autism in children with profound visual impairment

Research with children who are congenitally and totally blind is challenging and the relative rarity of occurrence contributes to this. Brown, Hobson, Lee and Stevenson (1997) carried out an extensive study with 43 children (24 of whom were children who were congenitally and totally blind) and in order to consider the association with autism. They adopted the Childhood Autism Rating Scale – CARS (15 items) (Schopler et al. 1988) and Behaviours Checklist for Disordered Preschoolers – BCDP (Sherman, Shapiro & Glassman, 1983) as screening instruments focusing on real life social competence.

An interesting comparison can be drawn between their findings and our own (Tadic, Pring & Swettenham). We used a different instrument to screen for autism in a different group of children with congenital visual impariment, namely the Autistic Screening Questionnaire (ASQ) (Rutter, Anderson-Wood, Becket et al.,1999) The ASQ was developed and tested by Rutter and Lord as a reliable screening measure rather than a diagnostic instrument and was based on the current diagnostic criteria for autism. An aim of the test was to fulfil the need of research in which the comparison of autism with other clinical groups (in terms of autistic-like features) was desired (Berument, Rutter, Lord, Pickles & Bailey, 1999). It includes 40 items assessing behaviours such as pronoun reversal, eye gaze, compulsions and rituals, unusual attachment to objects, imaginative play, repetitive use of objects, offering to share, etc. According to Rutter et al. a cut-off score of 15 or morer provides the best differentiation of pervasive developmental disorder (PDD) (including autism) from other diagnoses for children age at least 4 years. A much higher cut-off score of 22 or more would be required to separate autism from other PDDs (Rutter et al., 1999; Berument et al.,1999).

In our study the ASQs were completed by the carers (teacher and/or LSA) of 18 children who were congenitally and totally blind. There were a variety of aetiological causes for visual impairment in this group: Leber's Amaurosis (4), Retinopathy of Prematurity (3), Congenital Micropthalmia (4), Retrolental Fibroplasia (1), Congenital Glaucoma (1), Retinal Dysplasia (1), Retinal Detachments (1), Anopthalmia (1) and other unspecified causes (2). The children were between 8-15 years of age (mean age 8.67) with a male to female ratio being 2:1.

Three out of eighteen children (approximately 17 %) in our study received a score of 22 or over (mean score of 27.7) and eleven out of eighteen (61 %) received a score greater than (mean score of 19.55). Even though a score of 22 or over is required to separate autism from other PDDs the percentage of children who can be classified under the PDD (including autism) in this group was striking. This result provides strong and independent support for the findings by Hobson and his team (e.g. Brown et al., 1997; Hobson, Lee & Brown, 1999) who argued that there was a range of "autistic-like" clinical features in children who are congenitally blind. In addition, in our study no clear relationship emerged between the IQ data and severity of autistic features but this is likely to be associated with the smaller sample. Nevertheless, our general conclusion is that in looking at autistic features in our group of children who are congenitally blind a high number met the criteria. Blindness may predispose a child to autistic-like psychopathology.

MEMORY IN INDIVIDUALS WITH PROFOUND VISUAL IMPAIRMENTS

We have noted that initial delays in development of a child with profound visual impairment can sometimes be overcome in later years. Nevertheless, without visual experience cognition is likely to retain some specific characteristics. It is interesting to ask whether the later cognitive characteristics of children and adults who were born blind can provide any evidence of such alternative learning strategies. In the next section below we describe attempts to investigate this with school age children and adults with congenital and total blindness and in particular refer to memory processes.

Memory can refer to many different aspects of mental processing including both content and recollection. In this section autobiographical memory studies are described along with memory both in the long and short-term. Additionally, memory for pitch is considered since it links with the following section on talent and exceptional abilities.

