The Creative and Generative Capacity of Savant Artists with Autism

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Abstract

The aim of this thesis was to investigate the creative and generative capacities of a group of savant artists. As savant talent has a higher prevalence in autism, a disorder associated with deficits in imagination and creativity, it is surprising that one should find savant ability in areas such as music and art. Despite the interesting paradox this creates there has yet to be a thorough, empirical investigation into this area of savant performance in artists.

The measurement of the concepts of creativity and generativity is alone a contentious area in psychology; however, from the outset they were clearly defined for the purpose of this thesis. Creativity is defined as the capacity to produce novel and meaningful responses, whereas generativity refers to the amount, or quantity, of ideas produced, irrespective of their originality. As the creative and generative capacity of savant artists is a hitherto neglected area of research, this investigation began by measuring this capacity in the domain of ability, using a standardised test where the response was drawn. A second test looked at creative and generative performance on a construction task with no drawn element. Subsequent investigations focused on the processes thought to underlie performance on the initial two tasks, particularly relating to the assets and deficits in the performance of the savant group, which may have occurred as a result of their autism.

The results showed that a general autism-specific deficit was evident on tasks that required generativity outside of the direct domain of drawing. On the other hand, in relation to creativity, there were indications that such qualities were spared in the savants on tasks not directly involved with drawing, although still in the visual domain. These contrasting results are discussed in terms of a segmented visual processing style in the savant artists and an autism-specific deficit with regard to the generation of appropriate action plans.

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1.1 SAVANT ABILITY: AN INTRODUCTION

1.1.1 The Nature of Savant Talent

The term *idiots savants* was first used by Down in 1887, to describe those individuals with mental retardation, who demonstrated a particular ability in a specific area. Recently this term has fallen out of favour, in part due to it's derogatory nature, and also because it is factually inaccurate; the majority of savant cases showing an IQ above the requisite 40. Indeed, recently the definition of savant has been expanded to include not only individuals with lower than average IQ, but also those with developmental disorders who have IQ scores within the normal range (Miller, 1999; Young, 1995). Savant cases are also found to occur more in individuals with a diagnosis of autism than in any other disorder (Rimland, 1978).

Ability, skill and talent

In much of the literature on savant cases, terms such as ability, skill and talent are commonly utilised yet rarely adequately defined. The first aim of this section is, therefore, to present a discussion of the terminology that will be employed throughout, beginning with ability. *'Ability'* can be defined as those qualities, skills and talents that enable an individual to achieve a certain level of performance at a given time (Reber, 1985). The term ability thus pertains simply to the level of performance that has been attained and can be displayed at a certain time, without relating to any sort of inherent *'talent'*. The term *'skill'* on the other hand, is often associated with learning and practice. Reber (1985) defines skill as the capacity for carrying out complex, organised patterns of behaviour in order to achieve an end goal. The concept of *'talent'* is far more complex and has been hotly contested in psychology for many years. Whereas the definitions of skill and ability imply that a behaviour can be learned, talent is often seen as innate or inherent within an individual. Winner (1996) for example, argues that talents are unlearned, domain-specific traits that may be developed in favourable circumstances, but that cannot be manufactured. Others have defined talent as the *potential for exceptional performance*, (Detterman, 1993; Feldman, 1988; Gardener, 1983) and as such it is more difficult to measure than ability and skill, both of which can be objectively assessed. Indeed, some have argued that the concept of talent is in fact a myth and cannot exist, with high performance arising as a result of extensive practice (Howe, 1991; Howe, Davidson & Sloboda, 1998). While a review of the talent debate is not relevant to this series of studies, a good overview is provided by Howe et al. (1998) and the responses to their article. Furthermore, due to these intrinsic problems with measurement of talent, the term savant *ability* is favoured throughout this thesis. It should be borne in mind that some researchers have proposed that the very existence of savant ability is evidence of innate talent (Rutter, 1998).

Talented and prodigious

The distinction between differing levels of savant skill has been noted by several researchers; Treffert (1988) for example, distinguished between talented and prodigious savant ability. In order to be considered a *talented* savant, he argues the individual must possess a level of ability remarkable in comparison to their general level of cognitive functioning. On the other hand, there are instances whereby the level of skill an individual displays is remarkable, not only in comparison to the individual in question, but also to the population as a whole. These latter individuals possess what Treffert refers to as *prodigious* ability. Hill (1978), in accepting this distinction, argues that only those with prodigious ability should be considered a savant. Young (1995) however, extends Treffert's view further still to incorporate splinter skills.

1.1.2 Cognitive Theories of Savant Ability

There have over the years, been a number of attempts to conceptualise the outstanding feats of these individuals. Early accounts, reviewed by Hill (1978) focussed on sensory deprivation (Hoffman, 1971), compensation (Lindsley, 1965) and abstraction deficits (Anastati & Leeve, 1960; Nurcombe & Parker, 1964). While many of these accounts have been widely disregarded over time, others have formed the basis for the contemporary theories that will be discussed below. This overview does not aim to cover all the theoretical accounts of savant talent, rather the intent is to provide an introduction to the approaches relevant to the study of the savant artist. For a comprehensive review readers are pointed toward Hermelin (2001), Miller (1999) and Treffert (1989).

Extended practice

Howe (1989a, 1989b) maintains that, as with all instances of high level ability, the majority of apparent savant ability is simply a manifestation of obsessive interest and a high degree of practice. Certainly this might help account for the high rate of savant ability found in individuals with autism, a disorder associated with repetitive and obsessional interests (Wing & Gould, 1979). Nevertheless, while it is likely that savants do spend a disproportionate amount of time practising (O'Connor &

Hermelin, 1991) this explanation alone cannot account for the savant phenomenon. Firstly, extended practice is a principle factor in the development of any high level skill (Ericsson & Faivre, 1988). Furthermore as Winner (1998) argues, while practice is *necessary* in the attainment of high level ability, it is not by itself *sufficient*. The extended practice account also fails to explain sufficiently the manifestations of 'talent' which occur from a very early age and in the absence of training, for example the artist Nadia, reported by Selfe (1977, 1983). Finally, it has been suggested that the obsessional activity associated with savants is qualitatively different from that practised by non-autistic experts. Trehub and Schellenberg (1998) refer to Lehmann's (1997) three-factor model of high ability, arguing none of the factors; goal setting, evaluation and feedback, are evident in savant activity. It appears then, as argued by Waterson (1988), that savants practice because they *enjoy the activity* rather than to *improve their performance*.

Rote memory

A number of explanations of savant ability have focussed on the outstanding memory often shown (Hill, 1975; Lafontaine, 1974). Indeed, Tregold (1914) noted that a considerable majority of the savants he investigated showed some sort of high level memory ability. Selfe (1977, 1983) and Sacks (1995) have both highlighted the capacity of savant artists to produce visually correct, complex artistic outputs, in some cases several months after seeing the initial image. This ability was also subject to an empirical investigation by Hermelin and Pring with Buhler, Wolff and Heaton (1999). Interestingly a strong tendency towards rote memory recall has also been found in autism in general (Hermelin & O'Connor, 1967, 1970; Frith, 1989) and thus could also explain the prevalence of savant ability in this disorder. While this explanation can account for the strong memory element often associated with savant ability, again it does not provide a full explanation of the phenomenon. Miller (1999) identifies three core characteristics of rote memory; that it results in a high-fidelity representation of the original information, involves little reorganisation and is primarily concerned with the physical aspects of the stimuli, resulting in an inflexible and domain-specific output. While certain aspects of Miller's criteria are certainly evident in savant ability in areas such as music, art and calendrical calculating, savant output rarely consists of an *exact replica* of the original input. With regard to art, such outputs often display a number of notable transformations that go beyond mere memory omissions (Hermelin et al., 1999; Pring & Hermelin with Buhler & Walker, 1997; Sacks, 1995; Selfe, 1983). The types of transformations evident in art are discussed more fully later in this chapter and in chapter 2. Further evidence against the rote memory account can be seen in savant calculators (O'Connor & Hermelin, 1989) and savant musicians (Miller, 1987, 1989). It seems then that savant ability involves both generative and flexible elements. Indeed Heavey and Colleagues (Heavey, 1997; Heavey, Hermelin & Pring, 1999) found that savant calculating ability results from a structured knowledge base, which is likely to have arisen through exposure to calendar information rather than rote learning.

Segmentation

Until 1989, the majority of research into autism had focussed on the triad of impairments (socialisation, communication and imagination) identified by Wing and Gould (1979). In particular this research did not address the spiky IQ profile associated with autism (see Happé, 1994a). Uta Frith (1989) argued that the deficits and the assets associated with the performance of individuals with autism on tests such as the WISC (Wechsler, 1992) resulted from the same cognitive process. Specifically, she argued that individuals with autism had difficulty in processing information contextually; that is the drive for meaning that dominates normal, everyday thought, is absent. In autism, instead of looking for global meaning, processing is dominated by a focus on detail at the expense of overall gist. This can explain the good performance of children with autism on the block design sub-test of the WISC (Shah & Frith, 1993) and Shah and Frith's earlier (1983) finding of autistic superiority on the children's version of the Embedded Figures Test (EFT; Witkin, Oltman, Raskin & Karp, 1971). The central coherence account can also explain some of the deficits associated with autism, such as the poor performance of autistic children at correctly integrating homophones into sentences (Frith & Snowling, 1983; Happé, 1997). Happé (1999) argues that weak central coherence is demonstrated at several levels: perceptual, visuo-spatial constructional and verbal semantic. She maintains that this processing style can also account for the assets found in autism particularly within the first two levels.

A segmented processing style has been related to savant ability in a number of domains. Firstly Hermelin and colleagues (O'Connor & Hermelin, 1987a; Hermelin, Pring & Heavey, 1994) found that artistic savants were better able than controls at reconstituting a visual display in the form of a picture puzzle. Initially they attributed this superiority to the savant artists possessing a greater pictorial lexicon, however, such performance is clearly similar to that displayed by autistic groups on the block design task. In 1995 Pring, Hermelin and Heavey investigated this observation in more detail. They found that savant artists were as able as normally developing children, gifted at art, on an abstract block design task. What is more, in support of

Shah and Frith's (1993) finding, the performance of the autism control group was also above that of the non-gifted, normal controls. From such results, Pring et al. (1995) argue that a tendency towards *segmentation* may prove particularly adaptive to artistic ability; a domain in which individuals are required to go beyond the usual constraints imposed by Gestalt law, in order to isolate and emphasise component elements. In support for this view, superior segmentation ability has been found in artists with no cognitive or intellectual impairment (Getzels & Csikszentmihalyi, 1976, O'Connor & Hermelin, 1983; Pring et al., 1995).

Another area that could benefit from perceptual segmentation is music. It has been argued that the presence of perfect pitch often found in accomplished musicians, and all musical savants, may represent a type of auditory segmentation (Heaton, Hermelin & Pring, 1998; Miller, 1989). Heaton et al. (1998) argue that whereas for normal people global strategies tend to dominate perception, in music both local and global strategies play an integral part. They suggest here that a tendency for local processing might increase the salience of some surface pattern elements, such as individual pitches.

As the discussion of both art and music have hopefully illustrated, a tendency toward segmentation might constitute a building block for ability. One area which does not immediately appear to be a perceptual ability in the way that music and art are, yet which is also facilitated by a segmented processing style, is calendrical calculating. Heavey et al. (1999) suggest that this ability may arise in part, due to savants processing parts of the calendar individually through repeated exposure. Perhaps more interestingly they also found a correlation between block design score and calculation span.

The segmentation explanation of savant ability is useful in that it not only provides some reasoning as to the prevalence of such ability in autism, but can also account for the manifestation of ability in the normal population. This supports points made earlier, whereby it was stated that the knowledge structure underlying savant ability is the same as that found in unimpaired individuals. Interestingly, this theory has clear parallels with Rimland's (1964) high fidelity attention account of savant skills. This suggested that savant syndrome arose due to a preferential processing system, which places greater emphasis on the *physical characteristics* of stimuli rather than *meaningful aspects*. However, as Heaton, Pring and Hermelin (1999) point out, the existence of superior segmentation ability does not necessarily denote that a person will develop a high level skill. They illustrate this point by describing the case of a young boy with autism who, despite showing exceptional segmentation ability in a number of tasks in the musical domain, exhibited no special musical competence. This case study shows that although a segmented perceptual style may benefit savant performance, alone it cannot provide a full explanation for it. As Heaton et al. (1999) maintain, "any plausible account of the savant phenomenon has to include the notion of inherent talent, however ill defined" (pp.508).

1.1.3 The Relationship with Intelligence

The fact that savant skill occurs against a background of cognitive impairment naturally brings into question more traditional views that cognitive processing is governed by a general processing capacity. Spearman (1904, 1927) for example, argued that all intellectual activity was largely attributable to innate differences in '*g*' that is general intelligence. The fact that individuals with either mental retardation or developmental disorders are capable of such extraordinary feats has been cited as evidence against this idea of a general intelligence (Howe, 1989a, 1989b). Indeed some have argued (Fodor, 1983; Gardener, 1983) that the existence of savant ability is evidence for the modular nature of cognition. However, the relationship between intelligence and savant ability is not as simple as strict modular theorists might indicate. Despite the apparent independence of a general factor on savant ability, the overall level of cognitive functioning possessed by an individual has been shown to influence performance on some tasks. While this thesis does not aim to review how savant syndrome fits in with current views of intelligence (for a review see Anderson, 1992, 1998; Nettlebeck & Young, 1996), it is important to outline the effect that intelligence, as measured on standardised IQ tests, has on the manifestation of this ability.

Miller (1999) reviewed the IQ scores and aetiologies of the individuals included in most, if not all, published savant research. He found that where IQ had been formally assessed, most participants fell into the "low normal" or borderline levels of functioning, that is having an IQ of between 70 and 75. However, he also points to a number of cases of exceptional ability in individuals in whom intelligence is un-measurable, for example the child artist Nadia (Selfe, 1983). Miller refers to the doctoral thesis of Robyn Young (Young, 1995) in which a sample of 51 individuals with a variety of savant skills, were investigated. The IQ range within this sample was from 50 – 114 and it was reported that the majority of the savants seen to possess prodigious ability had performance IQ's of 85 or above. Such a finding certainly implies that, in some cases, a certain level of general intelligence is necessary for the manifestation of truly exceptional skill. Similarly, IQ has been found to correlate with performance in a number of studies. Firstly, Hermelin and O'Connor (1986a) found that calendrical calculators with higher IQ's showed a wider range of calendrical knowledge than those at the lower end of the IQ range. Likewise they found that IQ significantly correlated with artistic accuracy, although no such relationship was found regarding aesthetic merit (Hermelin & O'Connor, 1990). Therefore, as Miller (1999) argues, although there are some well documented cases in which individuals with severe retardation are found to display a level of ability way above that found in the normal population, in the main there appears to be a correlation between the degree of exceptionality shown and overall cognitive functioning.

1.1.4 Savant Performance: The Main Issues

As previously mentioned, the aim of this section was not to give a comprehensive review of all the factors associated with savant performance, but rather to provide the reader with an introduction to the pertinent issues that will arise throughout this thesis in relation to the creative and generative capacity of artistic savants. For example, the biological and genetic accounts of savant ability have not been covered (see Miller, 1999; Waterhouse, Fein, & Modahl, 1996 for a detailed review of these issues), nor have the questions that savant ability poses for theories on intelligence in general (see

Nettlebeck & Young, 1996). However, such issues were not deemed essential for the understanding of the creative and generative nature of savant artists and readers have been directed to relevant reviews throughout. More importantly this section has identified a number of key issues and findings that will form the basis of the following investigations. The first is the prevalence of savant ability in individuals with autism. This finding has naturally moulded several of the cognitive theories proposed to account for this phenomenon, namely obsessional practice and rote memory. While neither of these theories can provide an adequate account of savant ability, more promising is the segmentation approach proposed by Pring, Hermelin and colleagues. As Heaton et al. (1999) rightly point out, while this account is not without flaws, it does have the propensity to account not only for the prevalence of savant ability in autism, but also for those abilities evident in the normal population. Finally a brief summary was provided, outlining the influence that the level of cognitive functioning may have on the these abilities. Here it was concluded that while savant talent does occur in individuals independently of their overall level of functioning, it does appear to place constraints on exactly how this ability is displayed.

1.2 ARTISTIC SAVANTS: EMPIRICAL INVESTIGATIONS

1.2.1 Descriptive Accounts of Savant Artists

Whereas the first section of this chapter sought to provide an overview to the relevant issues surrounding savant ability, this next section aims to deal specifically with previous studies with savant artists. Accounts of savants with a specific skill in the graphic domain have appeared in the literature since the 1900's. Whilst not the most prolific of savant skills (Hill, 1979), artistic ability is possibly the most commonly documented, at least in terms of descriptive accounts. One of the most well known descriptions of this ability was provided by Selfe in her reports of child artist, Nadia (Selfe, 1977, 1983). Diagnosed with autism when she was six years old, Nadia possessed no language skills and poor comprehension, however, at the age of three and a half years she developed an amazing capacity to draw. This drawing ability apparently arose spontaneously, omitting the normal scribbling stage associated with children's normal drawing development (see Thomas & Silk, 1990, for a review), and she went straight on to drawing very sophisticated images, mainly of animals but also including people, trains and other objects. She drew without regard to the edge of the paper and never made mistakes or used an eraser. Perhaps more outstanding was that she was able to generate these images from memory and, not only did these drawings possess a unique style full of life and movement, but she was also able to add and omit details and to rotate the original image in order to represent it from a different perspective. Furthermore Nadia displayed the use of complex graphic strategies such as linear perspective, foreshortening, occlusion and proportioning, which are not usually apparent in artistic output until much later in life, all without any sort of training.

Figure 1.1: Church drawn from life, by savant artist ML

1.2.2 Empirical Investigations

Controlled experimental research into the ability of savant artists was initiated in the late 1980's, with the work of Beate Hermelin and Neil O'Connor. They began a series of experimental studies, not only into the skills of savant artists, but also in other areas such as music, language, arithmetic and calendrical calculating. In such studies they attempted to isolate the component aspects thought to be related to specific ability, or to talent in general. They then compared the performance of the savant groups with IQ matched, non-talented controls or gifted individuals with no cognitive impairments. In this way it became possible to identify whether performance was a result of the overall level of cognitive functioning or associated with a specific ability. An example of a savant artists work is shown in figure 1.2.

Figure 1.2: Still life by savant artist TM

Memory

A number of the descriptive reports outlined previously have mentioned the outstanding visual memory possessed by savant artists (Sacks, 1986, 1995; Selfe, 1983; Tregold, 1952). It thus follows that the initial investigations undertaken by Hermelin and O'Connor should begin by focussing on this topic. Comparing the performance of five savant artists, three of whom had a formal diagnosis of autism, with a control group closely matched on diagnosis, IQ and age, O'Connor and Hermelin (1987a) presented participants with a variety of simple memory tasks, involving both recognition and reproduction of concrete and abstract drawn shapes. It was found that the memory of the savant group was superior to that of controls only on tasks involving reproduction, but not on those requiring recognition. That is the performance of the savants was comparable to the IQ matched control group on a short term memory matching task, yet it was superior when the task involved a drawn response, such as reproduction of a complex figure and of concrete and abstract line drawings from memory.

The results of this study, therefore, do not provide any support for the observation that savant artists possess a superior visual memory to their IQ matched control participants. However, whilst overall the savant artists were not found to differ from controls, the finding that only tasks with an output of drawing distinguished savant performance warranted further research. O'Connor and Hermelin (1987b) compared the performance of the savant group with a group of talented child artists (matched mental age to chronological age) and a non-talented, IQ matched control group. In this task they attempted to directly compare recognition and reproduction performance by presenting participants with a variety of analogous tasks. Memory was assessed either by a drawn output, matching or recognition. Here again it was found that recognition performance, and also visual matching, were determined by IQ. However, as with the previous study, when drawing was required the performance of the savant group was found to be equal to that produced of child artists.

At first glance this result might seem unsurprising, after all we would expect that those with a gift for drawing would be better at tasks where the response is drawn. However, it does indicate that motor control is a primary skill in the talent of the savants; what is more, the relationship between this motor output function and performance is not as simple as first implied. In particular the question arises as to how the *reproduction* memory of the savant group is superior to their controls, while this memory ability is not evident on the easier *recognition* tasks. A simple answer to the above question is that recognition tasks are easier, hence the performance of the non-talented control groups improves to the level of the savant group. However, the results of such studies show that this is not the case, on the contrary, the performance of the LDC group tends to remain constant throughout conditions while, by comparison, the savant group show noticeable improvements on tasks requiring drawing. The role of motor operations then became the focus of subsequent studies.

Motor operations and manual dexterity

Following these results O'Connor and Hermelin (1990) proposed an alternative suggestion for the observations that savant artists are able to produce their outputs in the absence of direct visual stimuli, despite not displaying superior short term memory. They suggested that drawing ability might depend on an encoded motor programme, operating independently of visual memory. Here they looked at visual-addition as the control group, with the only significant difference being that the savant group made less errors of omission. That the non-talented control group left out more details in their responses, might be less indicative of memory ability and more a result of their lower drawing ability; that is they added less features because they could not draw them, rather than because they could not remember them. In contrast, however, Hermelin et al (1994) showed there was no difference between the savants and their controls on a simple pencil and paper task. What is more, in the 1990a study, the error pattern was not repeated on reproduction following tactile presentation, indicating that the non-talented control group might have been relying more strongly on memory schema, rather than perceptually based memory.

Memory schemas and segmentation

The influence of memory schemata on the performance of savant artists is one that has also received attention. In dealing with artistic ability it has been suggested that good artistic performance arises from drawing what is seen rather than what is known (Paine, 1981). It is therefore interesting that savant ability should be more common in a disorder which, as discussed, is related to a contextually independent processing style. The beneficial effect that such a processing style might have on artistic technique is illustrated by an example from Pring et al.'s (1997) paper. They point out that if a student in art school is instructed to draw a chair, their response will often be visually wrong. This is because their conceptual knowledge of what is known of the chair (i.e. it comprises of right angles) will interfere with the perceptual image. However, should the student be instructed to draw the spaces between the chair, the output is more accurate. This, Pring at al. (1997) argue, is because the spaces between the chair have no conceptual value thus are free from any preconceived kinaesthetic matching and reproduction, again using two control groups; non-talented, IQ matched participants and talented child artists. The above suggestion that drawing ability may depend on the conversion of visual input into a motor output, was supported in a number of studies. It was found that the performance of the savants was equal to the gifted children at visual to kinaesthetic tracing, but only to the level of the non-talented controls at visual recognition. Again, the reproduction performance of the savants was found to be determined by their talent. From this study O'Connor and Hermelin concluded that the graphic skill of the savants was related to superior output ability, rather than a particularly defined perceptual input.

Following on from the above finding, the nature of this motor control was the subject of investigation, specifically whether savant superiority was evident only on pencil and paper tasks, or if this was found this was a general ability. Hermelin, Pring and Heavey (1994) confirmed that, the savant group was better than the IQ matched controls at recalibrating complex visual feedback with motor ability, as evident on a mirror drawing task, and perceptual-motor control in 3-D space. Such results indicate that savant motor control is not simply related to simple pencil and paper operations.

An intrinsic problem naturally arises when comparing performance of talented individuals with non-talented, learning disabled control groups on drawing tasks. This relates to the level of manual dexterity possessed by the two separate groups. It might thus be that the savants are better at tasks involving reproduction, simply because they are *more able* to add detail to their responses. This suggestion gains some support when the error rates on O'Connor and Hermelin's (1990) reproduction task are looked at. Here, the savant group made as many errors of distortion and schemas regarding what a chair *should* look like. Art teachers refer to this as '*negative*' space.

The use of memory schemata in savants, in relation to artistic ability, was investigated by Pring and Hermelin (1993). They investigated whether savant artists used perceptual or semantic processing strategies. Despite finding no support for the idea that savant artists may sort and store information perceptually rather than semantically, they did find that the savants used similar strategies as the gifted control group. This supports previous studies with calendrical calculators and musicians (Heavey et al., 1999; Miller, 1989; O'Connor & Hermelin, 1989), in which the organisational structure of savants' knowledge was identical to their talented, normal counterparts. In this case it was found that the savants, like the talented art students, all used semantic strategies for retrieval in both a matching task and a reproduction task.

Having now established that both artistic savants and talented, young, normal artists recall information semantically, it is how they *perceive* this information which becomes the next focus of investigation. Indeed in the example given earlier in relation to how art students were taught the correct procedure for drawing a chair, the onus was on how the image was *perceived.* It has been shown that savants organise information semantically, but this does not necessarily denote that they perceive this information contextually in the fist place. In the earlier discussion of how a segmented processing strategy related to autism might facilitate savant ability, Uta Frith's work on central coherence was mentioned. Many of the investigations into this processing style were based on how information was initially processed. For example, in the children's EFT a measure of central coherence was gained by looking at how well the participants were able to identify a simple shape within a larger meaningful picture (Shah & Frith, 1983). Further to this Jarrold and Russell (1997) found that children with autism did not take account of canonical patterns when counting. Finally, it was found that children with autism did not perceive visual illusions (Happé 1996, however, for an alternative account see Ropar & Mitchell, 1999, 2001) possibly as a result of failing to see the image in terms of the contextual biases that produce the illusionary effect.

Previous studies (Hermelin et al., 1994; O'Connor & Hermelin, 1987a) have highlighted the skill of savant artists at reconstituting partial or fragmented images into a global whole, a process similar to that described by Shah and Frith (1983). Pring et al. (1995) investigated this segmented processing style in relation to artistic ability and the effect of context. Here they presented a group of savant artists and their autistic controls, as well as a group of talented art students and their non-talented controls, with both the abstract block design test and also a meaningful picture puzzle made of blocks.

Pring et al. (1995) found that both normal art students and the savant artists possessed a segmented processing style, as evidenced by their facilitated performance on block puzzle tasks. However, while the art students were able to use both perceptual and semantic, or contextual, cues to aid performance the savant group appeared to rely heavily on simple perceptual cues. This resulted in their performance only reaching the level of the non-talented, normal controls on a meaningful condition, despite being equal to the normal artists on the abstract task. This finding indicates that a cognitive style that emphasises the contextually free, segmented processing of visual information might aid artistic output and is also apparent in gifted artists in general (Getzels & Csikszentmihalyi, 1979; Hermelin & O'Connor, 1986b; O'Connor & Hermelin, 1983; Pring et al., 1995). However, as illustrated in the Pring et al. (1995) study, these non-autistic artists are able to use *both* perceptual and semantic cues to aid performance.

A similar view was adopted by Mottron and Belleville (1993, 1995) in a number of case studies with the artistic savant EC. Rather than looking at the effect of meaning and context on EC's art work, they focussed on his attention to detail and the lack of global precedence in his artistic technique. They observed that like Nadia, EC was able to reproduce highly detailed pictures with good perspective and perfect proportions, as well as showing an ability to draw images from unusual points of view. Also like Nadia, it was noted that EC never used an eraser to amend his drawings and was able to draw perfect lines and circles without the use of any drawing equipment. Mottron and Belleville (1993) noticed that when EC began to draw he did not start, as is usual, with a global outline, rather he started his drawing with minor features. In support of previous findings (Hermelin, Pring & Heavey, 1994; O'Connor & Hermelin, 1987a; Pring, Hermelin & Heavey, 1995) EC performed up to the level of professional, adult, draftsmen on jigsaw puzzle tasks and a fragmented picture task. From subsequent studies investigating his perceptual hierarchy, Mottron and Belleville (1995) found that, although EC was able to process information globally, that is to perceive the whole picture, this did not dominate how he perceived visual images in the way that it does in normally functioning individuals (Navon, 1977). This unusual perceptual hierarchy, they suggested, might account for

EC's detailed drawing style and his ability to depict exceptionally precise visual images, because he is not subject to global, or semantic, interference thus allowing greater local accuracy. Mottron and Belleville (1993) did not compare the performance of EC to groups of non-talented autistic or IQ matched controls, nor did they utilise a talented control group on all of the tasks; as such it is difficult to ascertain how much of this processing style is related to his diagnosis of autism or to his artistic ability. However, despite such flaws these results do support previous findings outlined previously, adding further weight to the suggestion that an unusual perceptual style might in part, account for the prevalence of savant artistic ability in autism. Interestingly, Mottron and Belleville suggested that EC's perceptual style might be the causal factor in a phenomenon commonly seen in savant artists, the ability to portray linear perspective.

Linear perspective and domain-specificity

The ability of savant artists to portray linear perspective in their art work has been commonly noted (Mottron & Belleville, 1993, 1995; Selfe, 1977, 1983; Young, 1995). Gombrich (1988) argues that, along with the abandoning of perceptual size constancy, linear perspective is a key feature in drawing. Mottron and Belleville (1995) investigated this ability in the savant EC. They found that although he was able to depict realistic perspective in his outputs, he did not make use of the oblique or linear projection systems taught in art schools (Farber & Rosinski, 1978), as evident in the observation that he does not maintain parallelism or use vanishing points in his work. Mottron and Belleville (1995) argue that EC's ability to draw realistic perspectives, more accurately than trained draftsman arose due to his idiosyncratic perceptual organisation. They suggest that EC does not experience the normal conflict between what is *seen* and what is *known* about a visual image. Thus, rather than using a consciously planned strategy, his ability was in part due to his visual realism. Mottron and Belleville's (1995) suggestion that a lack of perceptual hierarchizaton may facilitate artistic accuracy by sparing perceptual representations from top down processing, was also adopted by Costall (1997).

The ability to portray linear perspective was the subject of an empirical investigation by Hermelin and Pring (1998). They found that when asked to draw the image of a road with three cars at varying distances, all eight of the savant artists tested were able to portray linear perspective and size constancy. Interestingly, they were not able to replicate this ability in a construction task, when presented with two or three dimensional components. While at first this finding may seem at odds with the lack of a linear projection system reported by Mottron and Belleville (1995), it should be noted that they were referring to the lack of a single vanishing point, in a complex image. This differs from the simple image required in Hermelin and Pring's (1998) study; here only the point where the two road borders converged was investigated and not the vanishing points of the cars added to the picture.

1.2.3 Summary on Artistic Savants

Savant artists have received much attention over the last two decades and descriptive accounts of these individuals have often highlighted how this artistic ability arises in the absence of any special training. A strong memory element is also often apparent in their art work. Empirical investigations into this apparent memory ability have shown that superior memory is only evident in the savant group on tasks that involve drawing. The results of these early studies seemed thus to indicate two things, firstly the domain-specific nature of savant artistic ability and secondly, the importance of motor ability or manual dexterity here. It was suggested that in savant artists, visual stimuli may be directly encoded into a motor programme and thus bypass visual memory. Further investigation into the manual dexterity of savant artists indicated that superior motor ability was not confined solely to pencil and paper, drawing tasks, but that the savants also displayed superior manual dexterity in three-dimensional space. A number of studies have indicated the artistic knowledge of savant artists is organised in the same way as it is in other talented artists with no cognitive impairments and also that they organise and recall semantic information in a similar way as is evident in the normal population. However, while the savant artists perceive visual information comparably to artists in general, this differs from how information is processed in individuals with no artistic ability and they show a bias towards perceiving information in a segmented form. To conclude, it appears that in many respects, the artistic ability shown by savant artists is domain-specific and only really evident in their artistic outputs. Nevertheless, there are several skills that are evident in tasks that do not require a drawing response. Skills such as superior manual dexterity and the ability to recalibrate visual information into a motor output, along with a processing style that favours a possible context independent, segmented perception of visual stimuli, can thus be seen as primary factors in savant ability.

Chapter 2

Autism, Savants and the Generativity Question

The previous chapter provided an overview of the theoretical background of savant abilities, along with a review of the empirical studies conducted into the ability of savant artists. From this overview, despite a lack of consensus on the basis of savant ability, there is one unequivocal finding that stands out, the prevalence of savant ability in the autistic population. Indeed the segmentation account of savant talent is based around Frith's central coherence account of autism (Frith, 1989; Frith & Happé, 1994) and the relationship between the deficits and assets found in autism, suggested by Happé (1999). There has yet to be a comprehensive account of the deficits associated with autism. Other than the central coherence account cognitive explanations have focussed on executive deficits (see Russell, 1997, for a review) or a lack of theory of mind (Baron-Cohen, 1995; Baron-Cohen, Leslie & Frith, 1985). Meanwhile, recent advances have highlighted a likely genetic basis for this complex disorder (Bailey, Le Couteur, Gottesman, Bolton, Simonoff, Yuzda, Rutter, 1995; Maestrini, Paul, Monaco & Bailey, 2000). For a review of current theoretical and biological approaches to autism, see Lord and Bailey (2002).

Despite the lack of an overall consensus regarding the cause of autism, the pattern of behaviours associated with the disorder have been well documented, in particular the triad of impairments initially highlighted by Wing and Gould (1979). It is somewhat surprising then, that despite the generative and imaginative impairments so clearly evident in the behaviour of individuals with autism, savant ability occurs in areas associated with these very processes. In order to investigate this fascinating paradox a number of issues must first be addressed. First and foremost the terminology as it will be used throughout this thesis must be defined, second the relevant empirical investigations into the generative capacity of individuals with autism must be identified. Third, there will be a review of the creative abilities, as defined here, found in autistic savants. This review will then conclude with a discussion of the current methodological approaches to the measurement of creativity.

2.1 CREATIVITY AND GENERATIVITY: THE DEFINITIONS

The area of creativity, despite having interested the academic community for many decades, is one that has been widely overlooked in terms of scientific study. The majority of introductory text books and cognitive psychology texts rarely provide even a cursory review of this area, illustrating the difficulties that the area of 'creativity' has in being recognised as a valid psychological concept. Finke, Ward and Smith (1992) argue that this is due to unscientific connotations and difficulties in the development of an acceptable model to explain the creative process. Certainly, one of the biggest problems faced by researchers wanting to test creativity in an acceptable manner, results from the lack of a suitable definition. The difficulty in providing a workable definition perpetuates the problem of measurement, with the authors relying on the assumption that the reader has a general understanding of terms such as 'creativity' or 'imagination'. This lack of definition contrasts with cognitive processes such as memory, which have been defined, tested and redefined for decades. Such cognitive based studies generally introduce the topics with comprehensible definitions of the areas that will be discussed, such that the reader is given a clear indication of the what is actually being investigated. When compared to the lack of a functional definition in creativity research one can easily see the types of problem encountered when embarking on research in this domain.

2.1.1 Creativity: Providing a Workable Definition

Creativity:

> *"the mental processes that lead to solutions, ideas, conceptualisation, artistic forms, theories, or products that are unique or novel"*
>
> (Penguin dictionary of psychology; Reber, 1985, pp.172)

To provide a detailed review of the various accounts of creativity which have been proposed over the last century is way beyond the scope of this thesis and, more importantly, irrelevant to the study of savant artists undertaken here. For instance, many accounts of creativity written during the middle of the last century focussed on equating people historically seen as creative artists (painters, writers and the like) with certain personality traits (Gardner, 1994, Koestler, 1964, Vernon, 1970). Others have focussed on historical periods in society (Martindale, 1994) or on the study of genius, creativity in individuals with very high IQ's (Eysenck, 1995; Getzels & Jackson, 1962). The following investigation of the savant artist does not aim to compare how 'creative' the savant is compared to the artistic community or the population as a whole. Nor is the intention to cast any aspersions on how creative their artistic output is, as Vernon maintains "these are matters of aesthetic criticism or theoretical evaluation" (1960, pp.9), although attempts are made to equate performance on empirical tests to the spontaneous output of this group of artists. The objective of this series of experiments is to investigate whether this group of savant artists share any cognitive processes with normal individuals gifted at art or if their performance is more similar to that which would be expected as a result either of their autism or their general level of functioning. As such, much of the plethora of literature into this area is simply not relevant and any theories that may be are presented at the end of this chapter and where of importance throughout the experimental chapters. What is necessary, is that a workable definition of creativity as it will be used throughout the thesis is presented, however, as will now be evident, this in itself is no easy task.

Creative products

Despite the difficulties researchers have encountered in the past, in providing a general definition for creativity, a number of feasible attempts have been made to do so. Eysenck (1994) identifies four components of creativity; the product, the process, the person and the situation, and his model is a good starting point for this discussion. Firstly a number of definitions have focussed on the creative *product* or response, Baron for instance, defines creativity as the "ability to generate new and unusual ideas, often by combining existing information in novel and unusual ways" (Baron, 1989, pp.620). This emphasis on the generation of something new or novel was also accepted by Boden (1994) and Finke et al. (1992) amongst others. Boden (1994) does point out, however, that in order to be truly creative the product or idea must be meaningful, that is it must make sense and fulfil a goal or an aim, as such creativity has often been measured in the context of problem solving. Certainly the creative nature of the product or response, is of utmost importance in creativity research, especially when one adopts the view that the only way of testing creativity is by looking at the final manifestation, be that an idea or a concrete product. In terms of the definitions outlined above this manifestation must be thus, both novel and meaningful in order to be considered creative.

Creative processes

Next are the definitions that emphasise the creative *process*. Clearly the two concepts are inextricably linked, as evident in Baron's definition which also refers to the process of combining information in different ways. However, researchers who focus on the process by which creative products arise are less interested in the final outcome and more in how this came to be. As such they tend to centre on the process of creativity in normal individuals, rather than those with a particular ability. The upshot of this being that creativity research is not solely restricted to the domain of the talented or accomplished. Early views on the creative process focussed on the association between separate ideas (Mednick, 1962; Wallach & Kogan, 1965). Interestingly, Wallach and Kogan saw the essence of the creative process to be contained in productivity and uniqueness, two related but not indistinguishable concepts. Newell, Shaw and Simon (1962) on the other hand, equated creativity with problem solving. They saw problem solving could be considered creative as long as it satisfied one of four criteria; that the initial problem is vague and undefined, the product has novelty value, that the thinking is unconventional, that it requires high motivation and persistence.

Perkins (1981) distinguishes between being creative and the process of creating. While he sees *creativity* as linked to the traits that an individual might posses, his concept of *creating* is similar to recent accounts of the creative process in normal individuals. Creating is seen as going beyond what an individual is able to do effortlessly and Perkins sees it to involve four moves; planning, abstracting, undoing and making means into ends. As such he views creating as involving thinking, rethinking, amending and a preoccupation with the final product, again illustrating the link between the process and the product. A more recent model was proposed by Finke et al. (1992), who define the creative process as consisting of two distinct phases, generation and exploration. The resulting 'Geneplore' model identifies a number of processes related to each of these phases and is very similar to that outlined by Perkins (1981). In the generative stage Finke et al. (1992) propose that one constructs *preinventive* structures that are generated, regenerated and modified through the course of the exploratory stage, and that ultimately result in the creative product.

In this thesis the focus will be on both the creative product and the creative process, without dealing with the person or the situation. As such the definition of creativity proposed by Vernon (1989) appears to encapsulate the aspects we are referring to in particular. Vernon refers to creativity as a person's *capacity to produce* new or original, ideas, inventions or artistic products, which are accepted by experts as being of scientific, aesthetic, novel or technical value. Such a definition refers to both the process and the end product.

2.1.2 Generativity: How Many Ideas can be Produced?

A second term that will be used throughout this thesis is that of generativity. The expression generativity has been used in a number of recent studies, especially those looking at creative ability or imagination in autism (Jarrold, Boucher & Smith, 1996; Jarrold, 1997; Turner 1999). Unlike creativity, this term is often used as it is seen as more psychologically testable and can be viewed simply as the process by which an idea or behaviour arises, irrespective of how novel that idea is. Therefore, whereas in creativity the onus is on the *creation* of something new, in generativity the onus is on the *generation* of something. For this reason studies which look primarily at the amount, or type, of ideas which can be produced tend to use the term generativity rather than dealing with the negative psychological connotations that arise when using the term creativity. Indeed when looking at generativity, quite often the novelty of an response can also be measured by looking at how unusual it is, compared either to the group in question or the general population as a whole.

2.1.3 Creativity and Generativity: A Quality, Quantity Distinction.

The distinction between creativity and generativity is a useful one and one that will be used throughout this thesis. As such generativity is often equated with the overall number of responses produced, that is the *quantity* of responses, without any inference on the creative nature or quality of these ideas. Creativity, on the other hand, is concerned with *quality* and the unusualness of a response or an idea. As mentioned before, in this study of individuals with learning difficulties no assumptions will be made concerning the historical creativity of the ideas that will be produced. Rather, the processes that might allow these individuals to overcome the impairments associated with their disorder, a disorder that predicts impairments in both the creative and generative domain, will be investigated. The distinction made here, between creativity and generativity, can be seen as being very similar to the productivity, uniqueness distinction mentioned by Wallach and Kogan (1965) earlier.

2.2 AUTISM, CREATIVITY AND GENERATIVITY

One term not referred to so far in this brief introduction, and one that does not concern this thesis outside of this introduction area, is 'imagination'. The Penguin dictionary of Psychology defines imagination as "the process of recombining memories of past experiences and previously formed images into novel constructions" (Reber, 1995, pp.359). Clearly this definition is very similar to those previously proposed for creativity and indeed the two processes are inextricably linked. In the wider realm, however, imagination does not necessarily require the formation of an entirely novel output (despite Reber's definition) and is often used to denote the consideration of something which is not physically present (Karmiloff-Smith, 1990; Leevers & Harris, 1998; Scott & Baron-Cohen, 1996). It follows then, that if an individual has difficulty in imagining a 'non-present' entity they will no doubt have difficulty in producing a creative response. As such throughout this thesis the term creativity, rather than imagination, is preferred due to the emphasis in this term on the creation of a novel response.

Despite the interest and resulting empirical investigations into the socialisation and communication deficits found in autism, as well as non-triad behaviours and islets of ability, the imagination deficits associated with this complex disorder were widely overlooked until very recently. Even now the number of published papers on other areas far outnumbers reports regarding creative or generative ability and this may reflect the previous psychological climate with regard to such investigations. This imbalance does mean that an important area of functioning in autism, with particular relevance to savant ability, has been widely neglected. Initial studies into this area tended to focus almost exclusively on the area of pretend play, as it was recognised that the play engaged in by children with autism was qualitatively different to that shown by other children of the same mental age. Rather than engaging in pretend play the autistic children would engage in stereotyped or repetitive behaviours (Wing, 1978), they produced less spontaneous pretence than IQ matched controls (Baron-Cohen, 1987) and did not appear able to produce creative pretence (Atlas, 1990). Deficits have been found in both the quality of pretend play produced by children with autism (Riguet, Taylor, Benaroya & Klien, 1981) as well as the quantity (Jarrold et al., 1996).

Early investigations

Early explanations for the lack of imaginative or creative play of autistic children focussed on the mentalizing impairments thought to be at the centre of 'theory of mind' deficits. Leslie (1987) claimed that pretend play was metarepresentational in nature because it involved representing how another person sees the world. The failure of autistic children to produce pretend play was thus seen to be due to an deficit in constructing and manipulating metarepresentations, that is alternative representations of the world. There are, however, a number of flaws in this account. Firstly, a number of studies have shown that with explicit instructions and under controlled conditions, children with autism are able to produce or understand pretence (Jarrold, Boucher & Smith, 1994a; Lewis & Boucher, 1988) not in keeping with Leslie's prediction of a global deficit here. Jarrold et al (1996) extended these findings, and attempted to overcome previous methodological weaknesses. They concluded from a number of studies that the deficits in pretend play were executive in nature. What is more, the pivotal impairment was seen to be a generativity deficit, in that the children with autism were impaired in their ability to *generate* spontaneous pretend play rather than a global deficit in understanding pretence. This idea was expanded by Jarrold (1997), who argues that the lack of spontaneous pretence was not due to an impairment in inhibiting the correct use of the object in order to generate a new use, (for example using a banana as a telephone) as children with autism were able to do this in a controlled situation, following training.

Studies of generative ability

A deficit with regard to the generation of ideas has also been highlighted on tasks outside the domain of play. One paradigm often used in assessing the generative capacity of individuals with autism is word fluency. Classic word fluency tasks require the individual to name as many words as possible belonging to a particular category (Lezack, 1995) and have been used with a variety of subject groups. The results in autism have been inconclusive, with several studies indicating a deficit (Minsew, Goldstein, Muenz & Payton, 1992; Rumsey & Hamburger, 1988; Turner, 1998) whereas others report that the performance of autistic groups was equal to that of their IQ matched controls (Minshew, Goldstein & Seigel, 1995; Scott & Baron-Cohen, 1996). While these fluency tasks do measure generative ability in that they assess the amount of ideas that can be produced in a given period, they can be criticised in that they only measure a participant's ability to trawl a verbal lexicon in order to retrieve appropriate examples. As such these word fluency tasks provide us with little information as to the generative processes utilised by individuals. This last point was raised by Boucher (1988), who was interested in the processes by which responses were generated and who suggested, supporting Jarrold et al.'s (1994a) conclusion, that a generativity deficit might be pervasive in autism. Boucher (1988) found that children with autism performed equally to an IQ matched control group on a categorical word fluency task, but were significantly worse than controls when told to name as many miscellaneous words (i.e. "name me all the words you can think of"). Boucher concluded this was due to the autistic group's failure at generating a self-cueing strategy and similar results are also discussed by Jarrold (1997) and Turner (1997, 1999).

Further support for a pervasive generativity deficit in autism is provided by a set of studies conducted by Turner (1997,1999) who also looked at this generativity deficit in terms of an executive impairment. Turner presented participants with a variety of fluency tests in the visual, verbal and drawing domains and investigated whether the poor performance of individuals with autism on generative and creative tasks was due to an inhibitory impairment or a generativity deficit. One task used by Turner (1999) was the object uses task (Christensen, Guildford, Merrifield & Wilson,1960; Getzels & Jackson, 1962, Wallach & Kogan, 1965), where participants are required to name as many uses they can think of for a common everyday object such as a brick. This task had previously been used by Scott and Baron-Cohen, (1996) who reported no difference between children with autism and their IQ matched and mental age matched control groups. However, the low response rate produced by all groups in this study could indicate that the task demands were too high for individuals of such a young age or low IQ. Turner not only used older individuals of a wide range of IQ's but she also extended the study by presenting participants with both conventional objects (such as a brick) and non-conventional objects (such as a piece of material).

The use of conventional and non-conventional objects allowed Turner to investigate the cause of any poor performance. So, if participants produced a number of repeated responses this would be indicative of a low-level inhibitory impairment, in that the participants were unable to inhibit their previous response, resulting in high rates of perseveration. A high-level inhibitory impairment would be evident in a high percentage of redundant responses, that is responses of the same semantic category. On the other hand, if the performance of the autistic groups was better in the non-conventional condition than the conventional, this would indicate a deficit in terms of inhibiting the most common associations of the object in question. Again Turner found evidence of an overriding generativity deficit with regard to the number of responses produced by the autistic participants. Interestingly she found that it was only the control participants who showed superiority on the non-conventional condition, where as the autistic group did not show this bias. An autism-specific, fluency deficit was also indicated on the Torrance Test of Creative Thinking (Torrance, 1974) by Craig and Baron-Cohen (1999) this result is discussed in more detail in chapter 3.

Similar fluency results to those reported above were also obtained on the other measures used by Turner. In the pattern meanings task (Wallach & Kogan, 1965) the autistic group produced significantly fewer responses than controls and in the Design Fluency task (Jones-Gotman & Milner, 1977) they produced significantly fewer acceptable responses with more repeats, although their overall fluency score was equal to controls. Such results indicate a problem in the monitoring of action plans and this is particularly evidenced by the high error rate, particularly on the design fluency task. Turner argues that this is because individuals are not required to generate a complete action plan before they begin, rather they need to constantly monitor their behaviour throughout their response. In terms of executive dysfunction

Turner suggests that a lack of generativity and impaired inhibition are two sides of the same coin. She argues that in a situation that provides few cues for how to respond, the transition from one activity to another means one activity must stop whilst another begins. However, an inhibitory impairment alone cannot account for the pattern of results produced on such tasks, nor can an impairment in monitoring, as indicated by the low error rates on tasks such a word fluency. It is worth noting, however, that although a useful task for assessing generative ability in terms of the *amount* of responses produced, these word fluency tasks do not require the participant to produce new or novel responses. For this reason they cannot be considered tests of creative ability, it may be that word fluency tasks provide enough cues for participants not to have to monitor their behaviour. Therefore this generativity deficit is only evident on tasks that require the participant to go beyond stored knowledge.

If a generative deficit is at the heart of the imaginative impairments found in autism, what is the cause of this? Jarrold (1997) proposes a model of executive control based on Shallice and colleagues' Supervisory Attentional System (SAS; Norman & Shallice, 1986; Shallice, 1988, 1994; Shallice & Burgess, 1991). This model suggests that a limited capacity system (the SAS) provides conscious control over action selection, including inhibitory and excitatory control processes. The model can be split into three distinct levels; action scheduling, activation and inhibition, and goal selection and representation. A dysfunction at any of these levels could result in a generativity deficit, but Jarrold (1997) argues that the main impairment is due to a deficit at the highest level, that of goal representation and selection. He argues that in autism, goals are poorly represented in the SAS and as such control signals are poorly specified. Thus, as goals are poorly represented, adequate plans cannot be generated, behaviour cannot be monitored effectively and deficits in overall inhibitory control will also occur. Further support for this model can be seen in a number of the studies previously discussed, in particular, the monitoring, inhibitory and generativity impairments highlighted in Turner's study. A deficit at this level can also account for why, given the right environmental cues, individuals with autism are able to produce behaviours such as pretend play (Jarrold, Boucher & Smith, 1994b; Lewis & Boucher, 1988). Moreover, as suggested by Turner (1999), when there are no cues available to guide behaviour, then no behaviour can be generated. Finally an earlier study conducted by Russell, Jarrold and Henry (1996) indicates the locus for problems in goal selection rather than goal representation and specifically monitoring. Support for this view also comes from the fact that the only executive tests in which individuals with autism are constantly found to be impaired is the Tower of Hanoi or the similar Tower of London task, (Ozonoff, 1997), both tasks specifically measuring planning ability and require the generation and monitoring of appropriate goal states and plans. What is more, it is suggested that this inability comes from a lack of ideas, or a paucity of goals, rather than an inability to translate goals into action (Turner, 1995).

Autism and creativity

The review of work so far has tended to focus on generative ability. This may be because generativity, as defined here, can be measured in absolute terms (that is the total number of responses) where as quantifying creative ability is far more difficult. What is more, studies of the type described above can be viewed in terms of current theoretical models, thereby allowing different processes to be distinguished in an attempt to highlight a primary cause. The question can thus be raised, if individuals with autism are inferior in the *quantity* of responses they can produce, are they similarly impaired with regard to the *quality* of response? The imaginative or creative capacity of individuals with autism has been measured in a number of studies, Scott and Baron-Cohen (1996) used a methodology previously employed by Karmiloff-Smith (1990) to look at the ability of individuals with autism at drawing impossible pictures. They found that the children with autism were less able than controls on this task, thus were less creative. Unlikely to be a result of a deficit in fusing objects together (see Craig, Baron-Cohen & Scott, 2001) they concluded in line with the metarepresentation deficit hypothesis (Leslie, 1987) that the difficulties that autistic children have on this task resulted from problems in the representation of unreal objects. Therefore results were interpreted in terms of an imagination deficit.

Leevers and Harris (1998) replicated the Scott and Baron-Cohen (1996) study but reduced the executive demands by presenting children with a basic outline, which the children were then required to add details to. They found that not only were the children with autism able to produce as many correct responses as the controls, but also that many of the responses produced by the autistic group were considered very imaginative or creative. Leevers and Harris (1998) concluded that the deficit reported by Scott and Baron-Cohen (1996) on this task occurred in the generation of action plans for drawing unfamiliar pictures, rather than difficulties in generating novel responses. Again this fits in with Jarrold's (1997) hypothesis, in that a deficit in goal selection could disrupt the planning necessary to complete a novel response, especially if this results in non-specific action schemas. Thus when the task demands were reduced and the planning necessary to complete the task was lessened the autistic group were as able as the controls.

Could it be the case then, that the key problem autistic individuals have is in the generation of responses rather than the creative nature of these responses? While the results obtained by Leevers and Harris (1998) do provide some support for this view, they did not measure creativity specifically, indeed when studies have aimed to empirically test this dimension the results have not been positive. Turner (1999) included a measure of creativity in her studies and found that contrary to the suggestion above, the autistic group were less able to produce unusual or novel responses that controls. As the tasks used by Turner did not have standardised scoring guidelines or norms available, she measured creativity or imagination by looking at whether the response took into account all of the stimulus characteristics in a plausible fashion. She found that the responses produced by the autistic group were less creative than those produced by the controls on both ideational fluency tasks (the pattern meanings and the object uses). Similarly Scott and Baron-Cohen (1996) found that even though the response rate was very low, the mean number of creative responses produced by the children with autism was below that produced by the control group.

In keeping with the above findings Lewis and Boucher (1991) reported that although children with autism were able to produce drawings of the same technical level as IQ matched controls, the art work produced by the group with autism showed less thematic variation. They concluded that the autistic group felt constrained by what they felt they were able to draw, but this conclusion can be criticised as it is unlikely that given the equal performance of the groups in terms of ability, the autistic group should feel more constrained than controls. It might thus be that the lack of thematic variation is evidence of a generativity deficit in producing a variety of different or flexible responses, possibly related to an executive deficit.

In explaining the lack of creativity outlined above, further reference can be made to Jarrold's (1997) model. Jarrold states that initiation of appropriate action plans is possible if the external stimuli are strong enough to guide behaviour. This model then predicts that in situations where novel responses are necessary, where there are less environmental cues, the overall number of responses will be fewer and when responses are produced they are often the most common ones.

Summary: Autism and generativity

To summarise, a deficit in imagination and creative behaviour is one of the triad of impairments thought to characterise autism and forms part of current diagnostic criteria (DSM-IV, American Psychiatric Association, 1994). However, despite it's importance, this area is one that has been widely overlooked in research. Early studies tended to concentrate on children with autism's failure to generate pretend play, focusing on mentalizing impairments, while later work in this area has highlighted a primary problem of generativity. An overall deficit in generating behaviour has also been found to discriminate the performance of individuals with autism in areas other than play. This generativity deficit can be seen in terms of an executive impairment and in particular it has been suggested that this is because individuals with autism have difficulties in selecting and representing goals. While there appears to be much evidence concerning a pervasive generativity deficit in autism, any conclusions regarding creative ability are less clear. Indeed several tests have indicated that given the correct environment or when the task is non-verbal, individuals with autism are able to produce novel or inventive responses. However, the results of studies that have attempted to measure behaviour in novel situations, without the aid of environmental cues, do indicate a deficit associated with the disorder.

2.3 SAVANTS AND GENERATIVITY

Given the evidence outlined in the previous section, that individuals with autism are impaired in their ability to spontaneously produce a variety of responses that are away from the ordinary and established, it is very surprising that savant talent is found in domains associated with creative or generative ability. However, despite the high incidence of savant talent associated with autism, there has yet to be a systematic investigation into the generative and creative abilities of such individuals. While such investigations are particularly lacking with regard to savant artists, there are a number of studies which have looked at the generative capacity of savant musicians.

Investigations into the generative ability of musical savants have mainly centred on improvisation ability. Improvisation is seen to be a very good indicator for generative ability in music, as it requires not only inventiveness but also the ability to produce a response within the constraints of the original piece (Hermelin, O'Connor & Lee, 1987). Case studies of musical savants (Miller, 1987; Sloboda, Hermelin & O'Connor 1985) have found that savants not only possess an outstanding musical memory, but that they also have the ability to pick out appropriate melodies and harmonies. Charness, Clifton and McDonald (1989) reported the case of a blind man with epilepsy who, despite a very low IQ, was able not only to elaborate musical pieces, but also to imitate specific musical styles.

Hermelin, O'Connor, Lee and Treffert (1989) compared the improvisational ability of a savant musician with that of a talented, adult keyboard player. It was found that the overall performance of the musical savant was comparable to that of the adult musician, but interestingly, the output produced by the savant was richer and more elaborate that that produced by the control. Similar findings were also reported by Hermelin, O'Connor and Lee (1987) who compared the performance of a group of savant musicians to a group of talented, musically trained children. In this study participants were required to continue a tune started by the experimenter, as well as to invent an entirely new tune, an accompaniment, a melody and accompaniment and finally to improvise over a twelve bar blues sequences. A scoring criterion was calculated by using the mean ratings gained on completed tasks, thus giving an overall measure of inventiveness. Performance was also rated on overall aspects such as timing, complexity and balance, resulting in an overall competence score. The savant musicians were found to be both more competent and more inventive that the control group, indicating that their knowledge of musical structure was at least equal to individuals talented at music, but with no cognitive impairments. Access to such representational rules meant that the savants were not only able to reproduce music, but also to go beyond what was directly perceived in order to produce an output conforming to the original structural pattern. These results not only provide further evidence for the lack of a general intellectual capacity to govern all behaviour, but also support the notion that savant talent is flexible and based on the same organisation structure of the information in memory, as found in talented individuals with no cognitive impairments.

In many ways musical inventiveness can be likened to artistic inventiveness; both require structural rule-based representations as well as complex motor planning and control. Pressing (1989) argues that musical improvisation, which requires fluency and flexibility, is possible only after the individual has gained a level of automaticity in their motor organisation, thus allowing conscious attention to focus on a higher level of expressive control. Given the similarities between the structural basis of musical and artistic talent and the conclusion that savant artists have superior motor control with respect to their instrument (Hermelin, 1994) one might then expect that the generative ability of savant artists would be equal to that found in normal artists with no impairments.

Despite the apparent creative and generative nature of savant artists, this is a hitherto neglected area of empirical research. As previously illustrated, a number of studies have been conducted into the cognitive styles of savant artists but whether their generative ability is restrained or facilitated by their autism, has yet to be the subject of systematic investigation. Nevertheless, the creative nature of savant art has been mentioned by a number of researchers. Sacks (1995) refers to the art work produced by a number of savant artists. He points out that their outputs are rarely exact replications of the original image and thus must go through some sort of transformation. What is more Selfe (1977, 1983) pointed out that Nadia was able to draw her images from a variety of perspectives, introducing a variety of omissions and additions, similar to that reported by O'Connor and Hermelin in their 1990 paper. In their 1990 paper, *Art and Accuracy*, Hermelin and O'Connor made some attempt to look at the generative or aesthetic abilities possessed by savant artists. They compared representational ability (how true to the original image the response was) with aesthetic quality. It was found that whereas *representational* ability was determined by the overall level of intelligence, the *aesthetic* quality of the savant art was above that of the controls.

The above descriptions indicate that, despite their autism, savant artists do possess some generative ability. The existence of this is illustrated in a further case study of the autistic artist Richard Wavro (Hermelin et al., 1999). Hermelin et al. sought to investigate generative capacity by comparing Richard's artistic output with the photographs from which they were derived. Richard's preferred topic was landscapes and he would spend hours in the local library looking at photographs of scenes in books. He would then produce a picture based on a photograph he had seen days, weeks and sometimes months after he saw it. It was found that Richard made a number of novel transformations in his artistic responses, for example, he would enlarge certain details in the picture and occasionally add whole features, such as a house, to the finished picture. Furthermore, Richard would also exaggerate certain colours or place minor features to the foreground in order to enhance the overall composition.

It was concluded that Richard's most notable skills appeared to be in the depiction of light, colour and space, which he used to produce subtle atmospheric effects. His simplification and exaggeration of certain features resulting in balanced and harmonious representations, which were often markedly different from the original photograph on which they were based. On a more psychological note, it was suggested by the authors that the generative changes apparent in Richard's art work, probably resulted from his visual impairment (as well as being autistic Richard also suffered from extreme myopia and glaucoma) interacting with memory transformations.

The generative nature of savant talent, was also subject to a paper by Young and Nettlebeck (1995). Despite the evidence for generative ability outlined above, they argue that in areas where artistic creativity is permitted, outputs produced by savants are often mechanical, with low levels of expressiveness and emotional involvement. They maintain that the instances of reported creativity arise from a highly developed recall for visual details, which is then subject to a variety of transformations. They cite Hermelin and O'Connor's 1990 study, stating that the art work produced by the savants was not a literal photographic production of the model, as evidence for this view. However, they fail to expand on how a highly developed memory might account for this. What is more Young and Nettlebeck cannot account for cases, such as Richard's, where emotional expressivity is clearly evident in the overall feel of his compositions to create a harmonious atmosphere.

The review so far has aimed to illustrate how, in the domain of their talent and their artistic output, savant musicians and artists are able to produce responses deemed as showing creative aspects. In savant musicians the creative nature of their talent has been the focus of several empirical studies, while this was not the case in the studies of savant artists, there is still evidence of a creative transformation in their compositions. What has not been tested with such groups is performance on commonly used tests of creativity and generativity, both within and related to their domain of talent. The only group study which has attempted to assess creative ability on a standardised test is referred to by Hill (1978). He cites a study by Duckett

(1976) in which she used Torrance's Thinking Creatively with Pictures (Torrance, 1974) to assess the abstract thinking ability of a group of savants with a variety of talents compared to a control group matched on age, sex, and IQ.

Duckett's prediction that the savant group would score more highly on the initial dimensions of fluency, flexibility, originality was not supported. She found that while the scores of the savant group indicated some creativity, they were only similar to the norms for 5-year-old children and thus likely to be dependent on mental age. The exception to this result was on the elaboration dimension, however, although higher scores were produced on this dimension they were still below mental age equivalent norms. Interestingly, this superiority was only found in the calendrical calculators (Miller, 1999) a savant ability not obviously related to generative or creative ability in the way that say, art or music might be. Unfortunately no other information is available from this intriguing study, especially with regard to the diagnosis of the savant group or their controls. At the time of this study very little was known regarding the generative deficits associated with autism and as such the results may have been confounded by a lack of diagnostic matching. Certainly, if the incidence of autism found in Duckett's group was similar to that of the groups documented previously, it is likely significant findings may have been overlooked.

Since Duckett's study there have been no attempts to measure creative behaviour in such a standardised or scientific manner, therefore, whether the creative aspects apparent in savant artists' spontaneous outputs are extendable to established measures of creativity remains to be seen. Indeed, as yet only one published study has attempted to address this question. Dowker, Hermelin and Pring (1996) compared the performance of a poet, Kate, with Asperger's Syndrome to that of a similarly talented poet with no developmental disorder. They found that whereas the savant poet's performance was comparable on artistic merit, her performance on verbal creativity tests was significantly worse than that of the control poet. The results obtained with the savant poet provide an interesting comparison with those obtained with the musicians and artists. Indeed, if we were to disregard Kate's performance on the creativity tests and only look at her poems, then she does seem to show evidence of creativity, supporting the previously discussed results obtained with musicians and artists. The creative and generative nature of her spontaneous poetry is, however, very different to the performance obtained on verbal creativity tasks, which appear to relate more to her IQ or autism, rather than her talent. It is difficult to generalise on the basis of a case study as to how general the creative nature of savant talent is, nevertheless, from the results outlined above it might appear that the creativity exhibited by savants is only evident in their actual output, rather than being testable on established measures.

Apart from Dowker et al.'s (1996) investigation, the studies in which savant creativity has been identified all involve either an analysis of the actual spontaneous outputs only or improvisation within the domain of ability. These investigations have not presented the savants with common creativity measures and as such the full creative and generative nature of the savants' ability is questionable. This comes under more scrutiny when one looks at the actual artistic output of such individuals; here one can make a distinction between transformational ability and creativity. As previously discussed, the savant musicians are able to improvise in a given style and in some rare cases produce an original composition (Hermelin et al., 1987). However their spontaneous musical output does not generally consist of a totally unique composition (Hermelin, 2001). Likewise, savant artists again produce their outputs spontaneously, but these are rarely drawn solely from imagination and in most cases are closely based on real images they have seen. Thus although their transformational abilities do appear to show a creative quality, which often enhances the overall aesthetic quality of their compositions, the true extent of their generative abilities is less clear.

Referring back to the savant poet Kate, her poetic output can be seen to be generative in the truest sense of the word, as it is produced spontaneously and is not based on a representation of an image as with the artists, or a tune, as with the musicians. What is more, this poetic ability is far less common than the musical and artistic abilities more often found in savant talent. It would thus have been of interest to measure the performance of the musicians or artists on common creativity tasks and similarly it would have been noteworthy to measure Kate's improvisational ability (in much the same way that was used with the musicians). In this way a clearer picture would have developed concerning the flexibility of her talent.