Autobiographical memory

Autobiographical memory is comprised of biographical information and experienced events related to the self. Currently there is agreement on some of the broad cognitive features of this type of memory, in particular that autobiographical memories are mental constructions that very often feature imagery while simultaneously containing abstract personal knowledge (Conway & Pleydell-Pearce, 2000 for a review). Conway and his colleagues have developed a strong theoretical formulation in which retrieval involves access to an autobiographical knowledge base that contains hierarchical layers ranging from conceptual and abstract memories to highly specific details of individual events. These memories have, for most people, a strong (visual) imagery component; giving the memory its sense of immediacy. This central role of visual imagery has been highlighted in both observation and research (Brewer, 1986; Williams, Healey & Ellis, 1999).

Surprisingly little is known about this type of memory in individuals who are born blind and it could be that since visual images have traditionally been viewed as an integral part of remembering the past, visual impairment could have negative consequences on autobiographical memory. But our research (e.g. Goddard & Pring, 2001) revealed no evidence that visual impairment was associated with a deficient access to the past. Instead we found that individuals with total and congenital blindness even demonstrated a memory advantage in personal biographical/semantic memory. This was tested using a fluency task where participants generated names of people (e.g. friends and teachers) associated with different periods in their life. When comparing the mean number of names produced in recall, a standard recency effect emerged; significantly fewer names were recalled from primary school compared to both secondary school and 3 years post school. Critically, participants who were blind showed an advantage over the sighted with an improved ability in recalling names from primary and secondary school. No group differences occurred in the more recent time frame. Of course this advantage, demonstrated by those who were visually impaired, could be due to an exposure effect rather than the effects of visual impairment on memory. It is not uncommon for children with a profound visual impairment to attend boarding school where teachers (and maybe also friends) are likely to have a greater impact on one's life experience. Thus the greater fluency observed in the visually impaired may be associated with a larger pool of possible names upon which to draw, which in turn are better remembered because of their greater emotional significance. Alternatively the advantage observed might be explained with a superior encoding process related to attentional strategies, which in turn could be directly related to a lack of vision and it is this interpretation that is supported by other findings outlined below.

Verbatim, long and short-term recall

Bartlett wrote in his 1932 book on remembering that in the process of learning we tend to forget the exact material, the learning episode itself, but instead we remember the gist or the overall meaning of the material. It was of some interest then that in some early studies on memory performance we found that children and adults who were blind did not forget their experience in quite the same way as their sighted counterparts. Their recall was remarkably accurate and often exceeded that of sighted individuals. Certainly in terms of short-term memory performance we have known for some time that children with visual impairments perform particularly well on ‘digit span' i.e. accurately recalling the order of a string of numbers (e.g. Smits & Mommers, 1978). But we also found that this above average performance extended to many types of material not just number strings. For instance in a study where blind children were asked to listen to a text and make inferences about the material, we found that they recalled the exact wording of sentences they heard (Edmonds & Pring, 1995) significantly better than closely matched sighted control children. Furthermore, adults and children who were born blind had superior recall for random word lists, presented both in Braille and on cassette tape (e.g. Pring, 1988; Pring & Painter, 2002). It was difficult to explain such superior 'verbatim' memory performance. Reference to the increased attention to the remaining channels of input when vision was not available, and the need for an extra or attenuated temporary storage buffer holding the contents of direct sensory experiences which could be ‘read-out’ later were proposed as explanations.

While it is the case then that in terms of verbatim memory, recall is superior in people with visual impairment, no such superiority has been reported in connection with ‘gist’ memory; the type of conceptual, long-term memory mentioned by Bartlett. Indeed in our research, there have been a minority of studies where such conceptual or semantically-based memories have been worse than that of the sighted (Pring, 1988; Pring & Painter, 2002). It is likely that differing attentional resource allocations will have both advantages and, under some circumstances, disadvantages.

This general pattern of increased memory performance, particularly for unassociated items has been cited as a significant feature of autism (e.g. Frith 1989). In autism, it has been shown that memory for unassociated items, such as words or colour sequences, is only marginally less accurate than memory for associated items. This is unusual since association generally predicts increased recall accuracy. Frith argues that in the case of autism the 'lack of preference for coherent over incoherent stimuli must be regarded as abnormal' and links it to her belief that in autism, the inability to draw together information so as to derive coherent and meaningful ideas and the failure of the mind to be predisposed to do so, explains the essential features of autism. This theory of autism referred to as ‘weak central coherence’ has received considerable support (Frith, 1989; Happé , 1999) and is elaborated upon in the context of talent.