Summary: Savants and generativity

To conclude, although the spontaneous outputs produced by the savant groups, in domains such as art, music and language, do show clear evidence of creative and generative qualities, the true nature of these abilities has yet to be established. This is especially the case for the savant artists. Although a number of studies have referred to the creative nature of their work, there have so far been no attempts to assess this ability in a structured setting. The series of experiments to be reported here aim thus, to provide a systematic account of the creative and generative abilities of savant artists. Attempts were made to distinguish between the abilities previously discussed (i.e. transformation, creativity and generativity) and to investigate the processes that may account for these, in order to discover if the creative performance of the savant artists is evident only on spontaneous output or also evident on other related measures.

2.4 MEASUREMENT OF CREATIVITY

A thesis of this type needs firstly to deal with two pressing issues, the first concerns the adequate measurement of creativity and generativity. The second relates to the use of an adequate methodology which will pick up these processes in individuals with learning difficulties, especially those difficulties related to language and comprehension. In much the same way that the definition of creativity is fraught with problems, a discussion of the measurement of creativity could easily fill several volumes without providing an answer. The method employed to test creativity will clearly depend on the definition employed. For the purposes of this thesis creativity has been defined as the process by which a novel, yet meaningful, response or output is produced. This means that two factors need to be measured; the creative product and the process by which this is obtained. As discussed, the artistic outputs which are spontaneously produced by artistic savants do have creative aspects, and while this will be covered in more detail with regard to the savants in this group, it is not the main emphasis of this study. In this series of experiments the aim was to measure the savant artists' creative and generative ability *outside* of their spontaneous art work, it is thus useful to look at the methodology adopted in previous studies of creativity.

Many early tests of creativity, not concerned with specific artistic or scientific productions, consisted of pencil and paper tasks that could easily be presented to groups of individuals with the minimum effort. One of the earliest attempts at a full scale investigation of creative ability of this type was conducted by Guilford (1950). Guildford pointed out that all of the tests used by psychologists in America at that time were *convergent*, that is they required a predetermined, correct response. He argued that creative thought is, however, more likely to produce a variety of new answers through a process of *divergent thinking*. From his studies on the structure of intellect (Guildford, 1950, 1957, 1960) he regarded creativity as consisting of a number of primary abilities; sensitivity to problems, ideational fluency, flexibility, novelty or originality, elaboration and the ability to resynthesis and reorganise information. As such the tests he used, including tests such as the object uses (Christensen, et al., 1960), plot titles (Berger & Guildford, 1960), and consequences (Christensen, Merrifield & Guildford, 1958), were devised to pick up on these abilities. For example, many of the tests consisted of a total fluency score and the ability to produce a number of ideas in a given time was seen as an important aspect of creativity. Likewise the ability to produce a number of ideas which are figurally or semantically varied and free from perseveration (flexibility) was also measured. Novelty or originality were also scorable by looking at how common a response was and elaboration measured mainly on visual tasks whereby details needed to be added to two parallel lines.

Such tasks are commonly referred to as ideational fluency or divergent thinking tasks. However, the factors identified by Guildford have been criticised by a number of researchers. In particular the trait of fluency, which although found to correlate significantly with factors such as originality (Barron, 1963), is likely to result from the fact that those with higher fluency score better on other factors simply because they have produced more responses. As such, ideational fluency tasks are often seen as little more than tests of quantity (Hocevar, 1979, 1980, 1981). Leading on from this, other researchers have cast doubt over whether divergent thinking tasks have any relationship to creative potential (Barron & Harrington, 1981;Wallach, 1976).

Despite such criticisms Guildford's methodology has been very influential in the field of creativity. Both Getzels and Jackson (1962) and Wallach and Kogan (1965) used similar tests as those utilised by Guildford and colleagues in their investigations of the intelligence versus creativity distinction. Interestingly, in both studies visual measures were added to the original verbally based tasks; Getzels and Jackson used Cattell's Hidden figure task (1956), whereas Wallach and Kogan presented participants with a variety of meaningless line drawings which they needed to interpret. What is more, separate scores were often calculated from one set of responses, for example, total fluency, the uniqueness of a response and so on, in keeping with Guildford's components.

A slightly different version of Guildford's work was adopted by Torrance (1974). Using four of the component areas of creativity identified by Guildford (fluency, flexibility, originality and elaboration), Torrance developed a number of tests to measure creativity in a variety of domains (verbal, visual, movement) in ordinary non-gifted individuals. A full review of these tests and the dimensions they claim to measure is presented in chapter 4, but the ease of administration and, unusually for tests of creative thinking, the standardised scoring system, have meant that these tests have been very popular in creativity research over the last 40 years. Despite criticisms regarding the relationship between the types of divergent thinking tasks as used by Guildford and Torrance and the nature of creativity, their methodology is still found in many current approaches to creativity measurement. In particular the separation of dimensions such as fluency, flexibility and originality is frequently adopted. More recent approaches have, however, tended to move away from the divergent thinking approach, although many still have the requirement that the individual produces a variety of responses to a single cue or problem. In the present series of studies such a criterion is to be defined as meaning generativity rather than creativity.

In contrast to the traditional methodology described above, the creative cognition approach (Finke et al., 1992) emphasises the *processes* that lead to the production of novel responses. These authors maintain that creativity consists of a generative process and an exploratory process, and identify a number of measures that they use to tap such operations. For Finke and colleagues, creative thought arises when the individual is faced with an unusual challenge, thus the tasks they use to measure this concept differ somewhat from the more traditional methods. In particular they have tried to introduce novel tasks, in which they regard the cognitive processes leading to a response as crucial.

Like the tasks derived from Guildford and colleagues, the methodology used in the creative cognition approach can also be presented to participants of a variety of ages and cognitive abilities, with minimum effort and materials. Again, these tasks do not rely on the individual having produced a historically creative product or being considered a creative person, as they aim to look at such processes in the whole population. Tasks used by Finke and colleagues include measures of creative visualisation (Finke, 1989; Finke & Shepard, 1986) invention (Finke, 1990) and synthesis (Finke & Slayton, 1989). They also carried out a number of studies into structured imagination (Ward, 1991a, 1991b) and insight (Smith, Ward & Schumacher, 1991; Smith & Vela, 1991). The creative cognition approach to the measurement of creativity is a particularly useful one to adopt, because it acknowledges that creative thought can occur in the general population and that such occurrences can be objectively measured. Although the methodology adopted by this approach is aimed at identifying the cognitive processes that underlie creativity, Finke and colleagues recognise that occasionally creative products may arise randomly or by accident. Here they argue that the processes which lead to production, should not detract from the final creative product, but rather that both factors (the product and the process) should be looked at as separate.

Although this review did not aim to provide strong conclusions on the creativity nature of savant artists' spontaneous, artistic compositions, it is necessary to provide a brief discussion of the cognitive processes thought to underlie artistic creativity. Getzels and Csikszentmihalyi (1976) carried out a longitudinal study of creativity amongst talented art students. They found that artists who were most successful in later life, thus deemed more creative, treated their artistic outputs like a problem that needed solving. These successful artists tended not to begin their compositions with a definite idea of their final product, but let it progress and develop; this concurs with Perkins' (1981) ideas of the creative process. Gardener (1982) used a cognitive developmental perspective to explore artistic creativity, describing it in terms of computational and compositional schemas. However, as pointed out by Finke et al. (1992), Gardener's account is limited in that that he does not provide detail as to the underlying cognitive process that such schemas may involve.

2.5 OVERALL CONCLUSIONS

The aim of this chapter was to provide the reader with a introduction into the main issues relevant to this series of studies. Firstly, the problem that all researchers face when embarking on investigations into the domain of creativity was highlighted, namely the lack of a tight, workable definition. A brief review of various approaches to the study of creative ability were presented and it was recognised that a distinction could be drawn between the creative product and the creative process.

It is surprising that savant abilities should arise in areas that are commonly associated with creativity, considering the deficits individuals with autism have in generating ideas. Although a lack of imagination is one of the triad of impairments characterising autism, research in this area has been neglected up until recently. A review of the literature into the creative and generative abilities of individuals with autism was presented and across the board autism-specific deficits were found on a variety of tests leading several researchers to suggest that a generativity deficit may be pervasive in autism. It was further suggested that the root of this deficit was an executive impairment, specifically with regard to goal representation and selection.

Despite the distinction that was drawn between generative and creative processes, a generativity deficit will clearly have some influence on creativity, especially if the root of problems develops from a paucity of ideas. However, while some studies have indicated a lack of imagination or creativity in the responses of individuals with autism, others have found that given the right environmental circumstances these individuals are able to produce creative outputs. This seems to be particularly the case in studies where the verbal element is greatly reduced. It may thus be that the language deficits associated with autism mask creative ability to a certain extent. This is not to say that individuals with autism do not exhibit creative or generative impairments, but more that these impairments could be reduced or less evident outside of the verbal domain.

With regard to the creative performance of savant artists, again this area has been widely overlooked in research. A number of descriptive accounts and empirical investigations have been reported alluding to the creative or generative nature of their artistic outputs, but the generative capacity of this group has yet to be investigated in a systematic way. Despite this, there have been several attempts to measure these concepts in other domains. Generally it has been found that savant performance is equal to that of talented, non-autistic controls when the test takes place in the domain of specific ability. However, this ability rarely influences performance on standardised measures, or when the output is not a spontaneous production. Finally, the measurement of creativity was discussed and more specifically how general intelligence would influence both the presentation and output of such tasks.

Chapter 3:

Design considerations

3.1 THE SAVANT ARTISTS

As this thesis is concerned with the performance of a small group of savant artists it is necessary to provide a brief introduction into not only each savant artist's overall cognitive ability, but also their artistic style and personality. The savant group consisted of nine artists, two females and seven males; which is consistent with the sex ratio of 1:3 associated with autism (Steffenburg & Gillberg, 1986). Several of the savant artists (CH, DP, SQ & SW) had previously been included in studies conducted by Hermelin and colleagues. Three artists were recruited by the experimenter following telephone calls made to specialist autistic services affiliated to the National Autistic Society (NAS), requesting information on any individuals who had artistic ability above that found in the normal population. Following this examples of their art work was requested and any individuals with exceptional artistic ability were visited by the experimenter to confirm that these individuals possessed a genuine ability. From this investigation, CM, MD and ML were included in this study. Finally two artists (PM & TM) were introduced to the study as a result of the attention brought to them from various local exhibitions where they had presented work. A sample of the artwork produced by each savant artist was seen by an independent art examiner, who rated all of the samples to be of a standard that would gain them entry into art school. The age range of participants in this group was from 23 to 43 at the time of testing. Initially an attempt was made to obtain a group of young savant artists to combine with the performance of the savant group, however, as the IQ range of the savant artists was already very wide, a decision was made to restrict this investigation to the study of adult artists only. Table 3.1 illustrates the scores of each savant artist on a variety of cognitive tests. Performance IQ (PIQ) was measured using wither the Raven's Standard Progressive Matrices (PRM; Raven, Court & Raven, 1988) or the Raven's Coloured Matrices (RCM; Raven 1986). Verbal IQ (VIQ) was measured using the Peabody Picture Vocabulary Test (PPVT; Dunn & Dunn, 1997). As well as the measures of PIQ and VIQ discussed above, the scaled scores of four sub-tests from the WAIS-R (Wechsler, 1981) were also obtained (vocabulary, comprehension, block design and object assembly). These four tests often represent the most extreme ranges of performance of the Wechsler intelligence scales in individuals with autism (Happé, 1994a), with the verbal tests providing the lowest scores and the block design and object assembly the highest.

Table 3.1: Individual IQ scores and personal characteristics of the savant artists.

Personal characteristics			WAIS scores					
Name	Year of Birth	Diagnosis	PIQ	VIQ	Block Design	Object Assembly	Comprehension	Vocabulary
CH	1967	Autism	55	73	12	12	1	6
CM	1965	Autism	100	78	15	11	4	5
DP	1959	Asperger's	77	56	12	9	2	2
MD	1977	Atypical Autism	96	90	12	9	5	6
ML	1962	Autism	91	81	12	11	3	3
PM	1965	Asperger's	114	111	14	12	14	7
SQ	1966	Autism	72	74	9	9	5	4
SW	1974	Autism	65	82	14	18	3	2
TM	1969	Asperger's	86	108	10	6	4	8

3.1.1 Individual Descriptions

CH

I first saw CH in 1998, she is a friendly woman, currently 35 years old. Although very sociable, much of her behaviour and speech appears learned. She shows many classic characteristics associated with autism; her eye contact is poorly modulated and she tends to stare at those she is talking to as if looking to them for clues as how to respond. She will smile in response but her smile is mechanical and almost a grimace, she has no gestures beyond occasionally nodding her head. Her prosody is flat, very slow and halting and she makes constant use of stereotyped and scripted language. She has severe pragmatic difficulties and she tends to jump from topic to topic. However, she likes company and particularly likes to talk about what she plans to do in the future. She is currently working in a hairdressing store part time and speaks at length about different hairstyles and make up techniques. CH was diagnosed with autism as a toddler and attended a specialist school for children with autism from the age of five, before joining her local community college when she was 16 years old.

CH has attended various art classes throughout school at her adult education lessons. Previously she attended these classes up to four times a week and would also practice at home for several hours of a weekend. Currently, however, she does not spend any time on her art work, preferring carpentry, which she is also very talented at, and practising her make up techniques. Her preferred medium was to paint and, uncommonly in many artistic savants, she would tend to paint pictures of people, particularly pictures of fashion models which she would copy from magazines. Relating to this last point, she would rarely draw entirely from imagination, instead used a picture or a photograph for constant referral. An example of CH's artwork is shown in figure 3.1. CH was very willing to take part in all the tests presented as part of this thesis, and seemed very eager to please and preferred the testing which required a drawn response.

Figure 3.1: Watercolour by CH

CM

CM is a 37 year old male. He currently attends a residential and day centre run by the NAS, before which he attended a specialist school for children with autism after his diagnosis with autism at the age of five. His speech developed late and even now, although he has good comprehension, his spontaneous speech is limited to stereotyped questions. In particular he likes to question people about their family situations and where they live, before providing them with his own background details. He occasionally shows some echolalia and while his vocabulary is adequate, it is difficult to build a conversation with him. He shows no empathy or insight and asks no questions of the listener beyond his stereotyped speech. His facial expression is limited to smiling and nodding, with no other gesturing. He has a keen interest in art and often attends art exhibitions with his brother.

CM currently attends the day centre two days per week for computer and social skills training, for the remaining five days of the week he attends an art work shop affiliated to the day centre. Here he spends two days a week painting and one day on carpentry. He prefers to paint using a wax and wash technique and likes to draw from life, particularly still life images of plants and trees. He can use imagination only when prompted and needs to be talked through the process of thought generation, using a visual image as an aid, which he adds interpretation to. He has exhibited work at a number of exhibitions for individuals with autism and has had postcards printed which are on sale nationally. CM greatly enjoyed taking part in all of the tests presented as part of this thesis, and on several occasions expressed disappointment that the test had finished. Figure 3.2 shows the church visible from CM's desk at his day centre.

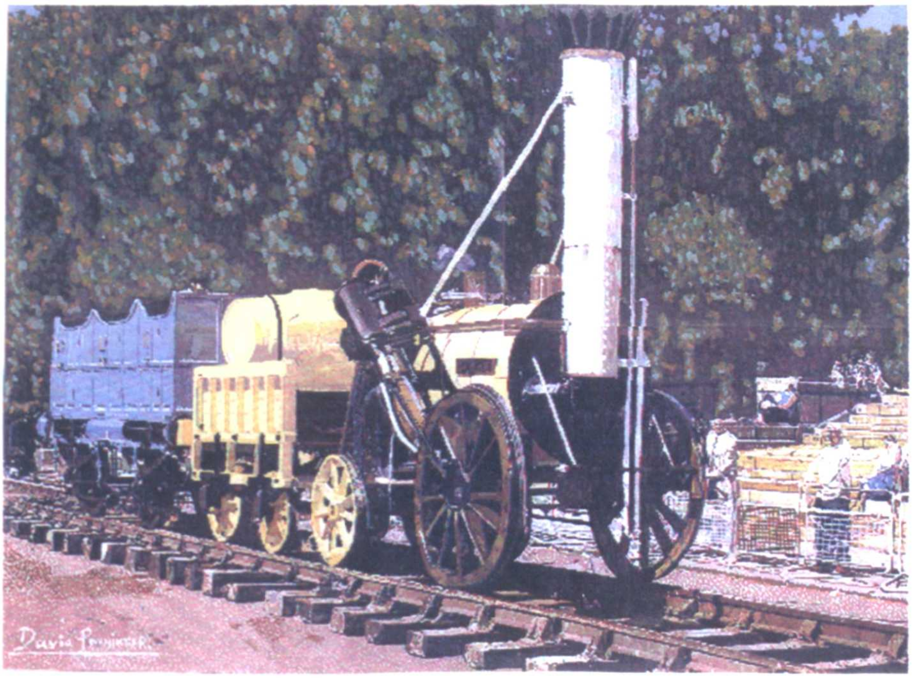
Figure 3.2: 'The view from the window' water colour from life by CM

DP

DP was born in 1959. He was diagnosed with Asperger's Syndrome by a consultant psychiatrist, however, no other details were available about the dates. DP is an interesting man, he shows very rigid behaviour with a strong reliance on routine. Often he misinterprets things which can lead to adverse reactions, however, throughout the course of this series of studies he was always friendly and willing to oblige. He shows very stereotyped speech patterns, the rate of his speech is very fast and his articulation is poor. He shows several obsessional interests, and likes to collect things, in particular things which are cubed. He has an outstanding episodic memory and spoke of his school experiences and when he learned to draw. He attended a local school for children with moderate to several learning difficulties and currently attended a day service for adults with a variety of developmental disorders and mental health problems. He found that he could paint exceptionally when he was at school and was allowed to spend a disproportionate amount of time at school practising his art work. As well as art he likes photography but will often use up entire films photographing the same image.

DP still spends most of his time at the day centre painting. He likes to paint pictures of trains or tractors using water colours. The standard of his art work is exceptional and it can take him up to one year to complete one painting, of A2 paper size. His method for painting is incredibly precise, he was taught this by his art teacher at school and will not paint in any other way. Firstly he selects an image, usually a photograph from a magazine, occasionally an photograph he has taken, this photograph is then photocopied twice, one is used as a copy the other is divided into a grid. A sheet of a A2 paper is then divided into an identical grid and the outline of the image in each square of the grid drawn onto the paper lightly in pencil. Particular attention is paid to getting the colouring and shading the exact shade as in the picture and this alone can take several weeks. An example of one of his paintings is shown in figure 3.3.

Figure 3.3: Water colour by DP



MD

Born in 1977, MD is the youngest artist in this group. She attended a variety of schools for children with mild learning difficulties, and although it was questioned from a young age, she did not receive a diagnosis until she was 14 years old, when she was diagnosed by a consultant community paediatrician with atypical autism. She is currently living in a residential home for high-functioning young adults with autism, which she shares with six others. She enjoys living in the house, but sometimes likes to get away from the other people. She particularly likes staying in the self contained flat which is part of the house, as here she has her own space more and can do the things she likes best. MD comes across as a shy lady, but she relaxes as she gets to know people. Initially her eye contact was very poor, however this improved substantially throughout the first interaction. Her intonation is very flat, however she has good verbal and comprehension skills. She was able to engage in a variety of conversations with myself, about her interests; she likes listening to pop music and watching 'Eastenders' on television.

MD becomes quite embarrassed when talking about her art work and needs constant reassurance. She is currently attending a supported unit for individuals with learning difficulties at a local college, where she is sitting an AS level art exam this year and hoping to take A level art next year. As well at the art course she also attends more relaxed art sessions at a local recreational centre twice a week, which she prefers in some ways as she is able to do her own thing at these, without being told what to draw. Recently she has had a piece of her art entered into a national competition. She also spends much of her free time at home painting, at least several hours a day. She has always been able to draw, but her artistic ability has improved over time as she has got older. She prefers to paint using oil paints or water colours, each painting takes her about 12 hours to complete and she paints for several hours a day. She prefers to draw landscapes and will obtain travel brochures which she select pictures from to copy. She tends to use these images as a constant visual guideline although she has drawn from life. She selects pictures with strong, bold colours and particularly likes to draw pictures from Italian travel brochures as these show "lots of bright blue sky, with sea and often mountains". An example of her work is shown in figure 3.4.

Figure 3.4: 'Sailing' water colour by MD

ML

ML was diagnosed with autism aged 7 by a consultant community paediatrician, after which he attended a school for children with autism, run by the NAS. He currently attends the same day centre and art workshop as CM, which he has attended since leaving school. ML has very little speech, although his comprehension is good. Throughout the experiments which he participated in as part of this thesis, he showed no spontaneous language and only gave short phrases of two or three words, in response to questions posed by the experimenter. His speech is very slow and halting, he often replied to questions with the phrase "I don't know". He has no gestures or facial expression. In his spare time he has an interest in buses and often travels the country to go to exhibitions and shows.

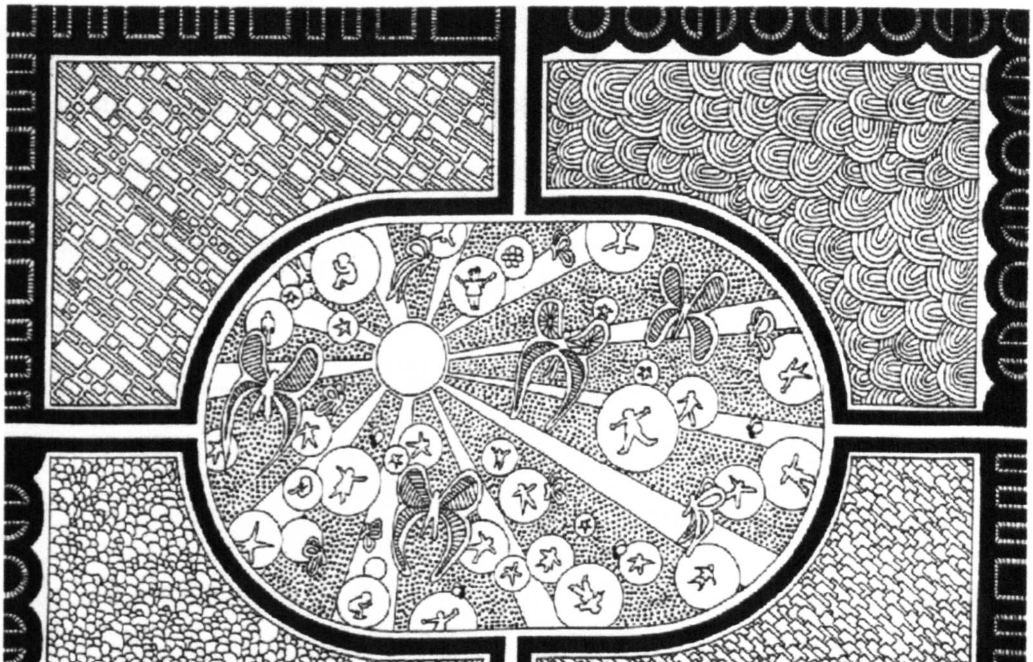
As mentioned ML attends a day centre for adults with autism, four days of the week are spent at the affiliated art workshop. Most of this time is spent drawing, he likes to draw linear pictures of buildings he has photographed. He rarely draws from imagination, and when he does the quality of his output is much reduced. ML has presented work at a variety of exhibitions and has had postcards printed which have sold nationally. It was quite difficult to engage ML in many of the studies involved here, especially those in which he appeared to being having difficulty. Examples of ML's work are shown in chapter 1 (pp.28) and in chapter 8 (pp.271 & pp272).

PM

PM is a 37 year old man, I first came into contact with, through his correspondence with the NAS. He lives independently and has a full time job. He previously worked as a draftsman and once even moved to Saudi Arabia with work, however, he found the demands of such a job too difficult and after several periods of depression took an administrative job locally to his parents. PM was not diagnosed with Asperger's Syndrome until he was 17 years old, when he was diagnosed by Dr Lorna Wing, although he states that he always knew he was different. In particular he shows social difficulties and finds it hard to be friends with people and to 'connect'. He has some stereotyped language and often speaks very quietly, with a tendency to carry on a long monologue.

PM states that he has always been very talented at drawing and painting, and has a diploma in art and design. Currently he spends most of his free time drawing as he finds it relaxing. He prefers to draw linear outlines with a fine nib pen, which he then copies and re-colours in different colour schemes. PM is unique in this group of artists in that he draws totally from his imagination. He likes to draw pictures and patterns in a 'pop art' style, using fibre tipped pens. He tends to draw pictures relating to one theme (for instance, trees, mermaids and fish or fairies) before moving on to another. PM has exhibited his work in a number of national exhibitions and also has had a number of postcards and prints produced which are on sale nationally. He was very interested in this series of studies, and a useful participant as, due to his high verbal ability, he was able to describe what he was thinking as he completed the task. An example of PM's work is shown in figure 3.5.

Figure 3.5: "Straights, rounds, bubbles and butterflies" by PM



SQ

SQ is a 36 year old man with Autism. He received this diagnosis from the Maudsley Hospital in London when he was a toddler. Up until the age of four he attended a special unit affiliated to his local school but from the age of seven he was educated at a local specialist school for children with autism spectrum disorders. He currently lives in supported housing run by his local authority, for adults with autism. By day he attends a large day centre run by the NAS, where he takes part in a number of different activities including computer lessons, social skills and carpentry. He is a sociable man, who likes company. His language is good, and it is possible to build a conversation with him, however, this is usually one sided and often comes back to his interest in geography, specifically where he has been and where people come from. His speech has little variation and although he does have limited facial expression, this is rarely integrated effectively with his language. He does not use gestures, although he often nods his head in confirmation. In his spare time he likes to cycle and to visit the local pub.

Figure 3.6: Example of SQ's art work, drawn from life

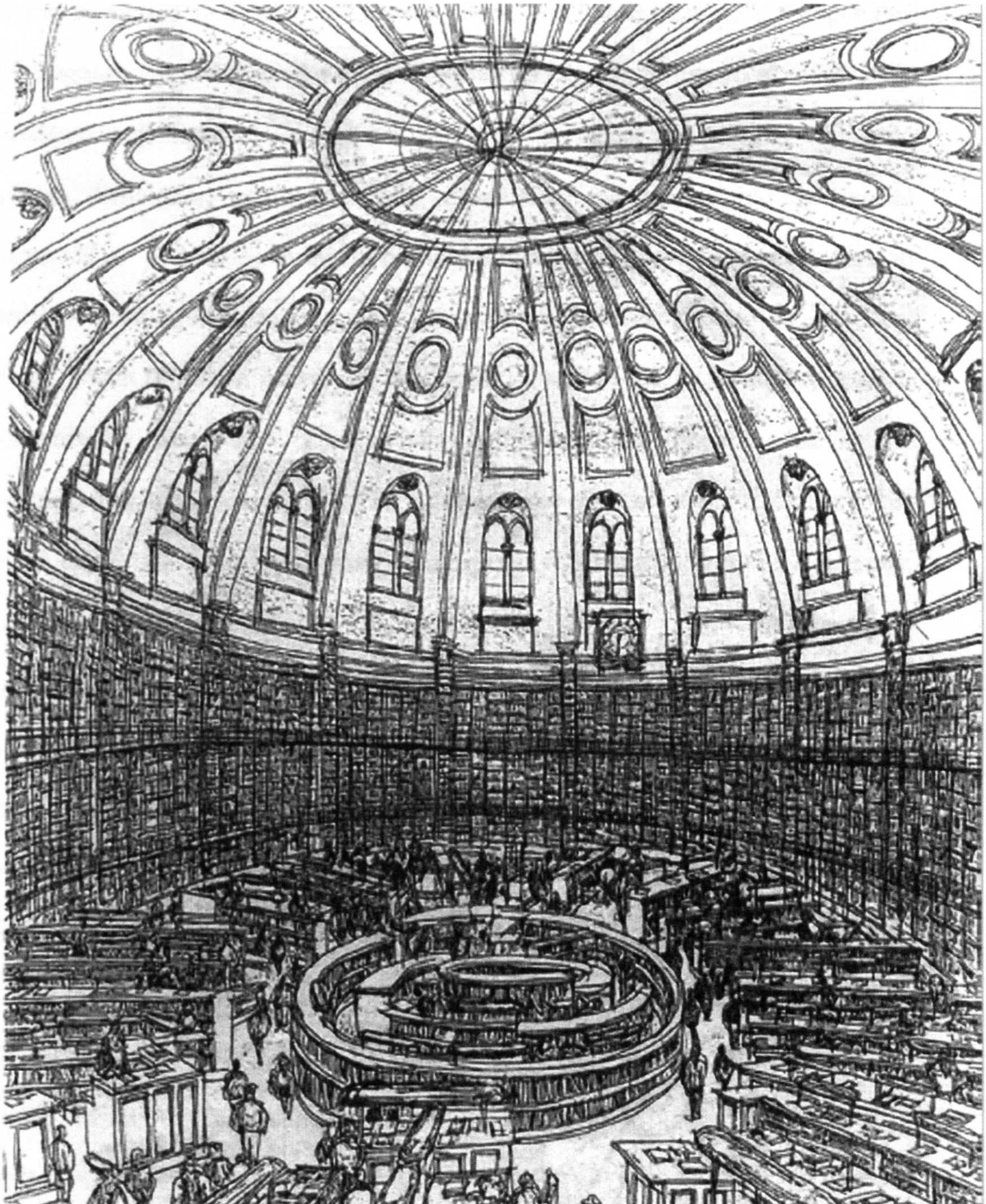
SQ has recently lost some of his interest in painting in favour of computer graphics. In the past he would attend art sessions at the day centre, although this generally involved carpentry rather than painting and drawing. Most of his artistic compositions were drawn in his spare time, especially over the weekends. He preferred to paint in water colour from photographs that he would take on country walks, each painting would take around five hours to complete. SQ was happy to take part in all the tests, and would repeat the instructions to himself as he completed them, to 'remind' himself what he was doing.

SW

SW is a 26 year old man who was at the time of testing, completing a diploma at a prestigious art college. Diagnosed with autism at the age of eight, SW attended a local school for children with autism, affiliated to the NAS. It was at this school that his artistic ability was recognised by his art teacher and he has gone on to exhibit his work internationally and to produce a number of books of his art. SW has outstanding social skills, although these are likely to have improved as a result of the attention focussed on him surrounding his artistic ability. His language is good, although he asked no questions throughout the sessions I spent with him. He was very happy to provide accounts of his recent trips abroad, although he did show some pragmatic difficulties, particularly in terms of losing his train of thought and the conversation tended to be one-sided and relating on specific questions. His speech was quite halting and his eye contact poorly modulated throughout. One area where SW was especially forthcoming in his speech concerned his art work and he happily presented his portfolio to me, pointing out why he drew certain pictures and the techniques he used to do so.

In the past SW's main interest was in drawing buildings and he showed an incredible memory, to the point where he could look at a building for a matter of minutes and then sometimes up to days later, he would produce line drawings of the building of scene with amazing accuracy. More recently his attendance at art school has widened the techniques available to him and he has also extended his artistic repertoire. Currently he has drawn a number of scenes from US television shows such a 'Friends', and images from films such as 'Saturday Night Fever' which he likes and he always carries his sketch book with him so that he can jot down things that he sees, which take his interest.