Sensory memory: Pitch processing

If it is true that people without vision do have a greater ability to retain sensory experience for longer periods than those who are sighted, then the result should extend from verbal material to pure sensory experience. It is hard to test this but in one attempt we prepared a cassette tape where approximately 20 words were presented one at a time and then participants were asked to recall them. But critically, in this study we focussed not on the memory for words but on the pitch of the voice that spoke the words on the tape (i.e. a low pitched man's voice or a higher pitched woman's voice). As predicted, what we found was that the individuals who were blind were significantly better at accurately recalling whether a man or woman had spoken the previously presented words (Pring & Painter, 2002). Their memory for the pitch of the voice speaking the words was clearly retained. It seems that paying increased attention to the available channels of the perceptual world and perhaps retaining that material for longer, has real advantages not least in terms of pitch processing. Indeed, this may help to explain the fact that individuals without sight seem to have a higher occurrence of absolute pitch ability than is normally found in the population (Oakes, 1955). This ability is extremely rare in the general population, estimated to be around 1 in 10,000 (Takeuchi & Hulse, 1993). Remarkably, in our study using the ASQ described earlier we have found that 8 out of 12 parents of blind children asked to comment on talent responded that their children had absolute pitch. This may be one explanation of why piano tuning has historically been a favoured occupation for people with visual difficulties. The nature of absolute pitch and the memory advantages outlined above have consequences for the understanding of both musical processing and exceptional ability. So we turn next to research with groups of individuals with exceptional abilities and ask if a predisposition to develop high level skills could reside both in individuals with autism as well, perhaps, as in blindness.

TALENT

Research that is concerned with the question of exceptional ability is hampered by the fact that so little is known about the determinants of talent and the conditions for nurturing its manifestation. For example there is an ongoing debate between those who argue in favour of practice as the key to skill acquisition (Ericsson, Krampe & Tesch-Romer, 1993) and those who see basic, possibly inherited, aptitude, as critical (Gagné, 1998). Green and Gilhooly (1992) summarised the cognitive performance of experts in comparison with novices. They mention superior memory performance, more elaborated problem-solving strategies and knowledge structures but emphasise that rarely are there any differences in terms of basic memory capacity. Implicit learning plays a larger role in the development of expertise and is emphasised in many influential models of cognitive architecture such as Anderson's Active Control of Thought (ACT) model, developed over the last twenty years (e.g. Anderson, 1993). Implicit learning does not involve conscious, attention-demanding resources and has been linked to the notion of innate genius. The existence of child prodigies such as Mozart has been taken as evidence of this phenomenon, although challenged by Howe, Davidson and Sloboda (1998). These authors go on to stress the problems of defining terms such as ‘motivation’, ‘aptitude’ or ‘talent’ itself and have instead emphasised the important role of practice.

Research with individuals with autism and exceptional ability

Nevertheless whatever it is that determines talent with all that it entails, it is natural to be astounded by cases of exceptional ability juxtaposed with low cognitive functioning . Langdon Down in the late 19th Century and later Kanner in the context of autism provided the first reports of these individuals. The savants described in the literature display conventional talents in restricted domains. They generally fall within the spectrum of autistic disorders and have been the subject of theoretical and empirical investigations (e. g. Treffert, 1989, Hermelin, 2001, Miller, 1989). The types of skills exhibited by savants include lightning and calendrical calculation (Pring & Hermelin, 2002), drawing (Pring, Hermelin & Heavy, 1995; Selfe, 1978), poetry (Dowker, Hermelin & Pring, 1996), hyperlexia (Frith & Snowling, 1983, Mehegan & Dreifuss, 1972), linguistics (Tsimpli & Smith, 1998) and music (Hermelin, O’Connor & Lee, 1987).

Neil O’Connor and Beate Hermelin designed the first empirical studies of groups of savants and the empirical work referred to in this section are nearly all ones carried out by the first author together with Beate Hermelin in the last 14 years or so (see Hermelin, 2001). We explored savant cognition by using both single case and group studies.

The question of why autism, in particular, seemed to be linked with cases of savant talent was one line of research that we pursued (e.g. Pring, Hermelin & Heavey, 1995). The answer seemed to be indicated by the 'weak central coherence’ theory mentioned earlier. In one part of this theory it is argued that individuals with autism adopt a perceptual strategy where an interest and bias towards the processing of segments of a display or experience takes precedence over the processing of the whole display or experience. Attention is given to the local processing of individual parts rather than to the processing of the global or wholistic display.

We have argued (e.g. Pring, Hermelin & Heavey, 1995; Pring & Hermelin, 2002) that there is a link between the expression of talent and this cognitive architecture characteristic of individuals with autism. The tendency to draw away from the integration of information to form an overall contextually meaningful and coherent representation may be a characteristic that is both unconventional and has certain properties that support talented thinking. The extent to which an individual uses such a *segmentation* strategy, as seen when perceptual coherence is weak, can be measured by their performance on psychometric tasks such as the block design test of the embedded figures task. Indeed Shah & Frith (1993) neatly demonstrated that the superior performance by children with autism compared to mental-age matched controls, was due to an ability to *segment* the configuration into its constituent parts and thus reconstruct the overall pattern, without the interference of the cohesive nature of the total gestalt.

The reasoning is the same for understanding the characteristic advantage shown by individuals with autism who speedily locate hidden or embedded figures in a display (e.g. Baron-Cohen, Jolliffe & Mortimer, 1997; Hermelin & O'Connor, 1986). When using the children's embedded figures test Shah and Frith (1993) made the point that the participants' superiority in comparison with a mental-age matched control group resulted from them being unhindered by the overall meaningful context, within which the simple figure was embedded.

From our perspective we wanted to ask if such a strong segmentation strategy, as has been seen in autism, would play an important role in the manifestation of talent amongst the autistic artists in particular, but also, amongst individuals with talent but without impairments.

Autistic savant artists

Some of the most pertinent data we collected linking the ability to draw and to weak coherence came from studies with a group of autistic artists who were at entry level to foundation art school (described in a paper by Pring, Hermelin & Heavey, 1995). We found that in a block design test that the artists who were autistic were significantly faster compared to their non-gifted, diagnosis and IQ matched controls. The savant artists seem to display *especially strong* segmentation skills that allow them to overcome the coherence of the visual displays even in comparison with their autistic counterparts without specific talent in drawing. Pring and Hermelin's postgraduate student Nicola Ryder (Ryder, 2003) tested a group of 9 autistic artists with a similar task, the embedded figures test. Table 2.4 below shows her results, namely that savant artists and art students were significantly quicker in locating a simple pattern from a meaningful or abstract context when compared to a mental-age matched autistic control group.

Place Table 2.4 about here

Although the small numbers advise caution our interpretation was that the group of savant artists fell at the extreme end of the continuum for showing the effects of a segmentation strategy. We hypothesised that the thinking style emphasising segmentation, found in individuals with autism, supports or is a precursor of the manifestation of critical talented abilities. Perhaps the attention to detail and away from the context affords a fresh access to visual ideas.

Segmentation style and talent

The work described briefly above with savant artists suggested to us that such segmentation processing might not only be the key to the prevalence of autistic individuals amongst savant artists, but could also link specific modular abilities to modular talents found in the general population. To test this we matched talented artistic children, selected by teachers, with a control group of children on age and verbal IQ. What we found was that, perhaps unsurprisingly, the children who could draw were also significantly faster at completing the block design test (Pring, Hermelin & Heavey, 1995). Similarly, university art students also were significantly faster at finding embedded figures than were IQ matched university psychology students (Ryder, Pring & Heremlin, 2002). These results with gifted children and adults artists echo earlier findings made in the context of creativity with students from the prestigious Chicago School of Art (Getzels & Csikszentmihalyi, 1976).