Figure 3.7: 'The British library reading room' by SW

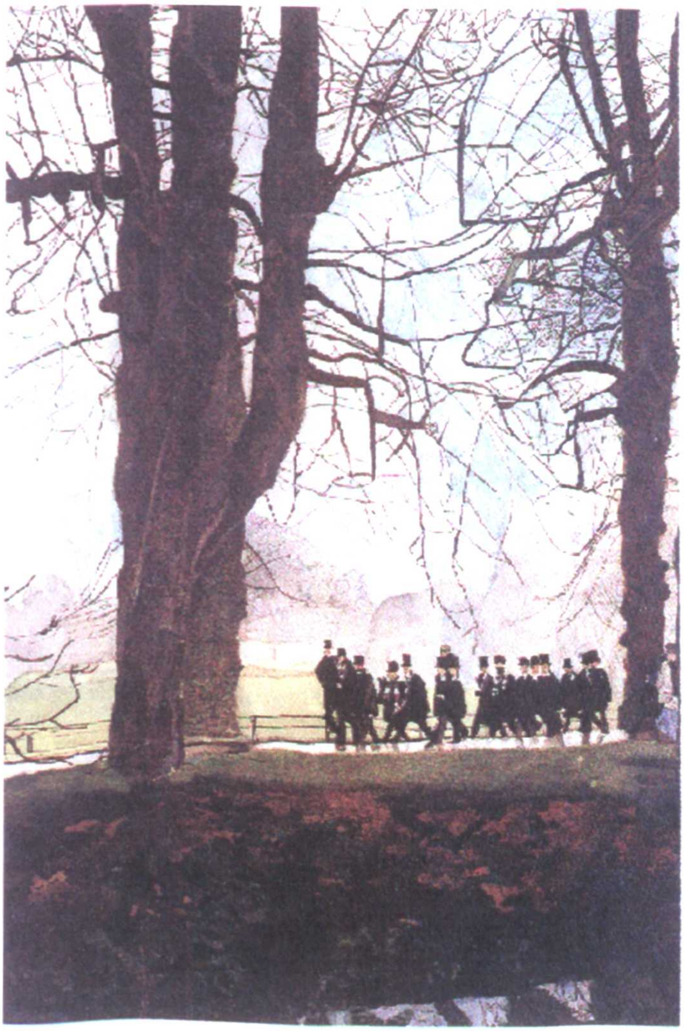


TM

TM was brought to the attention of this study following a local exhibition of his work. He was diagnosed by a consultant psychiatrist in 1991 when he was 22. Despite this late diagnosis he had throughout childhood and adolescence, displayed many traits associated with autism. He had no friends at his school for children with mild learning difficulties, and had trouble developing and maintaining any social relationships. In addition to this he showed a number of obsessional behaviours, in particular a strong reliance on routine. Currently he is working part time in a local library, which he enjoys because of the 'quiet'. He lives locally to his parents, but independently other than a part-time home help, who assists him with cleaning and shopping. TM is also an accomplished musician, who plays the organ and sings in the church choir. He has little spontaneous language, although he can write eloquently, and it is very difficult to build on a conversation with him as he tends to reply to questions with short phrases. Indeed, although he has learned some social skills such as hand shaking and introducing himself, he tends to look quite uncomfortable in the presence of people he is not familiar with. He too appeared quite frustrated during several of the more difficult tasks presented to him here and became visibly agitated and asked to stop several times before deciding to continue until the task end.

TM currently attends a weekly art group, and draws when he has time at home, usually during the weekends. His artistic ability was not recognised until he was 16 years of age, mainly as he had never given much time to art. However, on a family holiday poor weather meant he had to stay indoors and it was at this time he realised his ability. As he began to draw the scene outside using a fine nib pen, he realised he had the patience to draw the individual details of trees and buses. Now he still prefers to draw using this medium, however, he has recently moved on to water colours. He enjoys photography and likes to paint pictures of the photographs he particularly likes. Aside from the exhibitions he has presented at TM also produces prints of his work for sale as cards and post cards and has completed several commissioned pieces. An example of his early still life work is shown in chapter 1 (pp.29). Below, in figure 3.8, is one of his more recent commissions, drawn from a photograph he took himself.

Figure 3.8: 'The Kings' Choristers Returning From Chapel' water colour by TM



3.2 TESTING CREATIVITY IN INDIVIDUALS WITH COGNITIVE IMPAIRMENTS

3.2.1 The use of appropriate tests

The previous chapter presented a brief overview of some of the many approaches to creativity measurement in the normal population. The point of many of these tests was to provide a task that would measure creativity in the general population regardless of intelligence or previous creativity. This does not necessarily mean, however, that such tests are particularly applicable for use with individuals with cognitive impairments or developmental disorders such as autism. In particular many of these tasks presuppose a certain level of verbal ability and because of the deficits that individual with autism have with language, this can result in problems in adequately assessing creativity in such a group. A strong verbal element can be seen in many of the tests described so far, from the early tests used by Guilford and colleagues such as the object uses, through so called visual tasks such as those used by Wallach and Kogan (1965) and including more recent measures adopted by Finke and colleagues (see Finke et al., 1996).

Despite the verbal component integral in many of these tasks, they have often been used by researchers with autistic groups. For example, Turner (1997, 1999) in her study on generative ability, used the object uses task and the pattern meanings task, both of which it can be argued, require increasingly complex responses in order to gain higher ratings for originality or imagination. Certainly, in most of the tasks which require exclusively verbal outputs groups with autism have been found to perform particularly poorly, regarding either total output (Rumsey & Hamburger, 1988; Turner, 1997, 1999) or the creativity of response (Scott & Baron-Cohen, 1996; Turner, 1997, 1999). In response to such pitfalls, it might be better to assess performance by using tasks outside of the verbal domain or those with a minimal verbal input. Indeed as previously discussed, in tasks requiring only a drawn output the generative difficulties displayed by autistic individuals are less apparent (Leevers & Harris, 1998, Lewis & Boucher,1991). This thesis then, concentrates on tasks that do not require a complex verbal response and instead uses those that are primarily visual by nature. It is accepted that this may produce some bias in the savant group as they are gifted in art, but attempts were made to measure creative ability in several visual domains, not simply those connected to a drawn output. In doing so participants were presented with a variety of multifaceted tasks, in order to measure creative and generative ability on a number of dimensions. Although, as stated, the aim was to present participants with tasks outside of the verbal domain, it is accepted that most of the tasks involved did have an inherent verbal aspect. Nevertheless, attempts were made to pick tasks in which the visual aspect is dominant.

3.2.2 The Use of Appropriate Control Groups.

A primary aim of this thesis was to investigate whether the performance of savant artists was related to their artistic ability, their diagnosis of autism or their overall cognitive level, consequently, a variety of control groups were used throughout this thesis. In order to draw conclusions as to the creative capacity of the savant group, initially three control groups were necessary. Details of these groups are illustrated in table 3.2.

The autism control group

Firstly a group of nine participants with autism were obtained, matched individually to each savant artist on IQ, age, sex and diagnosis. In line with the savant group, PIQ was measured using either the RPM or the RCM and VIQ using the PPVT. Participants were matched individually for diagnosis, thus the artists diagnosed with Asperger's Syndrome were matched with non-talented individuals with Asperger's Syndrome. None of the members of this control group had ever displayed any artistic ability, although several took part in art sessions at their local day centre. Each of the nine participants in this group attended a day centre specifically catering for adults with autism spectrum disorders (ASD) run by the NAS. Aside from artistic ability there were no other significant factors which differed between these two groups. The individuals in the autism control group all displayed the social, communicative and repetitive behaviour problems as commonly found in individuals with autism. It is important to note here that in reflecting the diagnosis of the savant artists the participants in this control group have been diagnosed with a variety of autism spectrum disorders, however, for brevity in this thesis this control group are referred to simply as the autism control group. The individual details of this group (age, diagnosis, PIQ and VIQ) are shown in appendix 1.

The learning disabled control group

A second group included individuals with general learning difficulties (the LDC group) but without a diagnosis of autism or any related pervasive developmental disorder. The LDC group were matched closely on a one to one basis with the artists in the savant group on relative age, sex and PIQ using the RPM or the PCM, and VIQ using the PPVT. As illustrated in table 3.2, the VIQ of the LDC group is somewhat larger than in the two groups with autism. This reflects the recognised discrepancy between performance and VIQ in individuals with autism. However this difference did not reach significance (see pp.95) and it was felt that it was more appropriate to match closely on PIQ, due to the non-verbal focus of the tasks used throughout. Eight of the nine participants who made up the LDC group were obtained from a local adult education centre, they comprised individuals with a variety of developmental disorders, general learning difficulties and mental health problems. Although the clinical diagnosis of each participant was checked in order to clarify that the participants did not have an ASD, all individuals took part in a brief screening session subject to a screening process, loosely based on the Autism Diagnostic Observation Schedule (Lord, Rutter & DiLavore, 1998). This was to ensure that participants who possibly had an un-identified ASD were not mistakenly included in the non-autistic group. The final participant in this group, was obtained via the University of London, and matched PM, the one savant with very high score on the two IQ tests. Again no participants in this group showed any artistic ability, presently or in the past.

The mean scores and standard deviations (SD) for each of the mixed intelligence groups are shown in table 3.2, PIQ was measured using the Ravens' Matrices, VIQ using the PPVT. The participants in the two mixed intelligence control groups (autism and LDC) were instructed to draw a picture of a house or a person. This initial control task was to establish that each participant possessed adequate motor control and drawing ability to complete the tests and all participants in both groups were able to do this. The individual details of this group (age, diagnosis, PIQ and VIQ) are shown in appendix 2.

Table 3.2: The mean PIQ and VIQ scores (SD) for the savant artists, the autism control group and the LDC group.

Group	PIQ	VIQ	Age	Male: Female
Savant Artists	84.00 (18.5)	83.66 (17.49)	34.55 (5.13)	7 : 2
Autism Control Group	82.33 (16.59)	84.78 (14.79)	32.22 (6.59)	7 : 2
LDC Group	85.55 (19.19)	92.11 (17.86)	32.55 (5.77)	7 : 2

No between group differences arose between the three groups on the VIQ or PIQ scores (PIQ, $F_{(2, 26)} = 0.43, p = 0.65$; VIQ, $F_{(2, 26)} = 1.30, p = 0.38$).

Two other groups were also important in several of the tasks presented forthwith.

The art student control group

A group of talented A-level art students were included in order to assess the effect of artistic talent upon creative performance. While this paradigm has been used in several studies of savant ability, this is the first attempt to use A-level art students as controls. Previous studies have tended to use either a group of artistically talented children, matched mental age (MA) to chronological age (CA) or adult professional artists, however, neither of these methodologies were seen to be acceptable in terms of ability or training. For example, the use of talented children as controls does not account for the developmental level of participants, and what is more if matched on mental age, it is unlikely that the artistic proficiency of the child artists would be up to that level of that found in the savant group. Also, many relevant developmental processes (for example; field dependence, Witkin, Oltman, Raskin, & Karp, 1971) do not reach maturity until adulthood and thus the results would not show a true picture of the levels of ability found in the groups. On the other hand to use professional adult artists would not be acceptable for similar reasons, although several of the savant group have received formal training in art, this will not compare to the training that an adult professional artist will have experienced. It was thus decided that the closest match in terms of overall ability and training were a group of A-level art students, not only was their art work judged to be a similar level to that of the savant group by their art teacher, an A-level art examiner, but they also spent comparable amounts of time practising art work each week, around ten hours. Furthermore although the average age of the art student group was between 18 and 19 years, individuals of this age are seen to be young adults, and thus nearer to the level of the savant group than a group of MA children would be. The art students that made up this group were in the top 10 per cent of their year for artistic ability and were receiving A and B grades consistently for their A-level course work. Each individual in this group had received an A or B grade at GCSE art in the previous two years.

The normal control group

Finally, where necessary when investigating the processes thought to be related to artistic ability, a fifth group were included in the study. This final group comprised a group of psychology students, who were matched to the art students on PIQ, VIQ and sex. Participants in this group had no formal art qualifications and did not participate in art as a pastime. This group of normal students was included in a subset of studies in order to investigate the overall effect of artistic ability on performance.

The mean IQ scores and standard deviations, for the two student groups are illustrated in table 3.3. In matching the savant group, both groups of students contained seven male participants and two female.

Table 3.3: Participant details for the art student and normal student groups.

Group	PIQ	VIQ	Age
Art Student	114.00 (9.00)	114.67 (12.99)	17.44 (0.72)
Normal Student	116.44 (12.12)	115.22 (9.08)	18.72 (0.55)

Pilot studies

As savant ability is so rare the range of IQ apparent in this group and the two IQ matched control groups varies from borderline to average, or high, intelligence. This wide overall IQ range naturally has strong implications on the design of each task. For instance, too difficult a task will result in those at the lower end of the IQ range performing at floor level, while the opposite would have those of higher ability at ceiling. In order to avoid these potential complications a variety of training tasks were introduced in order to establish that all participants were aware of the task demands and thus ensure that any results were due to ability and not a lack of comprehension per se. In addition to this a group of individuals who were not used as control participants were incorporated into a 'pilot testing group'. This group included several participants with autism and general learning difficulties, with a range of IQ scores, who were given early versions of the tasks and the training materials to establish that the task instructions were easily understood by participants performance at a variety of cognitive levels.

Inter-rater reliability

In investigations such as this, where often the scores given reflect subjective judgements despite clear scoring criteria, it is important to have good reliability within scores. For this reason, the responses of five participants in each group were randomly selected and where relevant (that is where a response was not based on a subjective measure such as time of completion) scored by an independent second rater, blind to the participants' group. Overall the percentage of agreement was in excess of 80% for each test and kappa values were in excess of .70. Any discrepancies were resolved through discussion.

3.3 AIMS

The research presented here incorporates two main aims, the first of these to identify the generative capacity of a group of savant artists. The second, to investigate if their overall creative or generative ability is either impaired, inhibited or facilitated by their autism. Participants were presented with a variety of multifaceted tasks, which aimed to measure creative and generative ability on a number of dimensions. The use of this stringent methodology aimed to ensured that results were not due to any extraneous factors and allowed the examination of a number of separate factors, such as intelligence, autism, and artistic ability, to be investigated simultaneously.

Chapter 4:

Initial Investigations:

Savant Creative and Generative Ability, an Empirical Study

4.1 INTRODUCTION

This present chapter provides a introduction into the creative and generative capabilities of savant artists on a standardised test of creativity. Chapter 2 highlighted the interesting paradox arising when one considers that savant artists display ability in a creative domain, regardless of the deficits associated with their autism. Yet despite this obvious inconsistency between ability and diagnosis, there has yet to be an empirical investigation into the creative and generative capacity of such individuals, although there are many anecdotal accounts of the creative nature of their artistic outputs (Hermelin et al., 1999; Pring et al., 1997; Sacks, 1995; Selfe, 1977, 1983).

This first study aims thus to assess the creative or generative ability of a group of savant artists using a standardised test of creativity. In much the same way that the generative capacity of savant musicians was measured within the musical domain (Hermelin et al., 1987; Hermelin et al., 1989; Sloboda et al., 1985) this initial investigation measures savant performance in the domain of drawing. For this purpose the Torrance Test of Creative Thinking (TTCT) was selected (Torrance, 1974). The TTCT measures creative performance over three tasks and in four domains; fluency, flexibility, originality and elaboration. The performance of the savant artists was compared against that of two IQ matched control groups; a group of non-talented individuals with autism and a group of individuals with general learning difficulties. The performance of a group of talented A-level art students was also measured. The results are discussed separately for each of the creativity dimensions.

As was discussed in chapter 2 creativity is in itself an ill defined concept, the measurement of which is thus fraught with problems. Although there are a number of tests which claim to measure creativity very few of these are accompanied by standardised administration instructions and norms. For these reasons any tests that are intended to assess creativity ability need to be discussed in detail, in order to fully understand which aspects of creative ability they claim to measure.

The Torrance Test of Creative Thinking

The Torrance Tests of Creative Thinking were devised by Torrance in the 1970's in an attempt to devise an adequate and convenient test of creative potential on verbal and non-verbal tasks. The original format consisted of two equivalent verbal forms and two equivalent figural forms, the tasks were suitable for use with a wide range of age groups, from primary schools to the work place, and could be administered to groups in order to save time. Torrance (1974) suggested that the tests could have a variety of uses, from providing a more detailed understanding of the human mind and development and detecting potential skills which may otherwise remain undetected, to assessing the effects of teaching procedures or practices and providing cues for remedial programmes.

Torrance defined creativity in similar terms to the classic definition, but like Baron (1989) and Boden (1994) amongst others, rather than seeing creativity as a term which should be reserved for rare particularised kinds of ability, people or products, as many traditional definitions did, Torrance chose to focus on "*the production of something new*", and the process by which this is produced. Creativity was defined by Torrance as "*a process of becoming sensitive to problems, gaps in knowledge ...identifying the difficulty searching for solutions ...formulating hypothesis ..testing and re-testing these ...and finally communicating the results*" (1974, pp.8). This definition is more in line with the current views of creativity as a problem solving ability discussed in chapter 2, and in particular Torrance refers to Newell et al.'s (1962) description of creative problem solving (see pp.44).

Whereas more classical tests of creativity or divergent thinking looked at a variety of response patterns (fluency, flexibility and so on) the TTCT was the first to actually set out to measure these dimensions independently of one another and to provide a set of standardised scores. The TTCT consists of two equivalent verbal tests and two equivalent figural forms. Both verbal forms consist of seven tasks, each believed to require a different mental process and divergent direction. Examples of the tasks include; asking the participant to come up with ideas to improve a toy to make it more fun to play with; the unusual uses task as first used by Christensen et al. (1960) and questions about possible causes and consequences such as "what would happen if clouds had strings?". The figural forms each consist of three activities, on form a and form b these activities are identical although, the stimuli differ slightly. In the present study figural form a was used and a more detailed account of the rationale behind this test will be presented. The first of the three activities is the picture construction, here participants are presented with a tear-shaped piece of sticky paper, which they are instructed to stick on a response booklet and to use as the basis of a drawn response.

The second task in the TTCT was the incomplete figure activity. This test is an adaptation of the drawing completion test used by Barron (1958) and Kinget (1953). Here participants are presented with 10 meaningless squiggles or lines, which they are required to transform into a meaningful picture. The stimuli for this task were created in such a way that each figure could be clearly incorporated into a common response. To produce a creative response then, the participant must overcome the urge to complete the figure in the easiest way possible. The third task, or condition, in the figural TTCT is the repeated figure task. Here, participants are presented with 30 sets of parallel lines of three separate widths apart and the main element tested here is the ability to produce multiple responses from a single stimulus. The repeated figures activity is similar to the incomplete figures activity, in that both require the ability to bring structure and completeness to that which was once incomplete, to make a whole out of a part. The instructions for each of these tasks are written at the top of the response booklet, with emphasis on terms such as "unusual", "original" and "different".

What really sets the Torrance tests aside from those previously used in psychology are the scoring guides mentioned previously. The TTCT was the first creativity test to provide not only a comprehensive, detailed scoring guide, but also a set of standardised norms for different population groups. The figural form of the TTCT is scored on four dimensions, each thought to contribute to creative output. The dimensions used are very similar to those used in early studies of creativity, and identified in factor-analytical studies (i.e. Guildford, 1950). The first dimension measured is fluency. Fluency refers to the total number of responses per activity or overall. Torrance argues that the fluency dimension is particularly useful as a tool for interpreting the other scores. For example, a high score on fluency does not necessarily highlight a creative thinker and individuals that score highly on the remaining three dimensions often score lower on fluency, as they spend more time on each response. The second dimension is that of flexibility. This concerns the ability to produce a variety of semantically different ideas and shift mental sets. Again Torrance points out that this dimension should be viewed in relation to the fluency score and suggests that a flexibility index could be obtained by dividing the flexibility score by the fluency score and multiplying by 100. This equation results then in a fluency independent, percentage score.

The third dimension measured on the TTCT is originality, this refers to the participant's ability to generate novel or unusual ideas and high scores on this measure are often associated with intellectual energy (Torrance, 1974). As suggested with regard to flexibility, this score must be seen in relation to the fluency score and here again Torrance suggests using an originality index. High scores on this dimension are dependent on the individual overcoming the gratification associated with an immediate, yet common, response. These norms provide a measure of the frequency of response and thus a somewhat independent measure of originality. The final dimension measured by the TTCT is that of elaboration, reflecting the individual's ability to develop and elaborate ideas. As each of the dimensions can be seen to measure a distinct area of creative thought, it was suggested by Torrance that they should be studied separately. This has an added advantage in providing a more comprehensive account of creative potential and the areas in which an individual shows a particular ability. For example, a participant may be particularly original, but lack the ability to develop their initial idea, as evident on a high score for originality and a low elaboration score. The use of an index accounting for the overall effect of fluency illustrates earlier points made in Chapter 2 regarding the difference between creativity (originality) and generativity (fluency), allowing them to be studied independently.

The Relationship Between The TTCT And Other Factors: Although a test in which the response is drawn, the TTCT is not related to artistic ability (Torrance, 1974) as it is the *quality of the idea* which is important not the *quality of the drawn response*. Given the problems associated with creativity research in general, discussed in more detail in chapter 2, the TTCT can be seen to provide a good tool for assessing creative ability and test-retest reliability is consistently found to be high (Treffinger, 1985). Furthermore there is longitudinal evidence correlating scores on the TTCT with Treffinger's (1985) creative achievement criteria. With regard to the relationship between intelligence and creativity as measured on the TTCT, Torrance argues that the tests do not correlate with intelligence. However, although the relationship with academic achievement is questionable, it has been suggested that high intelligence is necessary for publicly recognised creative achievements (Yamanda & Tam, 1996). More recently in a re-examination of Torrance's original data Plucker (1999) argues that while intelligence may be an indicator of creative achievement, it is a weak predictor when measures of divergent thinking are considered. These two concepts thus, may be considered independent constructs, at least in individuals with IQ in the average range and normal development.

The main criticism aimed at the Torrance tests concerns construct validity (Chase, 1985). Particular criticism focuses at the use of the separate dimensions and a number of studies have highlighted the limited discriminant validity of the fluency, flexibility, originality and elaboration scores (Hocevar, 1979; Chase, 1998). In particular it was found that originality and flexibility sub-scores became unreliable when fluency was partialled out (Hocevar & Michael, 1979). The results of such studies suggest, as Clapham (1998) points out, that fluency is the primary dimension measured by the TTCT. Following on from this Heausler and Thompson (1988) argue that the use of the separate dimensions primarily represent a general factor and do not provide meaningful information when looked at separately. Such criticisms were supported by Clapham (1998) who looked at, not only the validity of the separate dimensions, but also the structure of the two forms, using 334 psychology students. Clapham concluded that separate dimensions contributed only a little to the overall variance of scores and factor analysis showed that the sub-scores reflected one general creativity factor. Still, despite this finding it was argued that although the sub-scores were highly related, they did provide some useful information and provided a pattern of results indicating that on this test a general score alone cannot adequately represent creative ability

Using the TTCT with individuals with lower intelligence

Although the Torrance tests were not designed for specific use with individuals with borderline or below average intelligence, they were designed to be used over a wide age and ability range, beginning with children as young as four years of age. As the TTCT does not involve complex verbal instructions it is very useful for use with individuals with lower intelligence. As mentioned in chapter 2, the TTCT has previously been used successfully with a savant group (Duckett, 1976) and a group of children with autism (Craig & Baron-Cohen, 1999). In Craig and Baron-Cohen's study participants with autism and Asperger's Syndrome groups were matched closely with a non-autistic group on VIQ and with a group of normally developing children, matched on CA to the clinical groups' MA. They used the incomplete and repeated figures conditions from the figural form a. On the repeated figures test, when the composite scores were analysed, an overall autism-specific deficit was found. When the dimensions of fluency, flexibility, originality and elaboration were analysed separately, in support of previous findings (Jarrold, 1997; Turner, 1999), fluency was found to be particularly impaired in both the autism and the Asperger's groups. Craig interprets these results in terms of executive function deficits, maintaining that a fluency deficit provides evidence of perseveration.

Craig and Baron-Cohen's explanation is, however, somewhat flawed as, although a fluency deficit can be seen in terms of an executive dysfunction as evidence of *impaired activation*, a reduced fluency score does not provide evidence of *perseveration*. As stated earlier, a perseverative response is a response that is either a repetition or variation of a previous response, or a semantically similar response. Perseveration would thus be measured on the flexibility dimension and evident in a lower flexibility score. A low fluency score on the other hand would indicate an executive function deficit at the activation level and would indicate a true generativy deficit. As such, the group means on the dimension of flexibility appear considerably lower in both autistic groups, but no significance is reported. Craig and Baron-Cohen's results would have been more useful if they had made adjustments for the confounding effect of fluency. A lower fluency score would mean that the scores on the other dimensions would also be lower, as participants completed fewer responses could be scored. It may thus be that the autistic groups produced responses that were as original and flexible as the two control groups but that this finding went unnoticed due to the low fluency score.

Following the repeated figures test, Craig gave the incomplete figures test to participants. Again the group with autism performed particularly poorly on this test. However, although there was no significant difference between the groups with ASD and the two control groups using the composite scores, significant differences were found on the results of the separate dimensions. However, despite the group with autism performing significantly worse on the dimensions of flexibility and both ASD groups producing less original responses, there was no difference in the fluency scores between groups. Craig argued that the fluency deficit apparent on the repeated figure test is due to the identical nature of the stimuli in this task. What Craig overlooks though, are the differential demands involved in the two tasks. Specifically, the incomplete figure test involves only 10 stimulus figures, whereas there are 30 figures involved in the repeated figure task. The failure to find a fluency effect on the incomplete figure task is likely to reflect the fact this was a shorter task in which many of the participants scored at ceiling level.

One particularly interesting finding to come out of the incomplete figure task is that although the performance of the autistic group was equal to the two control groups on fluency, they performed significantly worse on both originality and flexibility. Firstly, it should be reiterated that, a high score on originality is dependent on the individual going beyond the common, most frequent, response and as such delaying the instant gratification that would result from such a response. It would appear that the autistic group had difficulty in doing this and, particularly in this sub-test where the common response is often relatively clear, could not go beyond the initial evoked response. This finding is consistent with the executive dysfunction account in that the autistic groups were unable to inhibit this first, common response.

With regard to flexibility, the points raised earlier regarding perseveration appear to be strengthened and it appears the group with autism and the group with Asperger's syndrome both performed significantly worse on this dimension. This is somewhat surprising as one might expect that a perseveration score would be more evident on the repeated figure test. This is because on the repeated figure test the participant is required to produce a multiple response from a single cue, which as Turner (1999) maintains is a condition that often elicits perseveration, especially when the response is drawn. Turner argues that this perseveration is more likely on tasks where the response is drawn as participants also have to overcome the motor response associated with their previous response.

Craig and Baron-Cohen's (1999) finding that the results are not consistent across dimensions nor sub-tests, provides support for looking at each dimension separately. More importantly, however, and as touched on in the discussion of the above results, the dimensions measured on the TTCT correspond closely with an area in which individuals with autism have been shown to have impairments. These impairments include a lack of flexibility, a low fluency pattern, and a lack of imagination (see Chapter 2 for details). The dimensions measured on the TTCT also fit in with the executive dysfunction account of the generativity deficits in autism, as suggested by Jarrold (1997) and Turner (1997, 1999).

Test Modifications

It is evident from the above discussion that the figural form of the TTCT is a useful test with which to investigate the generative capacity of a group of artistic savants. It has clear scoring guidelines and standardised norms, has been successfully used before with learning disabled and autistic groups and the dimensions measured by this test correspond closely with areas found to be impaired in autism. What is more, it fits well with the theoretical background of generativity in autism. But, despite these positive attributes a number of modifications would be necessary in order to make the test more suitable for administration to a mixed intelligence group.

Following pilot testing the picture construction task was excluded from this investigation as it provided no useful information with regard to flexibility or fluency. Furthermore, pilot studies indicated that the presentation of a number of stimulus figures on one page tended to de-motivate participants and to reduce this in the investigations described here, figures were presented in small booklets with one figure per page. In an attempt to reduce the confounding effect of fluency on the other dimensions in the repeated figures task the overall number of stimulus figures was reduced, thus giving a more insightful result on the other three dimensions. Regarding the testing conditions, rather than using instructions written on the top of the testing booklet, instructions were given verbally to each participant. Although the TTCT manual states a training period is not necessary, this is referring to the use of the test with individuals of normal intelligence. As researchers have pointed to the importance of a warm up period in producing optimum performance with groups with lower intelligence (Leevers & Harris, 1998) a training task was introduced in this study. This consisted of a variety of practice stimuli, generated by the examiner, with the aim of clearly illustrating to each participant the aim of the study.

Aims

The aim of this first investigation was to assess the performance of a group of savant artists on a standardised test of creativity in the domain of their talent. Although this is the first study that attempts to empirically test the generative capacity of a group of artistic savants, it is possible to make a number of predictions based on previous studies and reports.

With regard to fluency mixed results have been reported in the literature depending on the task used. However, as Jarrold (1997) and Turner (1997, 1999) argue there is sound evidence for a fluency deficit in autism. What is unknown is how much the talent possessed by the savant artists may ameliorate this deficit. Nevertheless, it should be noted that in an attempt to reduce the confounding effect of fluency on the other dimensions, the number of stimulus figures in the repeated figures task was reduced to ten. Hence an autism-specific fluency deficit may not emerge.

Individuals with autism produce less imaginative responses than those produced by controls, so we might expect the two groups with autism, the savant artists and the autism control group, would show lower scores on the dimension of originality. Originality also involves a measure of inhibition, in that the individuals must inhibit the common response elicited by the stimuli in order to generate a novel response. As inhibitory impairments are associated with autism, we may expect the two groups with autism to perform significantly worse than the LDC group. Alternatively one interesting hypothesis is that the perceptual processing style associated with autism, referred to as weak central coherence, could result in more original responses on this type of task. It has been reported by a number of researchers (Frith, 1989, Frith & Happé, 1994, Shah & Frith, 1983, 1993) that individuals with autism have a processing style that favours piecemeal, context-independent information. It is proposed that this attention to detail and to the parts of an object may facilitate performance on this task, as it involves making a whole picture out of a constituent part. As such the TTCT can be seen as the reverse of the EFT, in which participants are required to identify a part from a meaningful picture. Individuals with autism have been shown to perform above IQ matched controls on this task (Shah & Frith, 1983) and thus we might expect the two autistic groups to be advantaged relative to the LDC group. In particular as it has been noted that although reduced facilitation by meaning is found on sentence processing (Frith & Snowling, 1983, Happé, 1997) children with autism are able to extract meaning from pictorial stimuli, hence are able to perceive an overall whole in this domain (Ameli, Courchesne, Lincoln, Kaufman & Grillon, 1988; Bryson, 1983). In particular better performance is expected from the savant group, who show superior segmentation skills to IQ matched autistic controls (Pring et al., 1995). Furthermore as Pring et al. (1995) and Mottron and Belleville (1993, 1995) argue, savant artists are capable of producing global, coherent visual responses

There is no evidence of an autism-specific deficit on elaboration (Lewis & Boucher, 1991) and as Hermelin et al. (1987, 1989) found, often savant musicians produced more elaborate responses than controls. Although more research is needed into this dimension it is expected, in line with the results outlined above, that the savant group will perform significantly better than the autistic and LDC control groups on this measure as a result of their superior artistic ability. Finally regarding flexibility a number of studies have indicated that individuals with autism have some difficulty in producing flexible responses (Turner, 1999), thus it is expected that the two autistic groups will perform poorly on this task. A lack of flexibility has been linked to a perseveration deficit and Turner identifies two types of perseveration; recurrent perseveration (repeats) and 'stuck in set' perseveration (semantically related responses). It has been noted that individuals with autism have difficulty in producing a variety of responses for a single cue, it is thus likely that perseveration will be more evident in the repeated figure task where participants are required to generate a number of responses for a variety of parallel lines. With respect to the performance of the savant group it has been noted that autistic savants tend to stick to drawing one thing, for example buildings or trains (Sacks, 1995). In some ways this can be considered to be evidence of 'stuck in set' perseveration and as such we can predict that the performance of the savant artists will be more similar to the autism control group.

The following study compares the performance of closely matched groups on a standardised test of creativity.

Experiment 1: The TTCT

4.2 METHOD

4.2.1 Participants

Four groups of participants were included in this investigation; the savant artists, the autism control group, the LDC group and the art student group. Full details of the participants in each of these groups is described in Chapter 3.

The scores produced by the art student group will be presented in the descriptive sections for broad comparison purposes but not included into any statistical analysis, this is because performance of the art student group was clearly far superior to that of the three mixed ability groups. The main focus of this study was the performance of the savant artists and whether this was due to their overall intelligence, their autism or their artistic ability. One area of interest was how the performance of the savant group compared to a group with similar ability and no developmental disorder or delay. As it happened the art student group produced scores so far above that of the other three groups that they were of a different order and to include their data would serve only to confound the analysis of the remaining three groups. For this reason only the scores for the three mixed intelligence groups (the savant artists, the autism control group and the LDC group) were included in statistical analysis.