It seems that segmentation strategy is a cognitive style can be emphasised in those with artistic talent and perhaps this enables them to hold basic elements or parts of a visual display quite separately and uniquely protected from the context in which they appear. In this way the individuals can resist the integration with familiar and learnt associations that develop as a natural consequence of dealing with the whole. For some talented individuals *without* other impairments, it may be that segmentation strategies are simply an optional 'mind-set' by which to view and experience the world. Through practice or by natural inclination the ability to break conventional associations and gestalt processes through a characteristic cognitive style may be an important element in displaying talents, at least in some domains.

Absolute pitch abilities and musical savants

What would be the manifestation of such an enhanced segmentation strategy? One possibility would be the enhanced perception and retention of discrete auditory elements such as pitches or tones in music. One example of such a special type of processing with music is the ability to show absolute pitch. Absolute pitch (AP) is the ability to recognise, label and remember pitch information without reference to an external standard.. To develop this ability you need to hold a single note in mind, associate it with a verbal label, and keep it separate from other musical representations. Normally we hold musical notes in a *relational* way so that if we are given an anchor note such as middle C we can then move up or down an octave. People with absolute pitch hold the musical notes independently and can therefore retrieve them directly from memory without referring to other notes. AP is not a necessary component of musical ability or talent and many professional musicians do not possess it. The separation of AP and musical ability has been confirmed in neurological terms by brain imaging studies that discriminate the brain structure of musicians with AP from musicians and non-musicians without AP (Schlaug, Jancke, Huang & Steinmetz, 1995).

Early musical instruction influences the development of AP (Takeuchi & Hulse, 1993) in certain individuals and is also associated with increased spatial abilities in adulthood (Eastlund-Gromko & Smith Poorman, 1998). In particular, people with AP perform better on the Hidden Figures Test than those with relative pitch or non-musicians (Costa-Giomi, Gilmour, Siddell & Lebfebvre, 2001). We reasoned that AP, in the same way as the good performance on the Hidden Figures Test, was an index of weak coherence. If this were the case then children with autism might be predisposed to show exceptional AP abilities. In a series of elegant studies on musical cognition in children with autism Heaton (1998; Heaton, Hermelin & Pring, 1998) found support for this suggestion. She was the first to confirm that AP is prevalent amongst children with autism and is linked to special musical abilities. AP is universal to all musical savants (e.g. Miller, 1989) and is probably necessary for such individuals to implicitly learn, store and recall the use of the rules and patterns that govern music. Certainly Hermelin & O'Connor (1986) argued that implicit learning and the extraction of the rules and regularities of musical grammar allow savants to create accurate reproductions of musical pieces.

Recently, an undergraduate student, Katherine Woolf, examined the pitch and rhythm processing abilities of five musical savants who were congenitally blind. They played a variety of musical instruments and had a varied cognitive profile ranging from severely to mildly retarded. Their performance confirmed their musical abilities and they all showed excellent AP. In addition, their performance on both a short-term memory for tone test and a more complex memory for rhythm test was either comparable or better than a group of sighted musicians without any cognitive impairment. Performance on the rhythm task in particular supported the notion that music processing is modular with some individual features, such as rhythm, developing independently (Woolf, Pring & Tadic, in preparation).

Treffert (1989) commented on the relatively common triad of mental impairment, musical genius and congenital blindness and Miller (1989) suggested that the linguistic and social problems associated with congenital blindness might be a contributing factor in the development of musical and in particular, absolute pitch ability. However, for us the critical perspective is somewhat different. We suggest that children who are blind, perhaps because of their dominant available sensory channels and their lack of vision, begin to develop weak coherence and this may be the explanation for their AP abilities. In some rare individuals this provides the basis from which to develop exceptional musical talent.