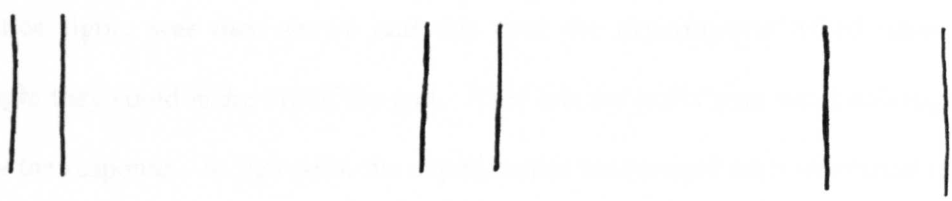
4.2.2 Materials

Two tasks from the TTCT (figural form a) were used, the incomplete figures and the repeated figures task. The incomplete figure condition consisted of 10 meaningless squiggles, an example of two of these stimuli figures is shown in Figure 4.1.

Figure 4.1: Example of the two stimuli figures presented in the incomplete figures condition of the TTCT

The stimuli for this task were presented in the same order as in the original booklet, but were presented to participants in the form of a small booklet, 215mm x 267mm in size. The second task was the repeated figure task. The stimuli for this task consisted of ten sets of parallel lines three separate widths apart. Again the *order* of presentation was the same as in the original TTCT booklet, although fewer stimuli were presented to the participants. The first two lines were 8mm apart, followed by four sets at 13mm apart and four sets at 20mm apart, as illustrated in figure 4.2.

Figure 4.2: The stimuli figures presented in the repeated figures task



As well as the experimental stimuli used for this task a number of separate stimulus figures were generated by the experimenter for the training period. These practice stimuli were similar enough to the experimental stimuli to illustrate the task requirements but not so similar as to give participants responses they could replicate. For example, where the repeated figures activity consisted of ten parallel lines, the practice stimuli consisted of three two sided triangles.

4.2.3 Procedure

All participants were tested individually in a quiet room at either their day centre or home, with the exception of the art student group who were tested in small groups at their sixth form college. Participants were informed they would be completing a test of creativity or imagination, whereby they would be producing a variety of pictures. They were reminded at this point that this was not a test of drawing ability, but of the creativity, thus it was not how good their drawings were which was important, but what they drew.

Participants were then presented with the training booklet. As stated in the introduction to this chapter, this booklet included a variety of stimulus figures, similar to the original TTCT stimuli. Participants were shown the first example figure and told that the aim of the test was to make a picture using the part and to elicit an initial response the experimenter provided the answer for this initial figure. A second practice figure was then shown and this time the experimenter asked what they thought they could make out of the part. After this the participant was encouraged to draw the response. At this point the experimenter encouraged each individual to add details to the original stimulus in an attempt to convey the original written instructions which emphasise the addition of detail to the stimulus. An effort was made to maintain exactly the same instructions to each of the participants. A final practice figure was presented in order to establish that the instructions had been fully understood, to stress the need to give a different response each time and not to try and draw the same thing. These instructions were modified slightly for the art group in which an example figure was put onto a board at the front of the classroom and the instructions given to the group, rather than individually.

After the training period participants were presented with the incomplete figure booklet, and the following instructions, "*Here is a booklet filled with parts of pictures, or squiggles like we have just seen. What I want you to do is to make each of the squiggles into a picture like we have just done. You can draw anything you want, as long as you use the line in your picture.*" Each appropriate response was congratulated, and for each inappropriate response, such as not using the lines or repeating a previous response, one warning was given. If participants could not complete a response they were informed to leave it out and to go on to the next design, with the opportunity to complete any figures which were missed out at the end of the condition. No time restriction was imposed.

4.3 SCORING, RESULTS & DISCUSSION FOR EACH DIMENSION

As the TTCT is a large task, consisting of two conditions, each scored on four dimensions, the results will be presented separately for each dimension, including the scoring guidelines, results and discussion.

4.3.1 Fluency: How many responses can be produced?

Fluency: Scoring

The fluency score was comprised of the total number of responses completed by each participant. In keeping with previous studies which looked at fluency (Turner, 1999), all responses in which the participant *made an attempt* to incorporate the stimulus figure into a picture were scored under this dimension. This included responses in which the picture did not resemble the title, as well as abstract patterns and designs. The only responses not included in this score were either responses in which the participant scribbled on the response booklet or several incidents where the stimulus figure was simply redrawn. Such scoring criterion allows the identification of a true generativity deficit regardless of the appropriateness of the response. The fluency dimension was thus a closed task, as the stimuli consisted of 20 figures.

Fluency: Results

Fluency measures the *total number of ideas* that an individual can produce, for this reason a composite fluency score, comprising of the sum of the fluency scores on the two sub tests will be presented and used in further analysis. However, as the two tests may tap different abilities the mean scores and standard deviations (SD) for the two sub-tests are also presented in Table 4.1.

Table 4.1: The mean scores (SD) for the dimension of fluency on the TTCT

	Incomplete figures	Repeated figures	Total
Savant	8.40 (2.13)	8.44 (3.13)	16.90 (4.7)
Autism	8.00 (2.92)	7.11 (3.02)	15.11 (5.40)
LDC	9.11 (2.03)	9.78 (0.44)	18.90 (2.31)
Art Students	10.00 (0.00)	10.00 (0.00)	20.00 (0.00)

As Table 4.1 shows, the pattern of data is similar for both of the conditions across groups. For this reason the total, composite scores across both conditions will be used for further analysis. The art student group performed at ceiling on this task. The fluency score was also very nearly at ceiling level in the LDC group, although performance was more dispersed in the incomplete figures condition as illustrated by the higher standard deviations.

A one-way ANOVA was carried out on the total scores of the savant, autistic control and LDC groups. Despite the indication of an autism-specific deficit on this dimension this difference did not reach significance ($F_{(2,32)} = 1.70$, $p = 0.20$, $\eta^2 = 0.12$). Moreover, further inspection of the apparently poor performance of the autistic group shows that although the mean performance of these two groups was lower than the LDC controls, the scores were not consistent *within* the groups and some individuals were scoring at ceiling level. No correlations were found between PIQ or VIQ (as measured on the RCM / RPM and PPVT) and fluency in any of the three mixed intelligence groups: savant, autism control group and LDC groups (r below 0.45, $p = 0.22$).

Analysis of error scores: Initially it was planned that analysis would be conducted on the error scores produced by the groups in this study, in keeping with previous studies (Turner, 1999), especially as the scoring methodology was relatively loose in relation to the type of response counted in the fluency score. However, the number of unacceptable responses produced was so low that this was deemed unnecessary. Indeed, only one participant in the savant group and two in the two IQ matched control groups produced any responses which were classed as errors and this was only on one item each.

Fluency: Discussion

The hypothesis proposed in the introduction, that there would be an autism-specific deficit on this domain was not supported. A trend towards this result was highlighted but this did not reach significance. It may thus be that the TTCT was not sensitive enough to pick up this difference. This result may reflect the closed nature of the task, as many of the participant's in the LDC and art student group consistently performed at ceiling level on both tasks. As mentioned in the results section, four of the participants in both the autistic and savant groups did indeed perform at ceiling level, thus if the test had been extended it is likely we would have seen much more dispersion in the scores of these two groups. However, the methodological decisions to reduce the number of figures was made with consideration to a number of other factors and extending the study would have had implications for the scores of the other three dimensions. It should be noted that previous studies which have identified a deficit in this domain have used open-ended tasks, or tasks in which the participant must produce as many responses as they can in a given period of time, such as word, design and ideational fluency tasks.

The failure to find a significant effect on this dimension may also be due to the type of stimuli used in this task. The nature of the task was such that the participant was required to complete a given figure rather than to generate a response from scratch, as in previous studies in which autistic participants have performed particularly poorly. It may be that the type of stimuli used in this task acts as a prompt, which enables the autistic participants to generate a number of responses. This would certainly seem the case when looking at the results of previous studies that have used stimulus figures (Leevers & Harris, 1998). No correlations were found between fluency and intelligence, although this is likely to reflect the fact that several participants performed at ceiling level.

The qualitative difference between creativity and generativity has been discussed throughout this thesis and this initial study provides further indication of this divide. As previously discussed *quantity* as measured by fluency gives us no indication of the *quality* of the responses and a high fluency score in normal participants is often equated with low scores on the other dimensions (Torrance, 1974). It has already been discussed that the primary deficit in autism may be one of generativity with some positive imaginative results reported (Leevers & Harris, 1998) although this result is not consistent (Scott & Baron-Cohen, 1996; Turner, 1999). The discussion of the remaining three dimensions will explore this distinction in more detail.

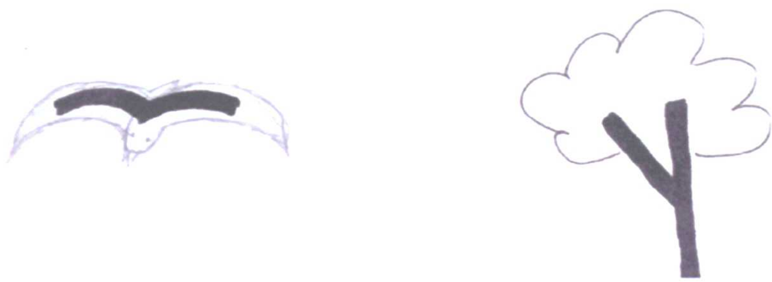
In conclusion, the dimension of fluency can be seen to measure the generative ability of the participants on a drawing task. Although the savant group and autism control group showed a slight tendency to produce fewer responses than the two non-autistic groups, this difference failed to reach significance. Considering the spontaneous nature of savant art, and artistic ability in general, and the failure of this test to highlight a difference between the talented and non-talented groups, the validity of this test as an adequate measure of generative ability is questionable.

4.3.2 Originality: How Novel is the Response?

Originality: Scoring

The scoring for the dimension of originality followed that outlined in the TTCT manual (Torrance, 1974). Based on a standardised set of norms, each response produced by the participant was given a rating depending on statistical rarity. In the incomplete figures task, commonplace responses were given a score of zero, with the most original responses given a score of two and those falling between given a score of one. The scoring for the repeated figure task was slightly different. Here responses were scored on a zero to three scale, based on a second set of norms. It is necessary here to refer to the distinction made in the introduction chapter between artistic creativity and cognitive creativity. The TTCT can be seen to measure the types of cognitive creativity referred to by Finke et al. (1992). Originality as measured on this test concerns the idea produced, rather than the expression of the idea and as such is not related to the artistic expression of the response. Examples of common and original responses in the incomplete figures task are given in figure 4.3 and figure 4.4 respectively. Examples of a common and original response in the repeated figures task are illustrated in figure 4.5.

Figure 4.3: Examples of two common responses on the incomplete figures task



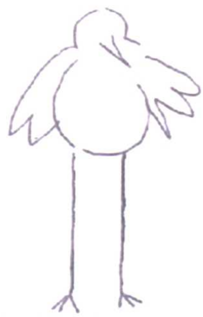
Response a: a bird *Response b: a tree*

Figure 4.4: Examples of two original responses on the incomplete figures task

Response a: a flying clock *Response b: a gateway*

Figure 4.5: Examples of a common and original response on the repeated figures task

Common response: a house



Original response: a chick

As previously discussed in the introduction to this chapter, it has been consistently found that the scores on the dimensions of originality, elaboration and flexibility are highly related to the fluency score. As a result of this, many studies have found no discriminant validity between the dimensions. This problem was addressed by reducing the number of stimulus figures in the repeated figure task. However, as illustrated in the fluency dimension, the two autistic groups did produce fewer responses overall, even though this difference did not reach significance it could still confound the results on the other measures. As such the scores of the two autistic groups on these dimensions will be confounded as a result of their lower response rate. Here we are concerned with the scores for each of the dimensions independent of the fluency scores and therefore it was necessary to transform the raw scores in order to gain a *fluency-independent score* for this dimension. To do this a mean response score was gained for each individual, by dividing their total originality score by their total fluency score.

Originality: Results

The total scores and standard deviations for the dimension of originality are shown in table 4.2. These consist of the combined scores from the two tests, both the total scores are shown and the mean response score and standard deviations (SD) for the two tasks combined.

Table 4.2: The total combined means (SD) and response scores for the dimension of originality on the TTCT

	Total originality scores	Mean response score
Savant	21.89 (9.45)	1.14 (0.33)
Autistic	17.89 (14.48)	0.95 (0.58)
LDC	19.44 (11.22)	0.91 (0.51)
Art Students	36.50 (1.90)	1.66 (0.08)

The performance of the art student group is again clearly above that of the three mixed intelligence groups, as can be seen on both the total scores and on the mean response score. What is more, the very low standard deviations found with regard to this group indicates that there was very little variance between their responses. Despite the confounding effect of fluency, the mean total score of the savant group is still higher than the LDC group. Due to the data not conforming to parametric assumptions a Kruskal Wallis test was used to analyse this data, using the mean response scores. Analysis found there to be no significant group difference (χ_2 = 1.54, $p = 0.46$).

Before a discussion of these results is presented, it is worth noting that there are several problems with using the combined score in this task instead of looking at the scores of the two tests separately. Firstly, the two tests are scored using different ratings scales, so the repeated figure scores will account for a larger part of the total score. What is more, the two tests can be seen to tap into different abilities. It may be more difficult to produce original responses in the incomplete figure task, as this task requires the participant to inhibit the obvious responses in order to generate an original response. In the repeated figures task the emphasis is on the inhibition of the previous response in order to produce a number of different responses from the same stimuli. For these reasons the two tasks will now be analysed separately, the mean total scores and responses scores, along with the standard deviations (SD), for the two conditions are shown in table 4.3.

Table 4.3: Mean total scores and response scores (SD) for the incomplete figure task and the repeated figure task

	Incomplete Figure		**Repeated Figure**	
	Incomplete Figures	**Mean response scores**	**Repeated Figures**	**Mean response scores**
Savants	9.00 (4.00)	1.04 (0.33)	10.10 (5.84)	1.10 (0.58)
Autistic	8.56 (6.02)	0.97 (0.51)	7.67 (8.58)	0.93 (0.87)
LDC	9.56 (4.53)	1.03 (0.39)	10.22 (7.28)	1.03 (0.73)
Art Students	14.4 (2.5)	1.44 (0.25)	18.50 (3.24)	1.85 (0.32)

As with the total scores, the performance of the art group is clearly superior in both conditions. The response pattern produced by the savant group appears to be more similar to that of the LDC group than the autistic controls on both conditions, however, when the scores from the three groups were analysed on the two conditions, no group difference was found (Incomplete figures, $\chi_2 = 0.46$, $p = 0.62$; repeated figures, $\chi_2 = 0.79$, $p = 0.67$).

In order to investigate the performance of the three mixed intelligence groups in more detail, the number of responses receiving the maximum score for originality were calculated. Again these scores were converted into percentages in order to account for any confounding fluency effect. The mean percentage of highly original scores are shown in table 4.4 along with the standard deviations (SD).

Table 4.4: The mean percentage of highly original responses produced in the TTCT by the three mixed intelligence groups (SD)

	Incomplete Figures %	**Repeated Figures %**	**Total %**
Savant	37.59 (23.47)	30.00 (16.58)	33.46 (16.33)
Autistic	31.27 (22.27)	15.85 (20.56)	25.13 (19.66)
LDC	36.94 (14.35)	30.37 (23.48)	33.16 (17.71)

The performance of the savant group is more akin to that of the LDC control group than the autistic controls, again the high standard deviations in all three groups points to high within-group variance found on such tasks. A Kruskal Wallis conducted on these scores indicated no differences on any on the conditions (incomplete figures: $\chi_2 = 0.32$, $p = 0.85$; repeated figures: $\chi_2 = 3.05$, $p = 0.22$; total scores: $\chi_2 = 1.87$, $p = 0.40$)

Analysis on each of the three mixed intelligence groups individually, indicated no significant intelligence by originality correlation, using Spearman's rho, in either of the groups with autism and the levels of association were particularly low in the savant group. With regard to the LDC group, there was a significant correlation between PIQ and performance on the repeated figures task, using the fluency independent, transformed scores (PIQ: $r_s = 0.87$, $p < 0.01$). What is more, whereas no inter-test relationship was indicated in the two autistic groups (r_s below 0.48, p = 0.19), when the scores of the LDC group were analysed individually there was a strong correlation between the repeated figures test and the incomplete figures (r_s = 0.85, $p < 0.01$).

Originality: Discussion

Where the fluency dimension could be seen as a measure of generative ability, originality can be equated with creativity, as it taps the ability to produce new and novel ideas. What is more, as the TTCT provides a set of standardised norms we can assess the statistical rarity of the responses. The performance of the savant group on this measure did not differ significantly from the two IQ matched control groups. Interestingly, as well as the large *within-group* variation evident in the large standard deviations, when the raw scores produced by each participant were studied it was found that there was a great deal of *within-participant* variation, especially within the two groups with autism. This means that each participant produced a variety of common and unusual responses, therefore the ability to produce original responses was not constant within individuals.

One explanation for both the lack a significant group difference and the large variation within-group concerns the relationship between originality and intelligence. As the within group IQ range is so wide in the three mixed intelligence groups, it is possible that the intelligence plays a large role in performance on this task. Certainly the scores on the dimension of originality appear to be strongly associated with intelligence, as shown by the far superior performance of the art student group. We may expect the art group to produce more original responses as their repertoire of ideas is likely to be larger as a result of their education. This conclusion is supported by the failure to find a significant difference between the three mixed intelligence groups, especially as these groups were matched closely on IQ

Turner (1999) found that, as with fluency, originality was not associated with intelligence in individuals with autism, in her study participants with autism and normal range IQ scores, performed as poorly as those with autism and below average IQ. The results of this study support her finding, with the only IQ and performance relationship found between the LDC group on the repeated figures task. Thus, while intelligence can explain the variation within the LDC group, it cannot account for the varied performance of the savant or autism control groups. This is a very interesting point, at least on this task. It appears that in autism, originality is an independent skill not related to intelligence nor talent, as indicated by the equal performance of the two autistic groups. Furthermore there were no inter-task correlations between the repeated figures and incomplete figures in the two autistic groups, suggesting that in these groups the two tests are tapping different abilities, this is in stark contrast to the high inter-test correlation found in the LDC group. A further explanation for the failure to find a significant effect of group on this dimension concerns the scoring of originality itself. Specifically it may have been that the task did not distinguish clearly between responses.

In the introduction to this chapter, two separate hypotheses were outlined regarding the performance of the two autistic groups on this dimension. The first of these referred to the lack of originality or imagination associated with autism and the evidence surrounding this reported autism-specific deficit. The second prediction concerned the possibility that autistic individuals, in particular the savant group, may produce more original responses due to an idiosyncratic perceptual ability. A discussion of these two explanations is provided below.

Firstly, there was no evidence of an autism-specific deficit on this task and this may be due to the non-verbal nature of the task. As discussed in the introduction, the area of creative or generative ability in autism has been widely overlooked in the literature and there are only a handful of studies with which to compare the results of this study. Previous studies highlighting an originality or imagination impairment have all required relatively complex verbal responses, at least in order to move away from conventional responses. In this study the performance of the two autistic groups was equal to that of the LDC group and this may reflect the non-verbal nature of the response. Although the TTCT did involve a verbal aspect, as participants were required to verbalise the title of the response, this occurred *after* they had drawn their response, and usually only required a one word label. This contrasts with tests such as the pattern meaning and object uses in which original or imaginative responses will often involve a detailed sentence. Here again the Leevers and Harris (1998) study can be used as support, as although originality was not specifically tested they provide a number of examples of the original responses provided by some autistic children on their drawing task, a task which had only minimal verbal demands. It may also be that there is a difference between the types of creativity tested in the two domains, for example verbal tasks may assess conceptual creativity whereas non-verbal tasks in the drawing domain may tap perceptual creativity. This argument is strengthened when one looks at the correlations within the LDC group. Here, a strong relationship was found between non-verbal IQ and originality on the repeated figures task, but, when the relationship between verbal IQ and performance was analysed it, albeit narrowly, missed significance.

The second hypothesis outlined in the introduction concerned how the unusual perceptual style of the savant and autistic groups may enable them to produce original responses. It was suggested that the context–independent, piece-meal perceptual style found in autistic individuals, might prove beneficial in this instance and that the TTCT could be seen as a generative version of the EFT. This is because, rather than having to find a part in a whole, the TTCT required participants to make a whole out of a part. It was hypothesised that the autistic individuals' focus on the parts of objects may allow them to generate unusual responses and that this effect would be even stronger in the savant group, not only because art often involves depicting things in unusual ways (Van Sommers, 1984) but also as this processing style has been found to be stronger in artistic savants (Pring, et al., 1995). This prediction was not supported by the results, with the two autistic groups performing at a similar level to the LDC group. Even when the percentage of high scores are studied the savant group produced the same amount of highly original responses as the LDC group. On one hand it seems that a heightened segmentation ability does not necessarily benefit performance on this task. Although, as yet the segmentation style of these savant artists has yet to be measured, therefore it cannot be concluded for certain that the autistic groups tested here do show superior segmentation abilities. At any rate, a note of caution needs to be applied since a number of studies have failed to replicate this finding using the EFT (Brian & Bryson, 1996; Ozonoff, Pennington & Rogers, 1991). Although the view that some parts could be more easily incorporated into a response has the propensity to explain the large *within-participant* variation found on this task.

A closer look at the differences between the two tasks may help us gain an insight into the performance of the three mixed ability groups on the dimension of originality. Here, the two sub-tests can be seen to measure different abilities. In the repeated figures the emphasis is on producing a number of ideas from a single stimulus figure and hence is more relevant to the flexibility dimension. The emphasis on the incomplete figures task is on producing an original response by overcoming the common response elicited by the stimulus figure, hence if the creative and generative deficits shown by individuals with autism are due to an inhibitory impairment we would expect poorer performance on this measure. However, this was not shown to be the case and the autism control group produced the same number of highly original responses on this task as the savant and LDC groups on the incomplete figures task. It may be that there are two processes operating simultaneously here, inhibition and unusual perception. On the one hand an inhibitory impairment possibly associated with an executive deficit could result in poor performance, whereas the unusual segmentation ability associated with autism and artistic ability could result in some original responses, thus explaining the wide within participant variance in the two groups with autism. This variance could relate to the stimulus figure, with some figures requiring less inhibition in order to produce an unusual response.

To summarise on performance on the measure of originality, there were no significant differences between the three mixed intelligence groups. The main finding on this dimension was the wide within-group variation. In the LDC group this was mainly a result of the impact of intelligence, still, this was not found to be the case in the two autistic groups.

4.3.3 Elaboration: The Addition of Detail

Elaboration: Scoring

Elaboration measures the amount of detail added to a drawn response, thereby representing the participant's ability to carry out and develop an idea. The TTCT manual states that credit should be given for each pertinent and meaningful detail added to the original stimulus figure. In this way every *new* detail, added to the initial meaningless stimuli, was given a point and the total number of new additions constituted the overall elaboration score. This scoring methodology did though create some confusion with regard as to what exactly was considered to constitute a minimum response. In order to clarify this point further it was decided, for the purpose of this study, a minimum response would refer to the simple outline of the response, minus any defining detail at all. An example of a minimum response given by a participant is shown in figure 4.6.

Figure 4.6: Example of responses given by participants constituting a minimum response on the elaboration measure of the TTCT

Response a: a horse *Response b: a head*

It is accepted that the scoring methodology adopted for this study is somewhat more stringent than suggested by Torrance (1974), nevertheless, it was noted that many of the participants simply drew the outline of a response, with out adding any other meaningful features or details. Should the scoring have followed that suggested in the manual, a participant who drew a face with simple features (slits for eyes and nose for example) would have been given the same score as an individual who drew only the outline of a head as their response. Further to this and in line with the methodology suggested by the manual, credit was only given to each *new* response, thus if a participant drew a tree and added several identical leaves, they would only score one point for elaboration, rather than a point for each leaf drawn. But, if a participant drew a tree with a variety of different *types* of leaves, they would be given credit for each different type. An example of the scoring methodology is shown in figure 4.7.

Figure 4.7: Example of elaboration scoring the incomplete figures task.

Balloons

Points awarded for the following:

String effect
Shading
Reflection
Bottom of the balloon

The confounding effect fluency may have on the remaining dimensions has already been discussed in the preceding section and the same discussion applies for the scoring of elaboration. Thus a participant who draws a low number of very elaborate responses will score poorly on overall elaboration as a result of their low fluency score. To take account of this effect, once again the overall elaboration scores were divided by the fluency score to give a mean response score, that is the mean number of details added to each figure. Any inappropriate responses were excluded from this score as were any exact repeats.

Results: Elaboration

As the scoring of elaboration was the same on both the incomplete and repeated figures tasks, and as such can be considered to measure the same ability in both conditions, the total elaboration scores for the two tests were combined. These group means and standard deviation are shown in table 4.5 along with the mean response scores and standard deviations (SD)

Table 4.5: The Mean total and overall combined response scores (SD) for the dimension of elaboration in the TTCT

	Total elaboration score	Mean response score
Savant	44.44 (36.90)	2.23 (1.52)
Autistic	12.77 (11.90)	0.66 (0.56)
LDC	30.22 (46.41)	1.37 (2.10)
Art Students	149.20 (50.49)	6.78 (2.29)

The superior performance of the art student group is again clearly evident on the results from the elaboration measure, with the autism control group appearing to perform particularly poorly here. The large within-group variation shown by the high standard deviations in the three mixed ability groups, illustrates the importance of individual differences on performance. Due to the large standard deviations, non-parametric tests were used to analyse the mean response scores produced by the savant, autism control group and LDC group. Kruskal-Wallis analysis on the transformed scores of these groups indicated a significant group effect ($\chi_2 = 6.04, p < 0.05$). Follow up Mann Whitney tests, using the Bonferroni adjustment rate, showed that the savant group produced significantly more elaborate responses than the autistic controls ($W = 11, p < 0.025$). The difference between the savant and LDC group failed to reach significance ($W = 23$, $p = 0.12$). The total scores, mean response scores and standard deviations (SD) for each condition, for the four groups on both conditions are illustrated in table 4.6.

Table 4.6: The mean total and response scores (SD) for the two conditions on the dimension of elaboration in the TTCT

	Incomplete Figures		**Repeated Figures**	
	Total score	**Mean response score**	**Total Score**	**Mean response score**
Savants	15.00 (11.53)	1.69 (1.08)	26.56 (29.34)	2.89 (2.78)
Autistic	5.56 (4.47)	0.67 (0.51)	6.67 (8.53)	0.83 (0.95)
LDC	19.00 (31.30)	1.92 (3.11)	9.44 (14.37)	0.95 (1.44)
Art Students	69.40 (21.40)	6.94 (2.14)	65.7 (29.35)	6.57 (3.22)

The pattern of results seen when the scores of the two conditions are looked at individually is somewhat surprising, with the LDC group producing more elaborative responses than the savants in the incomplete figures condition. This performance does not extend to the repeated figures task where the performance of the savant group is much higher. The performance of the art students on the other hand remains constant across the two conditions, as does the performance of the autism control group. When one studies the standard deviations produced by the four groups, however, the variance within the LDC group on the incomplete figures task is particularly high, and thus the mean scores do not give us a clear representation of the average performance of this group. The scores of the three mixed ability groups were again analysed using the Kruskal-Wallis, this difference did not reach significance ($\chi_2 = 3.20, p = 0.16$).

On the repeated figures task a significant group effect was found between the savant, autism control group and LDC group ($\chi_2 = 7.25$, $p < 0.05$). Follow up Mann Whitney U tests, using the Bonferroni adjustment, found that the savant group produced significantly more elaborate responses than both the autism control group ($W = 14.5$, $p < 0.025$) and the LDC group ($W = 14.5$, $p < 0.025$). Due to the differential performance across the two conditions by the savant and LDC groups, Wilcoxon tests were used to analyse the performance of savant and LDC group between the tests. A trend was found within the LDC group for superior performance on the incomplete figures task, although, when the Bonferroni adjustment was applied this difference missed significance ($Z = -1.97, p = 0.04$). There was no effect of test in the savant group ($Z = -1.40, p > 0.025$).

One explanation for the large standard deviations evident on this dimension is the role of intelligence, particularly because the IQ range of the three mixed intelligence groups is so varied. Using Spearman's Rho, significant correlations were found between IQ and mean combined response scores in the LDC group ($r_s = 0.88$, $p < 0.01$), and also using the mean response scores on the incomplete figures ($r_s = 0.73$, $p < 0.05$) and repeated figures ($r_s = 0.93, p < 0.01$). A further significant relationship was found between IQ and overall mean response score in the autism control group ($r_s = 0.68$, $p < 0.05$). None of the correlations between IQ and ability reached significance in the savant group (r_s below 0.23, $p = 0.55$).

Elaboration: Discussion

A number of striking findings are evident in the results of the elaboration measure. The first point for discussion concerns the finding that the savant group produced significantly more elaborate responses than the IQ matched autism controls on the combined mean response scores and both the autistic and LDC groups on the repeated figures test. This is the first measure so far in which the savant group have differed significantly from these two groups and thus elaboration can be seen as a key skill in savant performance. This finding supports the hypothesis outlined in the aims section of the introduction to this experiment. There it was suggested that the savant group would produce significantly more elaborate responses than the two non-autistic groups as a result of their superior drawing ability. However, the question now remains what is it about their drawing ability that allows the savant artists to produce better responses than the autism and LDC groups, especially when the measures of fluency and originality failed to pick up such a difference?

One explanation concerns the level of manual dexterity involved in this task. The figures were presented in small booklets and the elaboration measure comprised the total amount of new details added to this stimulus. Thus a certain level of ability was necessary in order to add small details to the initial given figure. As the savant group are better at drawing than the non-talented groups we can assume that they possess superior manual dexterity in this domain, allowing them to produce more detailed responses. Indeed, Hermelin et al. (1994) found that artistic savants possessed better motor control on a variety of tasks including several unrelated to drawing. It is unlikely that manual dexterity alone can account for all of the savants' superior performance on this task and this becomes clear when one looks closely at how elaboration is measured. Elaboration refers to the addition of each new idea or detail to the stimulus figure. The emphasis here is on *new idea*, thus it involves generation of details in a theme and this coupled with their superior drawing ability, might mean the savant artists are able to produce responses which are significantly better than their IQ matched control groups. As such the measure of elaboration can be seen to assess both creativity and generativity.

Although the performance of the savant group was found to be better than the two IQ matched control groups it was still far below that produced by the group of art students. In some respects this finding can be seen to support the view that the superior savant performance, in terms of the autistic and LDC groups, was not due to manual dexterity alone. The art student group were picked as they were seen to be the best matched group in terms of talent, the assumption being that the ability levels of the two groups are very similar, this being so it would be considered that their manual dexterity on a drawing task would also be similar. That the performance of the savant group was so far below the art students, indicates that there are other factors at play on this task, than simple drawing ability. Thus, while the savant group were able to elaborate more effectively on a theme than their IQ matched controls, they could not do this as well as a group of normally developing art students.

The difference between the savant group and the art students also highlights another factor important on the measure of elaboration – *intelligence*. What is particularly important here is that although intelligence was found to be an important factor in the performance of both the LDC group and the autism control group, it was not related to performance in the savant group. Therefore, whereas intelligence can account for the large variation within these two non-talented groups, it cannot account for the large variance within the savant group. Furthermore, this wide variance was not found in the talented art group, thus the question arises what is it that results in this wide variance if not intelligence?

A further point for discussion concerns the performance of the groups across the two conditions. It was found that the LDC group produced significantly more elaborate responses in the incomplete figure task, whereas this pattern of results was reversed in the savant group. Although this difference did not reach significance in the savant group, there was a trend toward higher performance in the repeated figures task over the incomplete figures task. In the discussion of originality we mentioned that the two conditions were not equal in terms of difficulty and the results from the savant group on this measure appear to support this view. It is suggested then, that again the incomplete figures task can be seen as more difficult than the repeated figures as it incorporates a relatively unusual stimulus figure. The stimuli for the repeated figures on the other hand appear to have presented the savant group with more scope for elaboration resulting in higher scores on this condition. As mentioned previously this was not the case in the LDC group who performed significantly better on the incomplete figures task, although the very large standard deviations evident on this condition highlight the variance within this group, making it difficult to generalise these findings.

In relation to fluency and originality, elaboration has been overlooked with regard to research into generative ability. Lewis and Boucher (1991) found no evidence of an elaboration deficit on this measure but few other studies have addressed this measure. Certainly, if we refer back to the previous suggestion that elaboration can be viewed as a type of fluency, this autism-specific deficit is somewhat unsurprising and provides further evidence of a pervasive generativity deficit in this realm. What is interesting is that the savant group did not show this deficit, despite their autism, indicating that their artistic ability allowed them to be more generative and creative on a task where the response was drawn.

To conclude for the dimension of elaboration, again the performance of the art students was found to be significantly above that produced by the three mixed intelligence groups. However, the savant group produced significantly more elaborate responses than the autism control and LDC groups. There was also a great deal of within-group variance on this dimension. Whereas intelligence was highly correlated with performance in the autism and LDC groups, this was not the case in the savant group.

4.3.4 Flexibility: The Ability to Switch Conceptual Set

Flexibility: Scoring

Flexibility measures how able the participant is at producing ideas that are *semantically different*. The scoring of this dimension followed that suggested in the

TTCT manual. Here each response was included in an overall semantic category, for example, clothing, buildings and so on. Each response was given a category number and the flexibility scores consisted of the total number of different categories. As such the flexibility dimension is a closed ended task and it was possible for participants to score at ceiling level if they produced 20 semantically different responses.

As flexibility measures the number of responses belonging to separate semantic categories it is not possible to calculate a mean response in this instance. One way in which a fluency-independent score could be obtained would be to calculate the *percentage* of category scores with respect to the total number of responses attempted, which were semantically different. This methodology would, however, result in a bias toward those participants who produced less responses overall gaining higher scores, as the less responses are given the easier it would be to make these responses semantically different, or flexible. For this reason the raw flexibility scores were used, although it is recognised that this scoring method does mean that results will be skewed towards those participants who completed more responses. Whereas on the previous dimensions of originality and elaboration any exact repeats of previous responses were excluded, they were included in the analysis of this dimension.

Flexibility: Results

The total flexibility scores and standard deviations (SD) are shown in table 4.7.

Table 4.7: The mean total scores (SD) for the dimension of flexibility in the TTCT

	Total flexibility Score
Savant	12.67 (3.43)
Autistic	10.22 (3.72)
LDC	12.89 (5.33)
Art Students	18.00 (1.33)

The performance of the art student group is again clearly superior to the three mixed intelligence groups and nearly at ceiling level, indicating the ease this group had at producing flexible responses on this dimension. A one-way ANOVA on the savant, autism and LDC groups indicated no significant group difference (F (2,24) = 1.05, p = 0.35, η^2 = 0.08) on the total fluency scores. Table 4.8 shows the mean scores and standard deviations (SD) for the dimension of flexibility across the two tests[1].

Table 4.8: The mean scores (SD) for each condition on the dimension of flexibility in the TTCT

	Incomplete Figures	**Repeated Figures**
Savant	7.00 (1.50)	5.67 (2.5)
Autistic	5.78 (2.68)	4.44 (5.89)
LDC	7.00 (2.45)	5.89 (3.06)
Art Students	8.90 (1.29)	9.10 (1.29)

[1] Due to the differing nature of the two tasks, one might expect a slightly different response pattern across the two tests. As already mentioned, where the emphasis in the incomplete figures test is to overcome the common response elicited by the stimulus figure in order to generate a novel response, the emphasis in the repeated figures condition is to produce a number of different responses using one stimulus figure. As such it was predicted that flexibility would be to be lower in the repeated figures test. This is particularly the case in the autistic participants, a group shown to have inhibitory impairments, as they would have to inhibit a previously correct response in order to generate a new response using identical stimulus figures.

In order to investigate the effect of test, in particular the hypothesis that individuals with autism will perform particularly poorly on repeated figures test, the data from the all four groups was entered into a repeated measures ANOVA. A significant main effect of condition was found although this effect was small (F (1,24) = 8.79, $p < 0.01$ $\eta^2 = 0.27$). The interaction predicted earlier, that the autistic group would perform more poorly on this measure was not found to be significant (F (2,24) = 0.03, $p = 0.97$ $\eta^2 = 0.03$). It is clear from the mean scores on the two conditions that this effect is mainly attributable to the poor performance of all three, mixed IQ groups producing less flexible responses on the repeated figures task. There was no main effect of group (F (2,24) = 1.094, $p = 0.35$, $\eta^2 = 0.27$).

The scoring on this dimension makes no distinction between semantically related responses (stuck in set perseveration) and exact drawn repeats (recurrent perseveration). As previous studies have found that autistic groups show more exact repetitions than control groups, an attempt was made to analyse the amount of exact repeats. However, as with the number of errors produced and discussed in the fluency section of this chapter, the actual amount of repeated responses was very low indeed. Repeats were only produced on the repeated figures task, and by only one individual in the savant group and two participants in the autism control group and LDC groups. As such these results could not be investigated using statistical methods.

The flexibility results of the three mixed intelligence groups were entered into a correlation matrix, no significant relationships were found within the autism control group and the group of autistic savants using Pearson Product-movement correlation coefficients (r below 0.28, $p = 0.45$). Moreover, in the LDC group, a significant correlation was found between PIQ and VIQ and the total flexibility score (PIQ: $r = 0.72$, $p < 0.05$; VIQ: $r = 0.71$, $p < 0.01$) as well as on the incomplete figures task (PIQ: $r = 0.66$, $p < 0.05$; VIQ: $r = .71$, $p < 0.05$) and the repeated figures task (PIQ: $r = 0.85$, $p < 0.01$; VIQ: $r = 0.83$, $p < 0.04$).

Flexibility: Discussion

As with the scores of the other three dimensions, the performance of the art students on flexibility was again clearly superior to that of the savant, autism control group and LDC group. Interestingly there was no difference between the scores of the three mixed intelligence groups on either of the two conditions. This pattern of results mirrors the pattern found with regard to fluency, with a trend towards the autism control group producing slightly less flexible responses than the savant and LDC groups. One explanation for the failure to find a significant effect on this dimension may reflect the closed nature of the task. It is possible that if the task been extended over more trials, the trend towards the autism control group performing worse on this dimension may have reached significance. However, this conclusion is tentative due to the possible confounding effect of the two groups with autism producing less responses overall and the unsuitability of using a fluency independent score on this dimension.

It was predicted that the autism control group, and possibly the savant group, would perform less well on the repeated figures. As discussed in chapter 2 a number of previous studies have highlighted the difficulties that autistic individuals exhibit when required to produce a number of *different* responses from a single stimuli figure. This prediction was in part supported, in that both autistic groups did perform less well on the repeated figure task. However, the performance of the LDC group highlights that this effect is not specific to autism. There are a number of explanations that can account for this finding. The first refers to the different types of stimuli used in the two tasks. On the incomplete figures task, the participant is presented with a relatively unusual figure and their response depends on how they are able to convert this figure. The emphasis on the incomplete figure task is on perceptual ability rather than semantic flexibility. For example, a participant may show a tendency to becoming stuck in one semantic set, yet, if they are unable to convert the stimuli into a response which is in keeping with that mental set it is possible they will be able to go beyond this inflexibility to create a semantically different response. On the other hand in the repeated figure task the participant is presented with the common stimulus figure of parallel lines. In comparison to the incomplete figure task, the parallel lines could be made, with relative ease, into a variety of different responses. As such it would be more likely that participants prone to this type of thinking could get stuck in a semantic set and thus less able to produce a variety of flexible responses. This explanation is supported by the finding that no repeat responses were produced on the incomplete figure task.

While it is likely that the stimuli differences can go part of the way to explaining the significant test effect, the finding that the art students performed equally on both of the conditions indicates that general ability may also contribute to this result. As was mentioned with regard to originality, it may be that the three mixed intelligence groups were unable to inhibit their associations linked with semantic retrieval, possibly as a result of their lower IQ. Coupled with the bias to semantic generation in the repeated figures, these three groups may thus show this significant tendency to produce semantically related responses.

The failure to find a significant autism-specific deficit on flexibility is at odds with previous findings. Lewis and Boucher (1991) found that in a free drawing condition the responses of autistic children were more semantically related than those produced by controls. Further to this, and in support of the previous hypothesis, Turner (1999) found that on ideational fluency tasks, including the object uses and the pattern meanings task, high-functioning, autistic participants produced significantly less flexible responses than a group of IQ matched controls. Interestingly this pattern was not found when the scores of lower functioning participants were studied; with the low-functioning autistic group performing comparably to a group of IQ matched LDC controls.

As mentioned Turner's finding may go some of the way to explain the failure to find significant group effects in this study. The range of intelligence found within the three mixed IQ groups may have meant that significant group differences which may have occurred amongst the higher functioning individuals were overlooked. The high correlations indicated in the LDC group go some way to confirming this suggestion, compared to the two groups with autism where again it seems deficits were widespread. One can tentatively conclude that a significant deficit would have arisen if the scores of the higher ability participants were compared, at least in the case of the autism control group.

In conclusion for the dimension of flexibility, the three mixed ability groups performed equally. There was a significant effect of condition, with participants in the three mixed ability groups showing a pattern towards poorer performance on the repeated figure task. Again the performance of the LDC group was strongly related to IQ. This pattern was not evident in the savant or autistic groups, this lack of relationship can be seen to be evidence of a deep rooted autistic deficit in flexibility, which may have been concealed by the low ability of many of the participants.

4.4 GENERAL DISCUSSION

The aim of this study was to provide an insight into the creative and generative capacity of a group of savant artists on a standardised creativity test, related to the domain of their expertise. The TTCT was thought to be a particularly good measure to use initially as it separated performance into a variety of areas, allowing any strengths or weaknesses the savant group might posses to be highlighted. Three control groups were used in this study, in order to identify if the performance of the savant group was due to either their diagnosis of autism, their general level of intelligence or their artistic ability. The art group was found to produce far superior responses on the measures of originality, flexibility and elaboration. The savant artists were found to use elaboration significantly more often than the autism control group and all three mixed ability groups were less flexible on the repeated figures than the incomplete figures.

Returning to the performance of three mixed intelligence groups, no significant difference was found on the dimension of fluency, although an autism-specific deficit was indicated. It is likely the lack of significance arose due to the closed nature of the task and this view is given support when one looks at the results obtained by Craig and Baron-Cohen (1999) on this test previously. They failed to find a fluency effect on the incomplete figures task, a task with only ten stimulus figures, but found an autism-specific fluency deficit on the original, 30 figure format of the repeated figures, suggesting that had the task been extended an autism-specific fluency deficit may have been indicated on this task.

On the dimension of originality again there were no differences between the savant group and the two IQ matched control groups. The two hypotheses outlined in the introduction, that an unusual visual processing style might facilitate performance in the two autistic groups or alternatively that the two autistic groups may perform significantly worse on this dimension as a result of an inhibitory impairment, were not supported although it is possible that the two processes cancelled each other out. Originality thus seems to result primarily from intelligence and this appeared to apply especially to the LDC group, as shown by strong correlations between PIQ and VIQ and originality.

As hypothesised the performance of the savant group was superior to the autism control group on the dimension of elaboration. While this finding is thought to result from the artistic ability of this group, intelligence still plays a large part in performance here, as illustrated by the superior performance of the art student group and the strong IQ correlation found in the LDC group. Interestingly, this supports Duckett's finding discussed in the introduction, it may thus be that the ability to elaborate is associated with savant talent in general. This point is particularly relevant as it contradicts the view that elaboration is associated with drawing skill alone.

Finally on the dimension of flexibility, no significant group differences were found between the savant group and the two IQ matched control groups. This is in contrast to the prediction that the two groups with autism would perform poorly on this dimension as a result of "stuck in set" perseveration associated with their autism.

One recurring issue that has arisen throughout the discussion of the various dimensions is the effect intelligence has on performance. A number of researchers have suggested that intelligence is not correlated to creative ability or at least not the divergent type of thinking measured by this test (see Torrance, 1974). Whilst this may be true when discussing the creative achievements of individuals with IQ in the normal range, it is not the case when looking at individuals with impaired cognitive functioning. As such the TTCT can be criticised for not representing a true measure of creative ability. What is particularly interesting is that whilst correlations with IQ were highlighted on every dimension with regard to the LDC group, they did not occur within the two autistic groups. This result suggests that whereas low performance on creativity scores in the LDC group was a result of a low IQ, in the two autistic groups deficits were widespread across all ability ranges. This autism-specific finding provides evidence of deep rooted generative deficits, which may have been obscured by the wide ability range of the groups. Such reasoning provides support for results outlined by Turner (1999) in which deficits were often found in the high-functioning group with autism, but not between the two lower functioning groups. This problem is inherent when studying groups with such a wide intelligence range. Indeed the results of this study support suggestions made by a number of psychologists several decades ago, stating that creativity and intelligence can only become independent after a critical IQ level has been exceeded (Taylor, 1964; Vernon, 1964)

In general this study did not provide support for previous studies in which autism-specific deficits have been highlighted and aside from the IQ influence discussed above, there may be other factors which have lead to these results. Methodological considerations concerning the closed nature of the tasks and the fact that the TTCT did not provide a singular starting prompt from which individuals were required to generate a number of different responses, have been highlighted as playing a part in failure to find such a deficit. Further attention was brought to the use of a prompting figure or starting point, specifically that this prompt may have resulted in the participants with autism, producing results which were comparable to the LDC group. Indeed, as Leevers and Harris (1998) found in their replication of Scott and Baron-Cohen's (1996) study, the use of a starting figure can enhance performance in individuals with autism. What is more, it may be that individuals with autism are more able to express ideas when there is no strong verbal aspect.

In terms of the executive dysfunction hypothesis, this study provides little evidence of an inhibitory impairment specific to the autistic groups, although this was not specifically tested in this study. There is minor support for the view that the autistic groups have impaired activation, but this needs to be followed up with an open-ended task. There was no support for the view that the autistic groups produce more errors that would be associated with a monitoring impairment. Nor did they produce more perseverative responses of recurrent or "stuck in set" type, as was predicted, associated with an impairment in shifting mental set.

With regard to central coherence, it was tentatively suggested that an idiosyncratic perceptual style might facilitate creative performance in individuals with autism and particularly in the savant group. Again this hypothesis received little support. Furthermore, it is important to note that while a number of studies (Happé, 1996, 2000; Jarrold & Russell, 1997; Jolliffe & Baron-Cohen, 1997; Pring et al., 1995; Shah & Frith, 1983, 1993) have identified this style to be stronger in individuals with autism, not all studies have supported these findings (e.g. Ropar & Mitchell, 1999, 2001). This is particularly the case with the EFT (Brian & Bryson, 1996; Ozonoff et al., 1991). In the introduction it was suggested that the TTCT could be viewed as a generative version of the EFT. The hypothesis that the groups with autism will perform better on this task, is thus dependent on the result that such individuals have superior disembedding ability, which as mentioned is not a consistent finding. In particular concerning the savant group, although this group have been found to have better segmentation ability on the block design (Pring et al., 1995) their ability on the EFT has yet to be tested. Furthermore, as mentioned in the discussion of originality it may be that the results of this measure reflect a play off between the deficits associated with executive functioning and the assets linked to their perceptual processing. Further studies are warranted to prise apart these processes, which could be competing against each other, before any firm conclusions are drawn.

Finally tasks such as the TTCT aim to pick up creative thought in the population as a whole, not in individuals with a specific skill in one domain. It can be argued that the creative ability of the savant group, as evident in their artwork, is above that of the non-talented controls. If creativity is looked at in such a way then the TTCT can be criticised for not adequately measuring this concept in relation to art. However, as we mentioned in the introduction, the aim of this study was to identify any creative or generative skills that the savant group possessed *unrelated* to their artistic output. The results from this initial study indicate that while the savant group can be considered artistically creative, this ability does not extend to performance on a standardised test.

In summary, the aim of this initial test was to measure a group savant artists' creative and generative performance on a standardised test of creativity, in the domain of their ability. It was found that the performance of the savant group was determined by their overall level of cognitive functioning on the measures of fluency, flexibility and originality. In contrast, the performance of the savant artists on the dimension of elaboration was above that of the two IQ matched control groups, although it was not up to the level of the art students. This result indicates that the artistic talent of the savant group, in this respect, compensates for what would be expected considering their general cognitive abilities. It should also be considered, to what extent the qualities measured in this test are general characteristics, such as the TTCT was designed to measure, or are more domain-specific factors.

Chapter 5:

Figural Synthesis and Creative Discovery

5.1 INTRODUCTION

In this chapter, the aim was to investigate the performance of the savant group on a test of creativity in which the response mode was not drawing. By studying performance outside of the area of the savant group's talent it will be possible to establish how domain-specific their creative and generative ability is. In particular, although the TTCT was not a measure of artistic ability, one criticism that could be aimed at this task was that the response mode may bias in favour of the artistically talented groups. In this context, Perkins (1981) argues that creativity is not a general quality but tends to be restricted to certain specific domains. As Bell (1965) points out, there are a number of instances where creative scientists were able to make contributions only in their own narrow field of study. This view is supported by Baer (1998) who refers to a growing body of evidence, which suggests that rather than being domain transcending, creative achievement is specific to certain areas. In contrast, Finke et al. (1992) argue while it is possible that cognitive strategies may promote creativity in one area (especially if the individual has a particular ability in that domain) there is no reason that such strategies could not be extended to others. That is providing the strategies in question are suitably flexible in order to accommodate changes in structure or context.

There have been a number of studies into the domain-specific nature of the savant artists' talent. While some studies have found that superiority is only evident on tasks that contain an element of drawing (Hermelin & O'Connor, 1987b, 1990), positive results have also been obtained where the emphasis has not explicitly focussed on drawing tasks (Hermelin et al., 1994). While such *tasks* are unrelated to drawing, the *skills* they measure can be seen to be closely associated with this particular ability. Savant artists have also been consistently found to obtain superior scores to controls on visual processing tasks which measure segmentation ability (Hermelin et al., 1994, Pring et al., 1995; O'Connor & Hermelin, 1987a; Mottron & Belleville, 1993, 1995). The link between a segmented processing style and artistic ability has also been found in normal artists (Getzels & Csikszentmihalyi, 1976; O'Connor & Hermelin, 1983; Pring et al., 1995).

To summarise, when the performance of savant groups is compared to non-talented, IQ matched, control groups on equivalent tasks in and out of the artistic domain, the artistic ability of the savants artists results in superior performance only on those related to drawing. Greater scores are also found on measures that may tap skills related to this ability, such as segmentation or manual dexterity. One interesting study which illustrates the domain-specific nature of savant talent was conducted by Hermelin and Pring (1998) who directly compared the use of linear perspective, a skill commonly associated with savant artistic talent, on a drawing and construction task. They found that while the savant group was able to apply linear perspective and size constancy to drawings, their performance on a construction version was only equal to their IQ matched, non-talented controls. In fact, only one of the nine savant artists tested was able to apply perspective in the construction task, compared to all nine of the gifted controls. It was concluded from this result that whereas the savants' performance on the drawing task was dependent on their talent, their performance on the construction task was determined by their overall level of intelligence. The question thus remains to what extent the savants' creativity and generative performance is dependent on the modality of response.

To test the ability of a group of savant artists out of the domain of drawing, the paradigm used by Finke and colleagues in their study of creative cognition was modified for use with mixed intelligence groups. As discussed fully in chapter 2, Finke, et al. (1992) proposed a model which attempted to identify the cognitive processes and structures behind creative thinking using the experimental methodology of cognitive psychology. The Geneplore model makes a distinction between a generative stage and an exploratory stage of creative discovery. One process thought important during the generative stage is *mental synthesis*. This refers to how separate components are mentally combined to form new configurations in order to provide various creative possibilities or unexpected visual discoveries. There is a range of evidence highlighting the role visualisation plays in the creative process (see Shepard, 1978, 1988). Finke et al. (1992) outline several examples of how mental imagery has been essential in the creative discoveries of great thinkers such as Einstein, Faraday and Feynman. More relevant to this study is the case reviewed by Finke (1986) of an adult artist who lost his sight, but used visualisation to paint landscapes by imagining how the landscape would look. Further to this, in his 1978 review of mental imagery, Shepard states that mental imagery is central to creative discovery in fields as diverse as psychology, literature and physics.

Studies of creative synthesis

Although introspective accounts of how visualisation aids creative discovery are somewhat unreliable, they do help to highlight the importance of imagery in creative or generative thought. Moreover, the role of imagery in creativity has also been tested empirically under laboratory conditions and it is these studies, rather than introspection and interpretation, which allow us more insight into the nature of this process and how it can aid creative discovery. The first empirical investigation to look at the generative nature of mental synthesis was conducted by Finke and Slayton (1988). Whereas previous studies of imagery had focussed on mental assembly (e.g. Thomas & Klatzky, 1978) Finke and Slayton questioned whether people could make genuine discoveries in imagery. Participants were presented with three figures at a time from a set of 15 alphanumerical shapes, which they were instructed to combine in any way to make some type of recognisable shape or object. The presented stimuli could be rotated and the size changed as long as the dimensions and overall shape remained constant. Participants were instructed first to write down the title and then to draw their response. Each response was scored on resemblance to the title given and originality. Recognisable responses were produced on 38.1% of trials of which 15% were deemed as creative. From this study Finke and Slayton concluded that visual discoveries could be reliably induced under laboratory conditions. This methodology has also, more recently, been employed in tests of working memory (see Helstrup & Logie, 1999, for a review).

Though the aim of Finke and Slayton's (1988) study was to measure creative synthesis in normal individuals, their methodology can be applied to the study of creative and generative ability in savant artists. Nevertheless, there are still a number of methodological concerns needing to be addressed. While this paradigm can be seen as an adequate measure of the abilities in question, the task in current form relies on complex verbal instructions and does not include a training condition, as such it is unsuitable for use with individuals with lower intelligence. The main problem envisaged here concerns the instruction to *imagine* how the shapes could be combined *mentally* and it is unlikely that the lower functioning individuals in each of the three mixed intelligence groups would be able to comprehend these requirements.

Visual versus mental synthesis

It has been noted by a number of researchers that when participants are able to physically manipulate parts, there is no significant improvement in their performance. Finke et al. (1992) refer to a study by Neblett, Finke and Ginsburg (1989) in which the stimulus figures were presented to participants on transparencies and found that there were no differences between the number or the quality of responses in the imagined and real conditions. This finding was supported by Anderson and Helstrup (1993). One further advantage that physical synthesis has over mental synthesis is that it places less emphasis on working memory and as such provides a method of assessing visual discovery which is free from memory constraints.

Again, as with the TTCT, the methodology of this task needed be modified in order to make the test applicable for use with individuals with learning disabilities. Firstly the number of stimulus figures was reduced from the 15 used by Finke and Slayton (1988), to eight. As the aim of this task was to assess generative ability out of the domain of drawing, the methodology employed by Anderson and Helstrup (1993) was adopted. Here, rather than present participants with transparent overlays, they presented cardboard shapes. As in this task the aim was to assess the responses generated spontaneously by each participant, it was decided that in this task participants would be free to pick the shapes that they wanted to include in a response.

One criticism aimed at the TTCT was that is was not an effective tool with which to measure fluency, as it was a closed test. For this reason, in this task participants were given a five minute time limit in order to produce their responses. Moreover, participants were required to generate their responses from scratch rather than being presented with the type of prompt or starting figure used in the TTCT. A further modification concerns the scoring of the measure of originality. Again the TTCT was criticised for measuring the originality of a *visual response* on only a *semantic title*. To overcome this, originality on this task was measured on how unusual the output was visually, rather than on the rarity of the title given to it. This would allow any unusual representations of common objects to be recognised as creative. Also, rather than presenting participants with three shapes only, this study incorporated three conditions. In the first condition all groups were instructed to create a response consisting of two shapes, followed by a three shape condition and lastly using four figures. All participants were presented with the conditions in this order.

Aim

The aim of this study was therefore to assess the creative and generative capacity of a group of savant artists on a test which did not require a drawn response.

Experiment 2: Figural Synthesis, Construction Task

5.2 METHOD

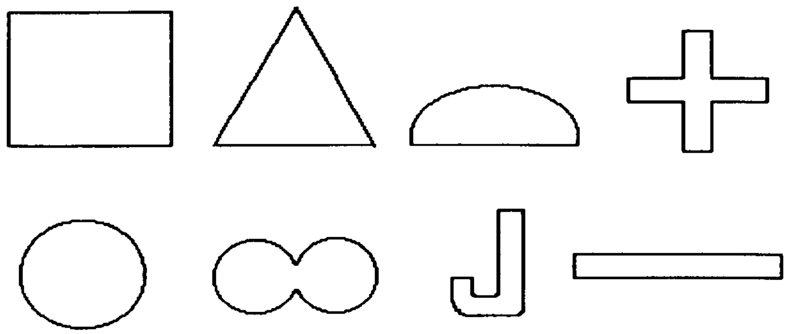
5.2.1 Participants

The same participants used in experiment 1 took part in this study; the savant artists, the autism control group, the LDC group and the art student group. See chapter 3 for full details.

5.2.2 Materials

Eight shapes from Finke and Slayton's (1988) investigation were chosen for this study. These figures, illustrated in figure 5.1, were chosen on the basis of pilot studies because they could be easily incorporated into a variety of designs. As well as five common, geometrical figures (square, triangle, rectangle, circle and semi-circle), the shapes included three others (i.e. a cross, letter J and figure eight). These less common shapes were included to elicit more unusual responses. The stimuli were quasi two-dimensional, and made out of thick cardboard. They ranged from 80mm in length to 80mm in width. Two-dimensional figures were chosen as these were more akin to pictorial representation.

Figure 5.1: Stimuli used in figural synthesis task



5.2.3 Procedure

Participants were all tested individually in a quiet room in their school, centre or home. The experimenter laid the eight stimuli shapes in front of the participant. They were not laid out in any particular order or rotation and the only specification was that they were not overlapping and each figure could clearly be seen. For the first condition participants were presented with the semi-circle and the letter J. They were instructed to add two of these shapes together to make a recognisable representation. This was then demonstrated by the experimenter who manually placed the semi-circle on the top of the J figure, and participants were then asked what this combination could be. Acceptable responses here were either an umbrella or the letter J. The inclusion of this trial was to visually demonstrate the task to participants, as well as to assess their initial representation skills and all individuals were able to do this. The two shapes were then added back to the remaining six and participants were instructed to see what they could make using two at a time. They were reminded that they had to produce answers that "*looked like real things*" and to name each response. After the instructions had been given, individuals were given five minutes to come up with as many responses as possible. The examiner drew each given response and wrote down the title given by participants. It was noted in pilot studies that one shape was often used as a prompt, for example the rectangle as a pole for a sign and then a streetlight. As the strategies used to produce responses were of interest here, the figures were not disassembled after each title was given, however, individuals were reminded that they could reuse the shapes. Finally participants were given two warnings for each type of error, that is if they used an incorrect number of shapes or if their response did not seen to resemble the given title.

Each individual was given a break between conditions, of around 30 minutes, during which they went back to their lessons or previous activity. On return they were presented with the same eight shapes and requested to do as they had on the previous task, but this time using three figures to make a recognisable response. No training was incorporated in this condition as pilot studies indicated that the task requirements had been suitably understood previously. Also, giving an example in this more difficult condition may have given participants prompts as to possible responses. Again two warnings were given for each type of error (incorrect number and unrecognisable response). This task was followed again by a break of at least 30 minutes. In the final condition participants were presented again with the same eight figures and informed that this time they had to use four of these. Again pilot studies did not show a training example to be necessary for comprehension on this task.

5.3 SCORING, RESULTS AND DISCUSSION

As with the TTCT, this figural synthesis task was scored on a number of measures, thus in order to present the results clearly, the scoring, results and discussion will be presented separately for each measure obtained.

5.3.1 Fluency: The Total Number of Responses Produced

Fluency: Scoring

The first measure was the *total fluency* score. This score comprised the total number of responses produced and named by participants and, as suggested by Turner (1999), included any repeats or errors. This scoring was in accordance with the methodology adopted previously on the TTCT and is also in line with that used by Finke and colleagues in their creative synthesis tasks. The total fluency score will result in a measure of overall generative ability, irrespective of the quality, or creativity, of the response.

Fluency: Results

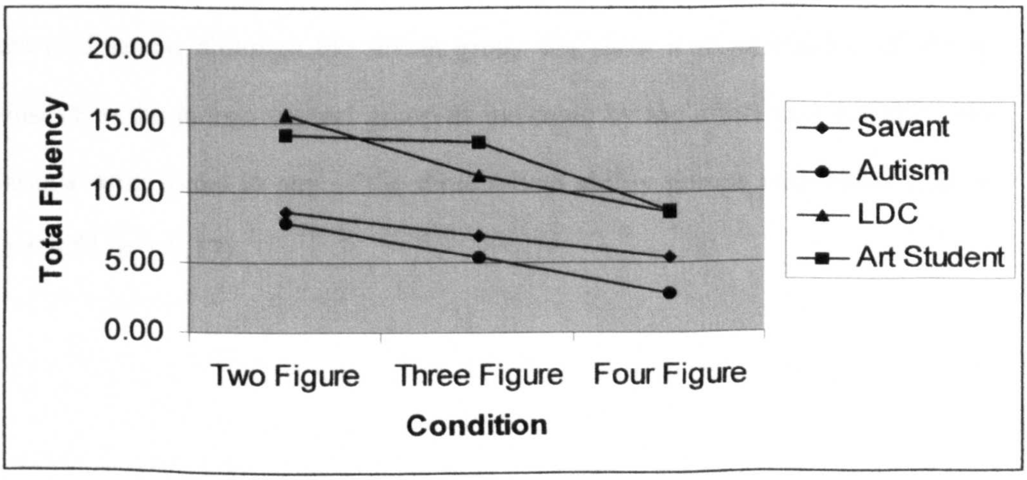
The mean scores and standard deviations (SD) for total fluency on each of the three conditions are shown in table 5.1.

Table 5.1: Mean overall fluency scores (SD) for the three conditions across groups on the figural synthesis task.

	Number of figures presented		
	Two figures	**Three figures**	**Four figures**
Savants	8.56 (3.54)	6.89 (5.16)	5.11 (2.42)
Autistic Controls	7.77 (4.27)	5.33 (2.12)	2.78 (2.33)
LDC	15.44 (8.49)	11.11 (8.35)	8.56 (6.48)
Art Students	14.00 (5.48)	12.00 (6.42)	8.56 (4.55)

The mean scores indicate an autism-specific deficit evident on the measure of fluency. Both the savant group and the autism control group produced noticeably less responses on all three conditions, than the two non-autistic control groups. Again the standard deviations are very large, indicating wide variance within groups. The mean scores across the three conditions are illustrated in figure 5.2. Here the performance of the two groups with autism can be seen to be distinct from the LDC and art student groups. Furthermore, the performance of all three groups decreases as the number of shapes increase.

Figure 5.2: The mean scores from each group on the three conditions on the measure of fluency in the figural synthesis task



The results of all four groups were analysed using a mixed design, two factor ANOVA, with condition (two figure, three figure and four figure) as the within-participants factor and group (savant, autism control group, LDC group and art student group) as the between-participant factor. A main-effect of condition was found ($F_{(2,64)} = 29.75$, $p < 0.01$, $\eta^2 = 0.5$), within-participant contrasts found a significant linear trend ($F_{(1,32)} = 62.38$, $p < 0.01$, $\eta^2 = 0.66$) indicating all groups produced less responses as the number of figures increased. The interaction did not reach significance ($F_{(6,64)} = 1.46$, $p = 0.21$, $\eta^2 = 0.12$).

A main effect of group was also found ($F_{(1,32)} = 119.38$, $p < 0.05$, $\eta^2 = 0.32$). Following Brace, Kemp and Snelgar (2000) as the number of planned comparisons were equal to the number of conditions, post-hoc t-tests were completed without the need for any adjustments. Using the total fluency scores across the three conditions, the savant group were found to produce significantly less responses than the art students ($t = -2.29$, $p < 0.05$, $d = 1.08$). The difference between the savant group and the LDC group narrowly missed significance however, the importance of this result is indicated in the large effect size difference between these groups ($t = -1.78$, $p = 0.09$, $d = 0.85$) there was no difference between the two groups with autism, ($t = 1.14$, $p = 0.27$, $d = 0.5$) This finding supports the prediction of an autism-specific deficit on the measure of fluency, although the savant group did show a slight sparing of ability comparative to the autism control group as indicated by the effect size statistic. No correlations were found in any of the three mixed ability groups with either PIQ or VIQ ($r < 0.51$, $p = 0.17$).