<u>In Conclusion</u>

In 'Seeing and Hearing and Space and Time' Neil O'Connor and B. Hermelin (1978) concluded that the characteristic processing style of children with autism or those who were blind or deaf depended on their distinctive sensory input or their possibility for decoding it. Here we continue in their tradition and have tried to show how early childhood behaviour, memory performance and talent abilities in children and adults with visual impairments connect to the features of autism that have been described in the literature. The cognitive strategies imposed by the lack of sight, and the failure to 'see' as can be argued in autism, have some similar consequences. It is clear that many congenitally blind children show autistic-like psychopathology and a number of these children meet the full diagnosis of autism. This has been linked to the role of vision in the development of Theory of Mind, which in blind children as we have shown (Cupples et al. 1999) is often delayed. We have illustrated this by describing research in socio-cognitive development in young congenitally blind children and most clearly through presenting three case studies of individual blind children. But what we have also understood is the crucial notion that not all blind children are autistic, not all of them manifest autistic-like features. This we have shown by describing Katy who is an example of a blind child with a typical socio-cognitive development of a sighted child. If lack of vision predisposes a child to autistic-like psychopathology then it must be possible to intervene with this specific aspect of blind children's development. If we understand this we can effectively circumvent delays/disturbances in development of a blind child and proceed to consider intervention studies.

The work described with talent and memory performance refers itself to the cognitive architecture that is likely to develop in a range of individuals both with talent and with impairments such as autism or blindness. First we noted that there were some similarities between the characteristic memory pattern found in children and adults who are blind and those with a diagnosis of autism. It is not certain whether the weak central coherence account helps to explain the memory advantages described for individuals who are blind but we would argued that it is likely. This was linked to the proposition that the strong perceptual segmentation strategy that follows from weak coherence is a characteristic of those individuals who display certain talent in general and autistic talent in particular.

We have tried to illustrate with examples from our research how the impairments in autism as well as congenital blindness may lead to the adoption of mental strategies that through shared characteristics have similar but not always the same consequences.

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Table 2.1

Table 2.2

Table 2.3

Table 2.4

Table 2.1: *The 3 children's verbal IQ scores as measured by WISC-R (1977) and WPPSI (1967)*

Verbal IQ	Katy	Robert	John
ull ver bal IQ	145	90	95
Information	18	6	9
Similarities	18	10	9
Vocabulary	15	13	9
Comprehension	17	6	5
Digit Span	17	7	14

Table 2.2: *The 3 children's performance on standard Theory of Mind assessments*

	Katy	Robert	John
1st order ToM task max=8	8	1 (1st session) 8 (2nd session)	5 (1st session) 3 (2nd session)
2nd order ToM task max=4	4	2	fail
Advanced ToM task max=6	5	fail	fail

Table 2.3: *The 3 children's performance on everyday assessment using Vineland Adaptive Behaviour Scale (Sparrow et al., 1984) and Active and Interactive sociability items (Frith et al., 1994)*

	Katy	Robert	John
Expressive communication max=26	22	12	13
Social Coping Skills max=32	12	8	19
Interpersonal Relationships max=16	8	0	3
Active Sociability* max=14	5	1	5
Interactive Sociability* max=14	5	3	3

*Active Sociability: independent of ToM skills, Interpersonal Sociability: dependent on ToM skills

Table 2.4: *The mean performance of artistic savants, art students and autistic controls on Embedded Figures Test*

	Meaningful (Children's Embedded Figures Test)	Abstract (Adult Embedded Figures Test)
Savant Artists	5.70 (3.54)	6.54 (5.37)
Autistic Control Group	11.29 (8.91)	10.42 (6.82)
Art Students	4.71 (2.67)	4.43 (2.69)

Summary:

The authors explore associations between autism and blindness by focusing firstly on early childhood behaviour in children who are blind and later on the verbal and auditory memory of children and adults with visual impairments. Moreover, the cognitive architecture associated with talent is linked to both groups.