Fluency: Discussion

The finding of an autism-specific deficit on the measure of fluency is in keeping with previous studies and can be seen to provide further evidence towards a pervasive generativity deficit apparent in the individuals with autism. Further to this, it provides more evidence for the domain-specific nature of savant ability as this finding is in contrast to the results of the drawing based, TTCT. While the savant group did produce more results than the autism control group, their performance was also below that of the two non-autistic groups. The finding an autism-specific fluency deficit is consistent with impairments in executive function, in particular the SAS as proposed by Shallice and colleagues (Norman & Shallice, 1986; Shallice, 1988, 1994; Shallice & Burgess, 1991). The relationship between the SAS and the generativity deficits found in autism was raised by Jarrold (1997) and discussed in chapter 2. Jarrold suggests that the primary deficit in generation in autism is a result of poorly specified goal states, which could result in a paucity of ideas. Similar results were suggested by Turner (1995, 1999) and the results of this study do indeed support this view.

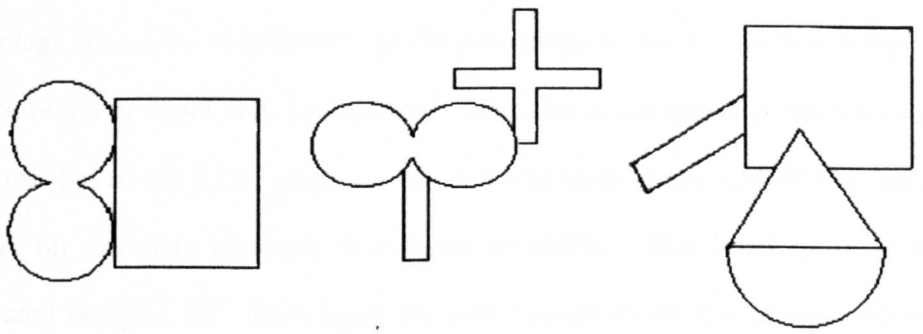
A further explanation for the contrasting results found on this task and the TTCT concerns the differential task demands of the two tests. Specifically the TTCT was a closed test whereas this figural synthesis task was open-ended, in that participants were required to produce as many responses as possible in a given time. Related to this, in the TTCT the participants were presented with stimulus figures to add details to. As was discussed in chapter 4, the stimuli in the TTCT may have acted as a visual prompt. Furthermore it has been found that deficits are less likely when there are environmental prompts to aid performance (Charman & Baron-Cohen, 1993; Jarrold, Boucher & Smith, 1994b; Turner, 1997). Whereas the stimuli used in the TTCT may have prompted performance, the lack of such a starting point on this figural synthesis task may have resulted in the reduced fluency found on this measure.

5.3.2 Representational Fluency: Providing a Recognisable Response

Representational responses: Scoring

A second, more interesting measure is the *representative fluency* score. This refers to responses that were clearly recognisable as a representation of the title they were given. Responses were scored separately by three independent examiners, according to how well the patterns produced corresponded to the titles they were given. If two out of the three examiners scored a response as recognisable that response was included in this score. This scoring methodology was adapted from that used by Finke and Slayton (1988) and subsequent studies (see Helstrup & Logie, 1999). Examples of unrepresentative responses are illustrated in figure 5.3, representative responses can be seen in figures 5.5 and 5.6 under the discussion of originality.

Figure 5.3: Examples of unrecognisable responses given in the figural synthesis task



Response a: a truck *response b: a butterfly* *response c: a penguin*

Representational responses: Results

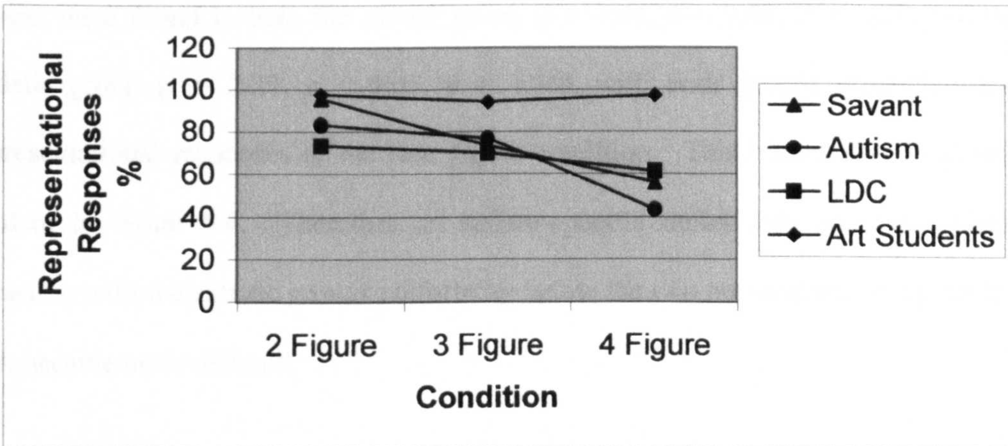
Table 5.2 shows the mean response scores and standard deviations (SD) judged by two out of three independent examiners as being representative of the title they were given by the participants. As there was a significant group effect on the measure of fluency, the fluency independent, *percentage* of scores judged as representational are also illustrated.

Table 5.2: The mean total scores (SD) and percentage scores for representational responses produced in the figural synthesis task

	Total representational scores			**% of representational scores**		
	2 figures	**3 figures**	**4 figures**	**2 figures**	**3 figures**	**4 figures**
Savants	8.11 (3.56)	4.78 (3.83)	3.11 (2.02)	95.3 (11.14)	73.1 (34.53)	55.9 (31.52)
Autistic	6.33 (3.67)	4.22 (1.78)	1.44 (3.46)	83.1 (19.84)	76.6 (32.36)	43.6 (44.01)
LDC	10.33 (6.32)	7.44 (7.70)	4.44 (3.46)	73.1 (25.41)	69.6 (28.15)	61.1 (27.01)
Art Students	13.78 (5.67)	12.67 (4.50)	8.44 (4.36)	97.5 (4.48)	94.0 (6.33)	97.1 (6.73)

Whereas the performance of the savant group appears poor in comparison to the art students and the LDC group when the total number of representational scores are examined for each condition, their performance is more comparable when the percentage scores are considered. As the percentage scores are fluency independent, it is these scores which will be discussed. Here, the performance of the savant group is above that of the LDC group on the two and three figure conditions, but drops sharply on the more elaborate four-figure condition. This relationship is clearly illustrated in figure 5.4. Here again the performance of the two groups with autism can be seen as distinct from the two non-autistic groups. Both the savant group and the autism control group illustrate a visible drop on the four-figure condition in comparison with the LDC and art student groups, whose ability to produce representational responses remains more constant across conditions.

Figure 5.4: The mean percentage scores for representational responses, produced by the four groups on the figural synthesis task.



Again, a mixed ANOVA was used to analyse the percentage scores of these three groups. Main effects were found on condition (F (2,64) = 12.44, $p < 0.01$, $\eta^2 = 0.32$) and group (F (3,32) = 521.01, $p < 0.01$, $\eta^2 = 0.31$). More interesting however was the significant interaction effect (F (6,64) = 2.71, $p < 0.05$, $\eta^2 = 0.34$). In order to investigate this interaction, the performance of each group on the two and four figure conditions was compared. Due to the low N in these studies, the analysis is very low on power, this and the large standard deviations evident on all conditions mean it is preferable to compare *within-group* as there is less of an effect of individual differences (it is important to note however, that despite the low N, the effect size calculations do indicate medium effects which warrant further investigation). Although it is standard practice to make adjustments for multiple comparisons of this type, in this case the low N means that such adjustments may mask any significant differences. For this reason planned t-tests were conducted on the scores, and the significance level kept at 0.05. It is, nevertheless, accepted that this does increase the probability of a type one error. The performance of the art students and the LDC group was not found to differ across the two and four figure conditions (art students: $t = 0.40$, $p = 0.69$, $d = 0.07$; LDC: $t = 1.50$, $p = 0.17$, $d = 0.23$). Significant large effects were found in both the savant group ($t = 4.07$, $p < 0.01$, $d = 1.67$) and the autistic group ($t = 2.20$, $p < 0.05$, $d = 1.16$), with both groups producing less representational responses in the four figure condition. This relationship is clearly evident in figure 5.4. Therefore an autism-specific deficit can be seen on this measure, with the autistic groups performing below the two non-autistic groups as the task became more difficult.

The results of this task were entered into a correlation matrix[2]. Again, no IQ relationships were found in either of the two autistic groups (r below 0.41, $p = 0.28$), however, a significant correlation was found between PIQ and representational ability in the LDC group ($r = 0.69$, $p < 0.05$). Also entered into the correlation were the results obtained on the TTCT. Interestingly a negative correlation was found, in the savant group between the overall percentage of representational responses and the transformed originality sores on the incomplete figures task in the TTCT (Overall originality: $r = -0.68$, $p = < 0.05$; incomplete figures: $r = -0.80$, $p < 0.01$), the opposite relationship was found in the LDC group (incomplete figures: $r = 0.64$; $p < 0.05$; repeated figures: $r = 0.83$, $p < 0.001$; overall originality: $r = 0.87$, $p < 0.001$).

[2] As in all the following statistical analysis reported in this chapter it was the fluency independent, percentage scores that were entered in to the correlation matrix.

Representational responses: Discussion

The discussion of representational performance needs careful consideration. The results indicated that whereas the performance of the LDC group and art student group remained constant across the three conditions, in the two groups with autism the number of representative responses *decreased* as the number of figures *increased.* This result was somewhat of a surprise, although a fluency deficit was expected in the total scores, there is no strong evidence that the representation skills of individuals with autism are poorer than that of their IQ matched controls (Pring & Hermelin, 1993). Indeed, as illustrated by Pring et al. (1995) savant artists were as able as artistically gifted MA to CA matched children at reconstituting an abstract visual puzzle, although they did seem to use a perceptual strategy rather than the semantic strategy adopted by the controls. Also, of each of the three measures to be discussed in this chapter, representational ability appears least related to generative ability. Indeed, it was in part expected that when the overall fluency score was controlled for by using percentage scores, the results here would mirror the meaningful picture puzzle result produced by Pring et al. (1995), whereby the performance of the savant group was still above that of the autistic controls. As is evident, this was not the case.

It is interesting that the performance of the two groups with autism significantly differed on the two and four figure conditions. This result can thus be seen as evidence for the domain-specific nature of savant talent. It is possible that the poor performance of the two groups with autism results from a limited processing capacity. However although there is some evidence for a deficit in working memory (Bennetto, Pennington, & Rogers (1996), this finding is not consistent (Ozonoff, 1997; Russell et al., 1996). Although then, it is unlikely that the cause of this autism-specific deficit lies in a limited processing capacity one can still look toward an executive explanation for this pattern of results. Indeed the findings from this measure are concordant with the points raised by Jarrold (1997) as discussed in chapter 2, regarding a deficit in goal selection or representation. While on the one hand a deficit at this level could result in reduced generativity, poorly specified goals would also result in a lack of adequate response monitoring and hence more errors. It may then be that the savant artists, like the autism control group, were not able to correctly monitor their performance and update rules in their mind. As the stimuli used in this task remained the same, participants needed to constantly readdress and update what they were doing in order to generate continually representational responses.

A high rate of errors was also reported by Turner (1997, 1999), particularly on the design fluency task, whereby it was not necessary to pre-formulate a response before production. In this way the figural synthesis, construction task is similar to the design fluency task and this could explain the difference in the high error score on this task (as evidenced by low representative scores) but not in the TTCT, where the response needs to be fully conceptualised before it is drawn. What is more it was noted that there was an observable difference in the strategies used by the participants with autism and those without. Whereas the LDC and art student groups seemed to produce their responses via trial and error, that is they manually manipulated the shapes in a number of combinations before naming only those which were representational, the two groups with autism tended to name every combination of shapes they produced. It may thus be that the autistic participants in this study were unable to modify their response when it did not resemble a real object and thus simply named an object in order to complete the task. This observation is consistent with a deficit in monitoring incorrect responses and possibly related to poor goal specification.

So why then does the performance of the participants with autism drop so much on the four figure condition? This result might reflect the strategies used to generate responses. A number of participants from all four groups commented that they were producing their responses from stored memory representations. Certainly in the two and three figure conditions, many of the responses were instantly recognisable from everyday life, examples being a house (inverted triangle on square), a man (circle on a cross) and so on. But, as the number of figures increases so the possible internal representations available for the earlier conditions reduce. Participants are, therefore, forced to rely on their generative ability and a deficit arises in the savant group and their autistic controls, as found in previous studies. In this way only the four figure condition can be considered a true measure of generative ability, as participants are forced to generate something completely original, not based on internal memory representations. The performance of the two groups with autism contrasts with that of the LDC group who, despite performing consistently across the three conditions, did produce less responses than the these two groups in the two and three figure conditions, although this difference was not explicitly tested. The strong IQ correlation found within the LDC group indicates that the overall score was brought down by those participants with lower IQ's. It might thus be that where they have appropriate memory schema to use, the groups with autism benefit from their segmented processing style, allowing them to produce more representative responses.

Individuals with autism do not have overriding problems with reconstituting visual representations, using a perceptual strategy (Hermelin et al., 1994; Pring et al.,1995) or perceiving meaning from pictorial stimuli (Ameli et al., 1988; Bryson, 1983). However, they do show semantic difficulties, specifically when extracting meaning from stimuli. This processing style can be seen in a number of studies, as outlined in previous chapters, and fits in with the central coherence account of autism. Here it was suggested that individuals with autism have difficulties in pulling together information for higher level meaning (Frith, 1989; Happé, 1999). The deficit on this figural construction task at *generating meaning* may then be closely linked to the difficulties these individuals have in *extracting meaning*. Thus, while individuals with autism and savants in particular, show a facility for constructive imagery, possibly associated with a segmented visual processing style, this ability does not appear to extend to generating meaningful, visual responses when no prompt is provided.

While the above explanations are consistent with the autism-specific deficits we find on this task, they do not immediately account for the negative relationship that is found within the savant group and originality on the TTCT. In particular it is unclear how the executive deficit hypothesis may account for this finding or how an impairment in the selection and maintenance of goals would result in good performance on one task and poor performance on another. Rather it seems more likely that the type of relationship found in the LDC group would arise, whereby the results of both tasks appear to be related to a general factor likely to be intelligence. The later suggestion that the poor performance of the two groups with autism might be related to a semantic deficit, again does not help us to understand this correlation, after all in both tasks the individuals need to name a perceptual output. If then, a semantic deficit was the cause of the impairment on representational ability, why was the pattern of results not similar to those obtained on the TTCT?

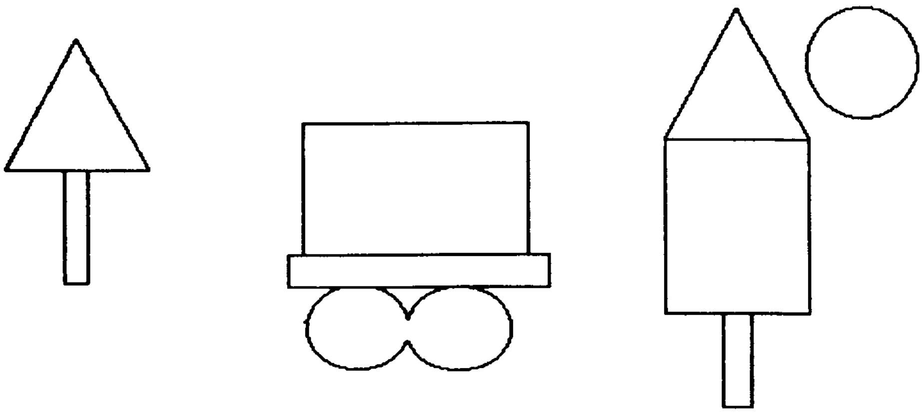
Although this negative relationship cannot be attributed to executive explanation or a central coherence explanation as related to a semantic deficit, the segmentation hypothesis, that individuals with autism have enhanced detail focussed processing, can go part of the way to explaining these results. Firstly, both tasks are perceptually based, that is they require making a whole response out of parts. In the TTCT, in order to produce an original response the individual needs to inhibit the common response that the stimulus figure may elicit initially, this is particularly the case in the incomplete figures task. It was suggested that a perceptual processing style that emphasises parts of visual arrays may facilitate performance on this task, as individuals with a particularly segmented perceptual processing may be able to see the stimuli figure as part of a more original response. Thus it is possible that segmentation is so strong in these individuals, that they found it difficult to generate a global, meaningful response.

5.3.3 Originality: Producing an Unusual yet Meaningful Response

Originality: Scoring

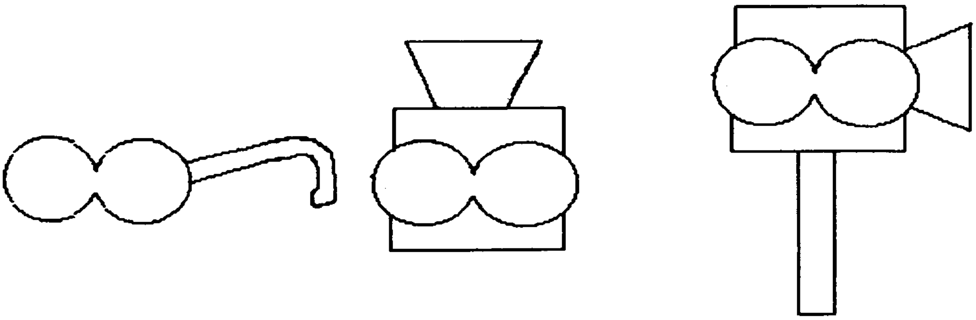
The final area measured on this task was originality. Here again, all responses were scored separately by three independent judges. The judges were instructed to score the responses on how original the *representation* was, not how original the *title* was. Originality was defined as an unusual but meaningful response, thus in this case, a response that was novel yet, still recognisable as a representation of the title it was given. Clearly, often an original title would be accompanied by an original representation and this would be credited as an original response. The reasoning for such guidelines was not to prevent the scoring of original title and response combinations, but to ensure that original representations of common words were recognised. Examples of original responses can be seen in figure 5.5. The distinction between common titles and common responses can be seen in responses *a* and *b*. Response *a* is a common representation of the common response title of train. This response is scored as recognisable but not as original. Response *b* was also titled train, however this is an unusual representation of a train hence it is scored under both representational and originality measures.

Figure 5.5: Examples common responses given by participants in the figural synthesis task.



response a: a tree *response b: a train* *response c: a house with a path*

Figure 5.6: Examples of responses rated at original by at least two out of three examiners in the figural synthesis task.



response a: glasses *response b: train (front view)* *response c: video camera*

Initially it was intended that the originality score would include some measure of frequency, unfortunately, the variety of responses produced by participants meant that this was not possible. It was, however, noted that the less frequent responses were more often scored as original. In scoring originality the judges had already seen the responses when scoring for representation, thus they were familiar with the types of responses produced. This and the randomised presentation meant the any primacy or recency effects were diminished. Again following the methodology adopted by Finke and colleagues, a response was seen as original if scored by two out of three independent judges. As scores have to be recognisable in order to be original the percentage scores were calculated from the representational scores rather than the total fluency scores, this again is in line with previous studies in this area (Anderson & Helstrup, 1993; Finke & Slayton, 1988; Neblett et al., 1989). What is more, in the light of the previous discussion concerning the deficits that affect individuals with autism, calculating the originality percentage using the number of representational responses, rather than the overall fluency score, meant that the originality results could be looked at independently of any other influencing factors.

Originality: Results

For the measure of originality, both the total number of responses scored as original and the percentage of representational responses judged as original are illustrated in table 5.3 along with the standard deviations (SD).

Table 5.3: Mean total originality scores and percentage originality scores (SD) produced on the figural synthesis task

	Total originality scores			**% of representational responses scored as original**		
	2 figures	**3 figures**	**4 figures**	**2 figures**	**3 figures**	**4 figures**
Savants	2.11 (1.54)	1.00 (1.41)	1.66 (1.87)	23.8 (12.03)	17.6 (21.57)	44.4 (44.10)
Autistic	1.11 (1.36)	1.11 (1.26)	0.33 (0.71)	18.1 (19.69)	22.5(23.13)	16.6 (35.63)
LDC	2.22 (2.49)	2.00 (2.74)	1.11 (1.96)	15.2 (15.94)	17.8 (17.78)	13.7 (20.97)
Art Students	3.55 (3.39)	3.00 (1.22)	3.78 (1.85)	21.9 (16.73)	25.1 (10.06)	47.0 (26.36)

The standard deviations on this task are particularly high and likely to be due to a number of individuals in all groups, being unable to produce any original responses. Even when the percentage scores are studied a great deal of variance is still evident in the three mixed intelligence groups. As a result non-parametric analysis was used on the data which is illustrated graphically in figure 5.7

Figure 5.7: The mean percentage scores for the measure of originality in the figural synthesis task

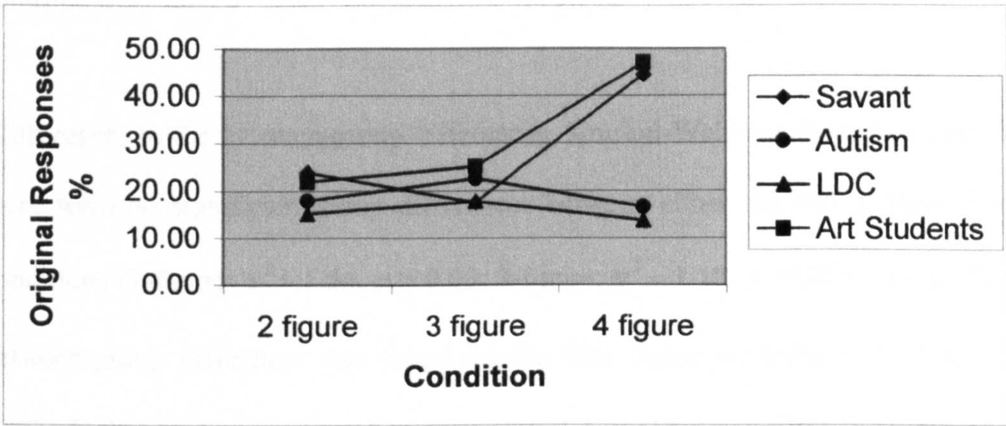


Figure 5.7 shows a clear interaction effect, with the savant and art student groups producing more original responses in the four-figure condition, whereas the performance of the two non-talented groups drops slightly as the task difficulty increases. This is a particularly important result as, unlike on the two previous measures, the performance of the savant group appears to result from their artistic ability rather than their general cognitive level or their diagnosis of autism. The pattern of results produced by the savant artists here clearly reflects that of the art student group, whereas the performance of the autistic controls mirrors that produced by the LDC group.

As parametric tests were not possible on the originality data set due to the large within- group variance, the Wilcoxon test for within-pair differences was used to test any differences between the two and four figure conditions within the four groups. The art student group were found to produce significantly more original responses in the four figure condition ($Z = -2.38$, $p < 0.05$), there was a strong trend toward the savant group producing significantly more responses on the more elaborate four figure condition, although this narrowly missed significance ($Z = -1.64$, $p = 0.09$). The difference in the two non-talented groups failed to meet significance (autistic controls: $Z = -0.21, p = 0.83$; LDC: $Z = -0.73, p = 0.47$).

With regard to the between-group differences, Kruskal-Wallis analysis indicated that there were no significant group differences between either the two or three figure conditions (2-figure: $\chi^2 = 1.54, p > 0.05$; 3-figure: $\chi^2 = 1.18, p > 0.05$). A significant between-group difference was found on the four figure condition ($\chi^2 = 7.88$, $p < 0.05$), further analysis indicated that the savant group did not differ from any of the control groups (autistic controls, $W = 24.0, p = 0.28$; art students, $W = 38.0, p = 0.86$) although it did approach significance in the LDC group, before any adjustments were made (LDC group, $W = 24.0$, $p = 0.09$). While the art student group did not differ significantly from the savant group on this condition they did produce significantly more original responses than the autistic control group and the LDC group (Autistic control group, $W = 13.0, p < 0.01$; LDC, $W = 13.0, p < 0.01$). Despite the limitations incurred by using non-parametric analysis on the originality scores it is possible to see an interesting interaction effect, with the two talented groups showing a tendency towards producing more original responses in the four figure condition compared to the two non-talented groups. While the savant group did not perform above the level of their IQ matched controls, unlike these controls neither did they differ from the art student group.

Again the results of this test were entered into a correlation matrix, which also included the results obtained on the TTCT. Interestingly in contrast to all of the results so far this test yielded an IQ relationship within the savant group. Here a negative relationship was found between VIQ and the overall percentage of representative responses scored as original (r_s = -0.68, $p < 0.05$). This was the only correlation found regarding IQ and originality (r_s below 0.47, p = 0.19).

Originality: Discussion

The results for the dimension of originality are the most interesting of this study. Here the performance of the savant group produces a pattern of data identical to that evident in the art student group. Furthermore, as the savants did not differ from the art students on the crucial four figure condition, compared to the non-talented control groups, it can be concluded that the artistic ability of the savants, compensated for the poor performance that would be expected from of their general level of cognitive functioning. What is more, the savant result is likely to have been adversely affected by the failure of several participants in this group to produce any responses that were seen as original. Although it has been argued that there is no relationship between IQ and creativity in the normal population (see chapters 2 and 4), the results of this study do indicate that a certain level of intelligence is necessary in order to produce responses that are deemed original. This finding has already been discussed in relation to the originality results gained on the TTCT and the results of this task appear to support this view. Again no IQ and performance relationships were indicated in the autism control group, illustrating that other factors determine performance on this task. The finding that the only significant correlation was the negative relationship between the savant group regarding VIQ and originality adds further evidence to the suggestion that creative ability does not increase with IQ.

It is interesting that while an autism-specific deficit was evident on the measures of fluency and representational fluency, performance on originality appears to result from their artistic ability. The savants' tendency towards producing more original responses in the four figure condition is also in line with the elaboration results of the TTCT. It may thus be that it is only when these individuals are able to be more elaborate, with the increasing number of shapes, that their true ability becomes apparent. One possibility for the spared performance of the savant group on this task might be due to their segmented processing style. It may be that as a result of this they are more able to produce meaningful responses out of abstract parts, particularly as a number of studies have indicated that savant artists have richer internal picture lexicons (Hermelin et al., 1994; O'Connor & Hermelin, 1987a). Thus, as discussed with regard to representational fluency, it could be that when the savants do not have stored memory representations to fall back on they are forced to generate responses themselves. A processing style that focuses on parts might then prove beneficial, as it will enable the individual to incorporate the stimulus shapes in more inventive ways. Similarly, the skills measured on this task can be seen to be akin to those involved with the block design, in that again a global whole must be made out of abstract parts. However, this suggestion does not fit easily with the semantic deficit account suggested in the discussion of representational ability.

It is interesting that despite the earlier arguments concerning the domain-specific nature of savant talent, we should find a positive result on originality on this task but not in the TTCT. This could in part be due to the two tests defining and measuring originality in different ways. In the TTCT originality was scored totally in terms of frequency; while based on a drawn response it was the title of the response that was compared to a list of standardised norms. In this way the task was confounded by verbal ability and no accommodations were made for unusual representations of common titles. As such originality was based purely on the verbal title given to each response. On this figural construction task, although not using a set of standardised scores with which to compare responses, the example in figures 5.5 and 5.6 illustrates the perceptual emphasis placed on the scoring of this task, as here the same title (train) is scored as a common response or an unusual response, depending on the visual representation. This figural synthesis task can thus be seen as a purer measure of perceptual originality.

Clearly, the test used here is not solely a test of perceptual ability and, like all tasks requiring a named response, it does have a strong verbal, semantic element. This point can be illustrated by the observations of one savant, TM, who despite producing a variety of easily recognisable responses (e.g. ice cream) was unable to think up the correct title and thus could not be credited. It is, unfortunately, very difficult to overcome such inherent, verbal constraints in tasks such as this, as they all too commonly involve a meaningful element. Yet, as the train example shows, the emphasis in this task was based on perceptual ability as far as possible. Indeed it may have been the emphasis on the verbal title that obscured any differences on the TTCT. The ingrained verbal aspect of these tasks puts individuals with autism at a disadvantage due to their poorer verbal ability, hence, it is even more surprising that the savant group show an ability related result on this task.

This final point also relates to the negative correlation that was found between VIQ and originality in the savant group. Initially this result seems a confusing one, after all when one considers that even on a perceptual task such as this, the response title is a verbal one, it would be expected that those with lower VIQ would be less able to name their responses. As we have mentioned, even though the scoring of this task was perceptually based, often the original responses produced would be the more unusual titles. Also, if individuals with poorer vocabularies, such as the savant TM in the example given above, were unable to name a response they would receive no credit. Why then do we find, in the savant group only, this negative relationship between VIQ and originality? Again we can turn to the previous explanation regarding perceptual ability, in this task scoring was based upon how visually unusual the response was, not how unusual a title was. Although, more often, the most unusual responses were given the rarer response titles, it needs to be recognised that these titles were not particularly unusual given the wider context, and within the vocabularies of even individuals with lower VIQ's (for example, video camera, traffic lights being examples of the more difficult titles). It could be then, that the individuals with lower vocabularies have a more perceptually based processing style, and thus find it easier to generate original, perceptual responses as they are possibly less confined by semantic associations.

5.4 GENERAL DISCUSSION

The aim of this figural construction task was to measure creative and generative ability on a task outside of the domain of drawing. On the measures of fluency and representational ability, the performance of the savant artists was determined by their autism. For total fluency this result is in line with the previous results, outlined in chapter 2, highlighting an autistic deficit in generative ability (Scott & Baron-Cohen, 1996; Jarrold, 1997; Turner, 1997, 1999). The savant group also performed poorly on the representational measure, showing a drop in performance as the number of figures increased, compared to the consistent performance found in the groups without autism. The representational fluency result stands in contrast to those gained on the originality measure where the savants' performance was comparable to that of the art student group, thus performance on this measure can be seen to be related to artistic ability.

The results gained on the fluency measure can clearly be attributed to the generative deficits and impaired activation, associated with the savant artists' diagnoses of autism. What is interesting here is that despite the generative nature of their ability, the savant artists were unable to generalise this ability into a test that took place outside of direct drawing, despite the task still being in the visual-motor domain. Perhaps one could question the usefulness of measuring creative ability outside of drawing in this instance, however, it is worth keeping in mind that visual-motor abilities are necessary for many creative activities relating to art, although not requiring a response that is drawn or painted, for instance sculpture. Further to this the results of the fluency measure on the TTCT were inconclusive due to the closed nature of the test, hence it may be that savant artists do show generative deficits regardless of the domain of response.

The cause of the poor performance of the groups with autism on the representational measure, although related to their diagnosis, was less clear cut. Here two explanations were proposed to account for the pattern of results, each related to current theoretical accounts of autism. The first was based on the premise that individuals with autism have executive deficits, specifically in monitoring their behaviour and updating goal states, as argued by Jarrold (1997) and Turner (1999). Specifically it was suggested that poor goal specification may lead to individuals with autism being unable to update rules in their mind, this being of particular importance in a task requiring the reuse of the same figures and the rejection of unsuitable combinations. It was suggested that this difference was particularly evident on the four figure condition as it was here that individuals were required to go beyond stored memory representations to be truly generative.

While the executive approach provides an adequate explanation for the results gained on this task, an alternative account was proposed with a basis in the central coherence theory proposed by Frith (1989) and Happé (1999) amongst others. While the executive account of the poor performance of the two groups with autism on the representational fluency measure, focuses on a monitoring deficit, the central coherence explanation needs further clarification. Specifically here the question can be raised as to whether the results obtained on this measure are due to a semantic deficit or an idiosyncratic perceptual processing style. Initially it was suggested that the poor representational fluency exhibited by two groups with autism, was a result of their inability to generate meaningful information from abstract stimuli. It was suggested that this result was similar to that found by Shah and Frith (1983) in which individuals with autism were found to be unaffected by visual meaning when identifying a shape within a picture. However, this is not a consistent finding (Brian & Bryson, 1996) and there is still some debate about the underlying causes of this finding, be it semantic independence or detail based processing, as discussed in chapter 2.

It may be then, that the poor performance of the savant and the autism control group, is a factor of this segmented processing style. Indeed it was suggested in the discussion of representation fluency that the responses produced by the individuals in these two groups were so detailed or focussed that they failed to be recognisable to the people scoring them, who presumably exhibit normal, global perception. Perhaps, had the overall, productive language skills of the individuals in this group been better, then it may have been possible to get them to explain how their responses resembled, in their eyes, the title they provided it with.

It is this later discussion which is more compliant with the results obtained on the originality measure, hence the central coherence account has the propensity to explain both the deficits and the assets reported on this task. Here it was suggested that the superior performance of the savant group was facilitated by their ability to incorporate the stimulus figures in more inventive ways. Clearly this is in contrast with the previously proposed semantic deficit explanation and the extent to which each level of processing influences performance needs further investigation. A further issue to discuss regarding the idea that a segmented processing style might facilitate performance on the originality measure, relates to why this effect is only found in the savant group, when it is supposed to be a universal processing style in autism. One explanation that can be put forward to account for this discrepancy is linked to the work of Pring et al. (1995) in which it was found that savant artists have even better segmentation skills than their autistic counterparts.

Finally the results of this study provide further support for the view that generative ability and creative ability are two very different concepts, a point raised in chapter 4.

Generativity relates to the *total number of responses* produced and the results of this task indicate, in line with previous results outlined in chapter 2 (see Turner, 1999), that individuals with autism do show a deficit in this regard. Despite the spontaneous nature of savant drawn output, in tests this generativity is not evident. Creativity on the other hand is concerned with the *quality of the response*, how novel it is. In this respect the talent of the savant group allows them to go beyond the constraints associated with their general cognitive function and thus to produce original responses. This is possibly related to an unusual perceptual style, which places emphasis on parts. This perceptual style may explain the lack of difference between the autism control and LDC groups in that it allowed the non-talented participants with autism to overcome the creative deficits they display on tasks with a verbal or behavioural basis. This difference is likely to be due to the task type, as has been discussed every effort was made in this task to measure *perceptual creativity* and to distance the scoring from verbal constraints. Previous studies have all tended to measure creative ability using tasks requiring complex verbal responses (for example see Scott & Baron-Cohen, 1996; Turner 1999). Considering the semantic deficits associated with autism, such tasks do not provide a true picture of creative ability in autism.

To conclude, the results from this figural synthesis task provide an interesting pattern of results and again illustrate the distinction between generativity and creativity. Whereas the performance of the savant artists on the measures of fluency and representational ability are clearly dependent on their diagnosis of autism, performance on the originality measure was related to their artistic ability. In terms of the processes underlying this performance it was suggested that the poor generative ability of the savant artists on this measure was a result of the pervasive generativity deficits associated with their autism. This supports previous findings which have located the root of this deficit as executive in nature. An executive explanation was also proposed to account for the lower representational fluency scores of the savant group, specifically regarding the ability to effectively monitor behaviour and update rules. It was suggested that the poor performance produced by the savants on this measure resulted from their inability to select appropriate goals. An alternative explanation regarding representational ability was suggested relating to central coherence, although it was unclear as to whether this was a result of a semantic deficit or a segmented visual processing style. One strength of the central coherence account is that is can also explain the superior performance of the savant artists on the originality measure, in that an unusual perceptual style might result in original responses when scored on a visual basis. Clearly the results of this task have raised a number of questions as to the processes underlying generative and creative performance and the next two chapters seek to address such questions. Firstly, the nature of central coherence, be it semantic or perceptual, is investigated. This is followed by a study of the executive abilities of the savant group, again relating to both domain-specific and domain-general factors.

Chapter 6:

Visual Segmentation or Semantic Independence

6.1 INTRODUCTION

The unusual processing style evident in individuals with autism is well documented. Early studies report the superiority of autistic children at the visuo-spatial sub-tests of IQ batteries such as the WISC, in particular performance on the block design and object assembly sub-tests (Bartak, Rutter & Cox, 1975; Lockyer & Rutter, 1970). Further to this Hermelin & O'Connor (1967, 1970) found that not only did children with autism fail to show a benefit from meaningful stimuli in a rote memory task, but, that they also displayed an overall preference for processing material spatially. Such a processing style was investigated in more detail by Frith and colleagues throughout the 1980's and 90's (Frith & Snowling, 1983; Shah & Frith, 1983, 1993). From these studies Frith, and later with Happé (Happé, 1999; Frith, 1989; Frith & Happé, 1994) generated the central coherence account of autism, with particular relevance to the non-triad features of the disorder. Discussed in more detail in chapter 1, the central coherence account postulates that the strong cohesive force that pulls together information in order to construct higher level meaning, is not present (or at least only present to a lesser extent) in individuals with autism. Instead, the focus of perception is on detail, at the expense of the overall gist or global picture.

Evidence for this hypothesis can be found in a number of empirical investigations. On a semantic level, several studies (Frith & Snowling, 1983; Happé, 1997) found that children with autism failed to use context in a homograph, reading task. On a more perceptual level, Happé (1996) found that children with autism were less likely to succumb to visual illusion, possibly as a result of their failure to perceive the overall context of the image. However, Ropar and Mitchell (1999, 2001) failed to find any support for this finding. The failure of such children to benefit from a canonical pattern presentation in a dot counting task (Jarrold & Russell, 1997) can also be seen as evidence of a locally focussed perceptual style. One test in which children with autism perform consistently well is on the block design and a number of studies have reported the performance of participants with autism is above that of their IQ matched controls on this measure (Happé,1994a; Ropar & Mitchell, 2001). Shah and Frith (1993) concluded that this superiority was a result of the autistic participants' segmentation abilities as they showed no improvement, compared to controls, on a pre-segmented version of the task. Interestingly, this segmentation ability does not appear to be confined to visually presented stimuli and has also been found to distinguish the performance of autistic participants on musical tasks (Heaton, Hermelin & Pring, 1998).

In a recent paper Happé (1999) provided a comprehensive review of the current scientific reasoning behind the central coherence hypothesis. Like Frith earlier, Happé defined central coherence as a cognitive style, evident in all individuals to a lesser or stronger extent. Further to this Happé distinguished between three levels of this detail based processing; perceptual coherence, visuo-spatial construction coherence and finally, verbal-semantic coherence. While not refuting Happé's trio, a simpler distinction has been made throughout this thesis, specifically concerning visual perception. This dichotomy concerns the difference between explanations that look to superior disembedding or segmentation abilities and those that have focussed on a freedom from contextual or semantic constraints. Indeed, this distinction can be seen in many definitions of central coherence, which state that this processing style is characterised by "*a tendency to process local vs. global information, and a failure to process incoming stimuli in context*" (Happé, 1994b, pp 873).

This perceptual versus semantic distinction can be seen in a number of studies. In Jarrold and Russell's (1997) dot counting task, the slower counting scores of the children with autism were seen to be due to their failure to use the canonical pattern, possibly as a result of their failure to perceive the global whole. Likewise the superior performance commonly found on the block design task can be seen to be due to greater *visual* segmentation skills (Shah & Frith, 1993). One test in which the distinction between semantic and perceptual processing styles is very clear, however, is on the EFT. Indeed, when Shah and Frith (1983) first reported their finding they proposed that the superiority of autistic children on this task resulted from the fact that they were unhindered by the overall meaningful context, within which the simple figure was embedded. Brian and Bryson (1996) investigated the factors underlying Shah and Frith's finding, specifically looking at whether superior performance was due to perceptual segmentation or contextual independence. Interestingly, in contrast to the previously outlined finding, they found no group differences on equivalent, meaningful or abstract conditions, concluding that Shah and Frith's finding was a result of developmental phenomenon rather than a true islet of ability in autism. Their finding supports a previous result reported by Ozonoff et al (1991), in which no autism superiority was found on either the EFT or the block design.

Despite the negative findings outlined above, several recent studies have reported similar results to those reported by Shah and Frith (1983). Jolliffe and Baron-Cohen

(1997) found that high-functioning adults with autism were significantly faster on the adult version of the EFT and, as the groups were also matched closely on age, the results could not be explained in terms of developmental processes. They argued that Brian and Bryson's (1996) failure to find this effect was due, in part, to the stringent statistical processes employed. Further to this they highlighted differences in participant characteristics, with Brian and Bryson using a group with a range of pervasive developmental disorders rather than a group with a strict diagnosis of autism or Asperger's syndrome. Similarly, Ropar and Mitchell (2001) reported that children with both autism and Asperger's syndrome were faster than mental age and IQ matched control groups, however, the group with autism were older than the other groups in the study, hence again the results could be due to developmental processes rather than being autism-specific.

While the results of the two studies outlined above do provide further support for the hypothesis that individuals with autism are better able at visual disembedding, they do not support the idea that autism is associated with "*less capture by meaning*". This is because both studies made use of the standard adult EFT, which presents participants with abstract images rather than the meaningful pictures utilised in the children's version. For this reason it would appear that this processing style is perceptual in nature rather than the outcome of semantic or contextual freedom. However, in relation to this last point it is necessary here to bring attention to an observation made by Jolliffe and Baron-Cohen (1997). In their task, individuals were asked to describe the complex figure before beginning their attempt to identify the hidden figure. The authors commented that individuals in the normal control group more often than not, described this figure as a meaningful image, for example a staircase. This self applied context and general human tendency to impose meaning, may thus have contributed to their slower scores, in a similar way to that suggested by Shah and Frith (1983).

In her 1999 review, Happé stated that central coherence was a perceptual style, evident in the whole population to a greater or lesser extent. One group of individuals in which this processing style appears to be particularly strong, is in those gifted in the visual arts. What is more, a number of studies have found a that children or young adults, gifted at art, are faster than non-gifted controls on the EFT or similar tasks (Getzels & Csikszentmihalyi, 1976; Hermelin & O'Connor, 1986b; O'Connor & Hermelin, 1983; Ryder, Pring & Hermelin, unpublished manuscript). It follows thus, that if this processing style is associated with both autism and artistic ability, it should be very strong in autistic savants gifted at art. As yet, the performance of artistic savants on a disembedding task such as the EFT has not been tested, however, as already discussed there is a growing body of evidence which indicates that their segmentation skills are above that found in the non-talented individuals with autism or the learning disabled population (O'Connor & Hermelin, 1987a), and in some cases above those found in the population as a whole (Hermelin et al., 1994).

The question of whether this processing style is perceptual or semantic is also relevant in the study of the artistic savant. Although this question has yet to be directly tested it was addressed to some extent in Pring et al.'s (1995) paper. Discussed in more detail in chapter 1, they found that on the abstract block design task, the two artistically gifted groups performed equally to the autism controls and above the non-gifted, mental age matched controls, this pattern was reversed in the meaningful picture condition. The authors interpreted this finding in terms of the strategies used by each of the groups to aid completion. Specifically they argued that whereas the two groups without autism were able to use semantic information processing in the meaningful task, the two groups with autism tended to rely mainly on perceptual processes. That the participants with autism, seemed not to utilise the semantic information presented to them, indicates semantic independence may play an important role on performance on tasks such as the block design and EFT.

Before the aims of the present study described in this chapter are outlined, it is of interest to note that several studies have identified a relationship between performance on tasks such as the EFT and creativity, especially the type of creativity measured in divergent thinking tasks (Chada, 1985, Noppe-Lloyd, 1977). Interestingly the Hidden Figures test (Cattell, 1956), a task very similar to the EFT, was incorporated into many early creativity batteries (Guildford, 1950, 1957). One explanation for this association was proposed by Ryder et al. (unpublished manuscript), who suggest that performance on both types of task, may be facilitated by contextual independence. They point out that good performance on many measures of creativity is reliant on the individual achieving freedom from common, semantic associations. For example, on the object uses test, higher scores are obtained by individuals who are able to isolate the perceptual qualities of the object and consider how such qualities can be used for a different purpose. They suggested that the finding that art students score highly on such tasks (Hartley & Greggs, 1997, Lloyd-Bostock, 1979, Ryder et al., unpublished manuscript) is a manifestation of this overall processing style. Interestingly, this effect seems to occur spontaneously or unconsciously in autism as illustrated by an example given by Happé (1994b). Here, she describes a child with autism who, when asked to label the objects in a toy bedroom, named a pillow as a piece of ravioli, purely based on the physical attributes without recognition of the overall context of the bedroom

Aims

The following studies sought to investigate firstly, the hypothesis that a perceptual style that favours segmentation is associated with both autism and artistic ability. This being the case, it was expected that the performance of the savant artists would reflect earlier studies and be up to the level of a group of gifted, non-autistic art students. Further to this, it was hypothesised that both groups with autism would produce superior scores to the LDC group. A second aim of this investigation was to highlight the nature of this perceptual style, specifically whether superior performance arose as a result of a visual segmentation or semantic, contextual independence.

To examine these hypotheses, modified forms of both the meaningful and abstract version of the EFT were presented to participants. If, as suggested, the groups with autism and those gifted at art, experienced a contextual independence a significant interaction would occur. This interaction would arise as a result of these participants experiencing less distraction from the overall *semantic context* of the meaningful condition compared to the non-autistic or non-talented groups. If, on the other hand this processing style is primarily *perceptual*, then the autistic or gifted groups would simply produce significantly superior performance on both conditions, with no interaction effects. In order to investigate this hypothesis fully, the inclusion of a fifth group of non-gifted students was necessary to assess the influence of artistic ability. Finally, to investigate whether any superior result is due to a superior visual disembedding ability or any other factors, a fragmented version of the EFT was generated to correspond to the segmented block design used by Shah and Frith (1993).

Experiment 3: The Embedded Figures Test

6.2 METHOD

6.2.1 Participants.

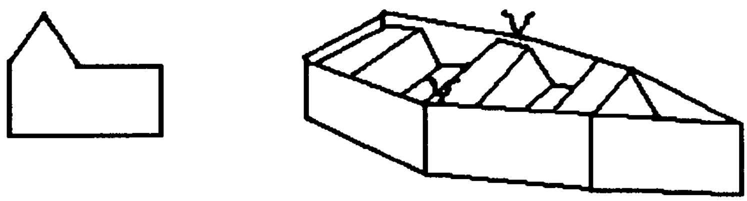
Five groups of participants took part in this study; the savant artists, the autism control group, the LDC group, the art students and the normal students. Full details of each of these groups and the justification behind their inclusion is presented in chapter 3.

6.2.2 Materials

Meaningful condition

Stimuli were adapted from the children's EFT (Witkin et al., 1971) for the meaningful condition, and the standard adult EFT (Witkin et al., 1971) for the abstract and fragmented conditions. The stimuli for the meaningful pictures task were picked depending on how closely they resembled the real object they was supposed to. The children's EFT involves two hidden figures referred in the manual as tent and house (an example of house is shown in figure 6.1). 20 psychology undergraduates rated each complex figure on a 5 point likert scale, depending how closely each resembled the real object. The four meaningful pictures with the highest mean score for resemblance for the 'house' figure were chosen (rowing boat, digger, present, robot) along with the five best resemblance pictures for the tent hidden figure (television, pram, ship, jug). An example of one of the meaningful figures (rowing boat) and the hidden figure (house shape) are illustrated in figure 6.1.

Figure 6.1: Example of stimuli used in the meaningful condition of the EFT



Several other modifications were made to the original stimuli, in order to render it useful for this task. In the original form the figures were considerably larger and coloured. Pilot testing indicated that this resulted in the task being very easy for all participants, hence it is likely that the results would simply have been indicative of speed of processing, rather than discriminating amongst processing styles. What is more it was necessary to attempt to make the meaningful condition comparable to the more difficult, abstract, adult version. For these reasons the overall size of the images was reduced by 75% and the colours removed. The black and white images were then displayed on laminated white cards of 90 mm x 120mm.

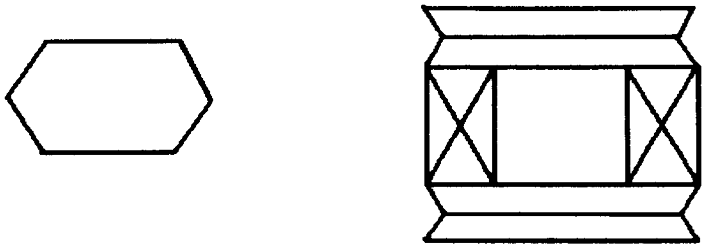
Abstract condition

The stimuli for the abstract condition were taken from the standard adult EFT (Witkin et al., 1971). The adult EFT consists of two equivalent versions (form A and form B), that do not differ in terms of difficulty. Of the total 24 complex figures in the two forms, there were 8 simple figures. In keeping with the stimuli chosen for the children's version, two hidden figures were picked for the abstract condition, figures A and G[3]. In order for performance on the meaningful and abstract conditions to be comparable it was necessary to modify the original stimuli in terms of size and overall difficulty. Firstly, the colours were removed from the complex figures and the size of each figure increased by 75%, which made them comparable in overall size to the meaningful images.

In order to equalise the overall complexity of each image, each of the original abstract figures were simplified by reducing the number of lines involved, without altering the hidden figure. 15 undergraduate art students and 15 undergraduate psychology students with no artistic background, were then asked to rate each image in terms of the overall complexity of each figure. Following this adjustments were made by increasing or reducing the amount of lines in the abstract condition, so that the two conditions were comparable. The nine meaningful and abstract figures were rated by the same group, depending on how deeply embedded the hidden figure was. This was done by presenting these participants with a card on which the hidden figure was illustrated adjacent to the complex figure. This was presented to participants for five seconds, after which they were shown the true location of the hidden shape, and asked to rate, on a one to five scale, how well hidden the simple figure was. Again following analysis the figures were amended to bring the two conditions in line. An example of one of the abstract figures and the hidden shape is shown in figure 6.2.

[3] Unfortunately, for hidden figure G, there were only two complex figures available. In order for the abstract condition to be comparable to the meaningful condition, in terms of the number of times each hidden figure was used, it was necessary to have three hidden figures. For this reason the hidden figure

Figure 6.2: Example of stimuli presented in the abstract condition of the EFT

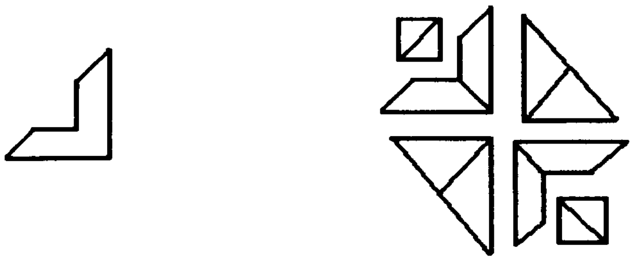


The fragmented condition

Stimuli for the fragmented condition were also modified from the standard adult EFT (Witkin et al., 1971). Here the simple figures of C and E were used. In order to allow the overall image to be broken up or fragmented effectively, the hidden figure of E was simplified into a square rather than the original 'cube' form. The aim of this condition was to assess the participants' ability to recognise a simple figure out of the overall embedded context. Again the original figures were simplified, following the same guidelines outlined above and presented on laminated cards. As this was a simple shape discrimination task, it was necessary for the overall image to be broken up into several distinct parts, as illustrated in figure 6.3.

D, which was very similar in appearance to figure G was modified and incorporated into complex

Figure 6.3: Example of the stimuli presented in the fragmented condition of the EFT



The hidden figures

The hidden figures were presented as black outlines on separate laminated cards 80mm x 80 mm.

6.2.3 Procedure

All participants were tested individually in a quiet room at their centre, college or home. Before testing began participants were presented with each of the meaningful condition items, and asked to name what each picture was. This was to ensure that all items in this condition were indeed meaningful and could be identified by the participants. The naming condition was presented before the full requirements of the task were made known to participants, hence is unlikely to have had any confounding effect on results. All participants were able to name each figure.

Training condition

A training condition was then presented to ascertain that all participants fully understood the instructions. The training session consisted of three extra items, one from each of the conditions, presented in a fixed order beginning with the fragmented figure, followed by the meaningful condition and finally the abstract condition. The

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figure 16.

training stimuli for the meaningful condition was taken from the children's EFT, however, a different hidden figure was used for the abstract and meaningful conditions taken from the adult EFT. A felt tip pen was given to the participants to draw their responses onto the laminated cards, which could easily be wiped off following any mistakes or after the correct response had been identified. Participants were given the following instructions; *"I'm going to show you some pictures, some will be just patterns and others will be pictures of real things. I'm also going to show you a picture of a small shape, I want you to see if you can find the shape in the bigger picture, shall we practice? This is the hidden shape, now this shape is hidden in this picture, can you find it? I want you to draw around the shape if you can find it, can you find it?"* On the practice items, no time restriction was included. All participants were able to identify the hidden figure.

<u>The Test Items</u>

The order of presentation was randomised amongst participants, with all three conditions interspersed within the same testing session. Participants were then given the following instructions; *"that was very good, now we are going to do some more. I will show you a small shape and I want you to find it in the bigger picture. Some pictures will be quite hard, but the shape is always there and always the right way up. When you have found the shape tell me and then I want you to draw around it with the pen. If it is not right, we can wipe it off with a tissue. Please work as quickly as you can."* The hidden figure was then placed in front of participants and timing began on presentation of the complex figure. Following the instructions in the manual a note of the time was made when participants informed the examiner that they had identified the shape. If the response was incorrect participants were informed and their answer removed from the laminated card. The time was only recorded when the correct response had been identified. An upper time limit of 180 seconds was imposed for each figure and this was the time recorded for any participants who failed to find the hidden figure.

6.3 RESULTS

Although the items were presented together, the main aim of this study was to investigate the relationship between the abstract and meaningful conditions, for this reason, the results of these two conditions are presented first. In all conditions the median scores were calculated for each participant, this was due to several participants in each of the groups having particular difficulty with one or more items, resulting in several outliers which would have obscured such participants' overall ability on this task

Meaningful vs. abstract

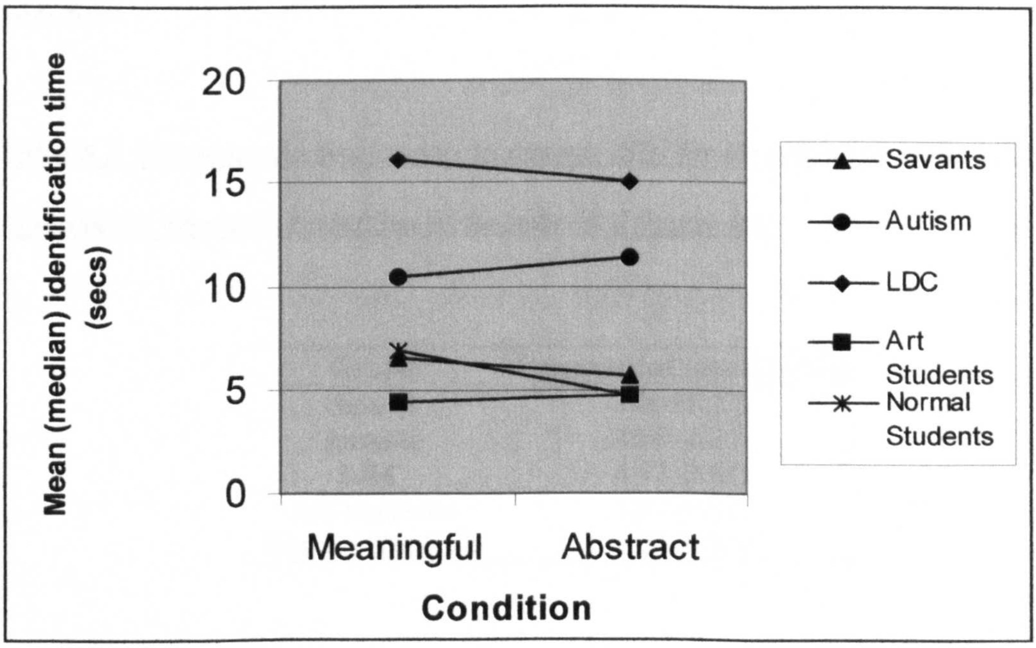
As errors were allowed to be corrected, they contributed to the overall time taken to identify the hidden figure. The mean completion times in seconds for the five groups, together with the standard deviations (SD) are shown in Table 6.1.

Table 6.1: Mean (median) time in seconds (SD) taken to identify the embedded figure on the meaningful and abstract conditions.

	Meaningful Condition	Abstract Condition
Savants	5.70 (3.58)	6.54 (5.37)
Autistic	11.29 (8.91)	10.42 (6.82)
LDC	15.03 (7.77)	16.14 (8.32)
Art Students	4.71 (2.67)	4.43 (2.69)
Normal Students	4.74 (1.29)	6.92 (2.78)

These results are depicted visually in figure 6.4. Contrary to the contextual independence hypothesis the performance of all groups is relatively constant across the two conditions, with no indication of an significant interaction effect. There does appear to be a significant group effect, with the savant artists performing comparably to the both the gifted art students and the non-gifted group.

Figure 6.4: The mean times taken to identify the hidden figure in the meaningful and abstract conditions in the embedded figures test.



These observations are supported by the results of a mixed 2 x 5 ANOVA, with condition (meaningful and abstract) as the within-groups comparison, and group as the between-participants variable[4]. A main effect of group was indicated ($F_{(4, 40)} = 6.91, p < 0.01, \eta^2 = 0.41$). Both the main effect of condition and the interaction were

[4] As was pointed out in the method section, although every attempt was made to equalise the two conditions, it is accepted that they may not be of equivalent difficulty however, the consistency

non-significant ($F_{(1,40)} = 0,70$, $p = 0.41$, $\eta^2 = 0.02$; $F_{(4,40)} = 0.65$, $p = 0.63$, $\eta^2 = 0.06$). A Post hoc bonferroni revealed that the LDC group were significantly slower than the savant artists and the two groups of student groups at identifying the hidden figure ($p < 0.01$).

Fragmented stimuli results

Again as errors were allowed to be corrected, the overall completion times are reported for the five groups on the fragmented condition, these scores are shown in table 6.2 .

Table 6.2: The mean (median) scores in seconds (SD) for identification of the hidden figure in the fragmented condition of the embedded figures test

Group	Fragmented identification
Savant	2.06 (1.22)
Autistic	4.56 (4.20)
LDC	4.97 (3.68)
Art Students	1.37 (0.51)
Normal Students	2.03 (0.95)

Again the it appears that the performance of the savant group is more akin to that of the two normal groups. A one-way ANOVA indicates that there was a significant group difference ($F_{(4,40)} = 3.56$, $p < 0.01$, $\eta^2 = 0.26$), post hoc bonferroni indicated that this was due to the superior performance of the art student comparative to the LDC group ($p < 0.05$).

between participants in all five groups indicates that the two conditions were indeed very similar in terms of the embedded nature of the hidden shape and the complexity of the overall images.

6.4 DISCUSSION

The aim of this chapter was to investigate the nature of visual processing in a group of savant artists with autism. Specifically performance was measured using a variation of the adult and children's embedded figures test, a test which had so far never been administered to savant artists. The use of an abstract and meaningful condition meant that it was possible to directly investigate if any superior performance arose as a result of perceptual or semantic processes. As an attempt was made to equalise the difficulty of the two conditions it is important to note that this should, in general, produce similar recognition times on the two tests. What was specifically being tested here was the *interaction* between the groups; those with contextual independence would thus show a greater advantage on the meaningful condition, as they would not be slowed down by the context of the image. Dealing first with the results obtained from the abstract and meaningful conditions; although the performance of the savant group was up to the level of both the art and normal students and above the LDC group, it did not differ significantly from the autism control group. This, and the equal performance of the two student groups, is discrepant with the hypothesis that performance on the EFT is related to artistic ability. What is more, the failure to find a significant difference between the autism control group and the LDC group, also fails to support the argument that weak central coherence is autism-specific. Nevertheless, that the savant artists did still produce faster responses than the LDC group, indicates that it is possible that a combination of autism and artistic ability facilitated performance on this task. Null results are unfortunately problematic with respect to drawing inferences and it was most disappointing to find that the picture was not really clarified.

More interesting perhaps, is the exploration of nature of this perceptual style and the within-group comparisons on which this investigation rests. In the introduction the question was raised as to whether this processing style was perceptual or semantic, the results of this investigation found no advantage in any of the groups, for the meaningful condition over the abstract condition. Indeed, performance was consistent within all groups on the two tasks. The lack of an advantage arising from contextual independence in the groups with autism (or indeed the two artistically gifted groups) indicates that the primary process governing performance in all groups was a perceptual one. Thus it is possible to conclude that the superior performance of the savant group, comparative to the LDC group, results not from semantic independence but perceptual segmentation. This is supported by the results of the fragmented condition when the performance of the LDC group equalled that of the savant group, reflecting the results obtained by Shah and Frith (1993) on their pre-segmented block design task.

What is also interesting is that this study did not uncover an art related ability, despite the previous support for this effect outlined in the introduction. Here no significant difference emerged between the savant artists and the autism control group, nor the art students and the normal students. In the case of the two student groups, this may reflect the comparative ease with which all participants in these two groups completed the task, in particular as the adult version was modified in terms of difficulty in order to make it presentable to individuals of a range of lower IQ's. Thus it may have been that the task was not difficult enough to discriminate between participants of normal intelligence. With regard to the savant group, however, the result is more perplexing, especially considering a number of tasks have highlighted superior segmentation ability in this group. This superior performance has mainly been found on tasks such as the block design (Pring, et al., 1995), or tasks in which participants have to re-assemble a meaningful picture from parts (Hermelin et al., 1994; O'Connor & Hermelin, 1987a) and although these tasks do not measure disembedding ability previous studies have highlighted a strong relationship between performance on these two different tests (Jarrold, Butler, Cottington, Jimenez, 2000; Ropar and Mitchell, 2001).

There are then, two possible explanations for the failure to find a difference between the savant artists and the autism controls in the study. The first is that the savant artists in this study do not possess stronger perceptual segmentation skills as a whole, this explanation is, however, somewhat unlikely considering positive findings to this effect that have been found on several previous studies. A second explanation looks at the different processes that may be involved in performance on the two tasks. Specifically that the block design can be seen as a *active*, construction task, in that participants actively have to construct the blocks to match the two-dimensional design. The EFT, on the other hand can be seen as a *passive* identification task, which involves the location of a hidden figure, but no ongoing, active manipulation. While the processes employed in each task might be similar for untalented individuals it might be that savants gifted at art show an advantage when the task involves a motor component. In order to investigate these questions, performance on the block design was investigated. This was measured in all groups, along with intelligence, as part of an initial battery of tests. Several of the savant artists had taken part in this test as part of a previous study, in these cases the original scores were used and participants not re-tested.

Experiment 4: The Block Design

6.5 METHOD

6.5.1 Participants

The same participants who took part in experiment 3, the EFT, took part in the block design experiment. These were: the savant artists, the autism control group, the LDC group, the art student group and the normal student group.

6.5.2 Materials

The block design is a subtest of the Weschsler Intelligence Scales (Wechsler, 1981). It consists of nine identical blocks (32mm x 32mm), each with two red sides, two white sides and two red and white, diagonally split blocks. The block design task is incorporated into both the adult and children's scales, however, the adult version is used in this instance. For the adult version, twelve patterns, illustrating the designs to be constructed, were presented on individual cards measuring 105mm x 105mm.

6.5.3 Procedure

The block design was administered in accordance with the instructions given in the WAIS (Weschler, 1981). Participants were given a specific time period in which they were required to assemble the blocks so that the upward faces matched the pattern illustrated on the card. A score was assigned depending on the amount of time taken to produce the design. This raw score was then converted into a standardised score, with a score of ten representing average performance.

6.6 RESULTS

The standardised mean scores for the block design and the standard deviations (SD) are reported in table 6.3.

Table 6.3: The standardised block design scores (SD)

Groups	Block Design
Savant	12.22 (1.92)
Autistic	8.22 (2.17)
LDC	6.89 (3.69)
Art Students	14.22 (1.92)
Normal Students	12.00 (1.50)

Reflecting the scores on the EFT, the performance of the savant group appears comparable to that of the non-gifted students. A one-way ANOVA, indicated a significant group effect ($F_{(4,40)} = 14.83$, $p < 0.01$, $\eta^2 = 0.60$), post hoc bonferroni analysis indicated that the savant group had a significantly higher score than the LDC group and the autistic controls ($p < 0.001$), there was no significant difference between the two student groups, nor the two mixed intelligence control groups.

6.7 DISCUSSION

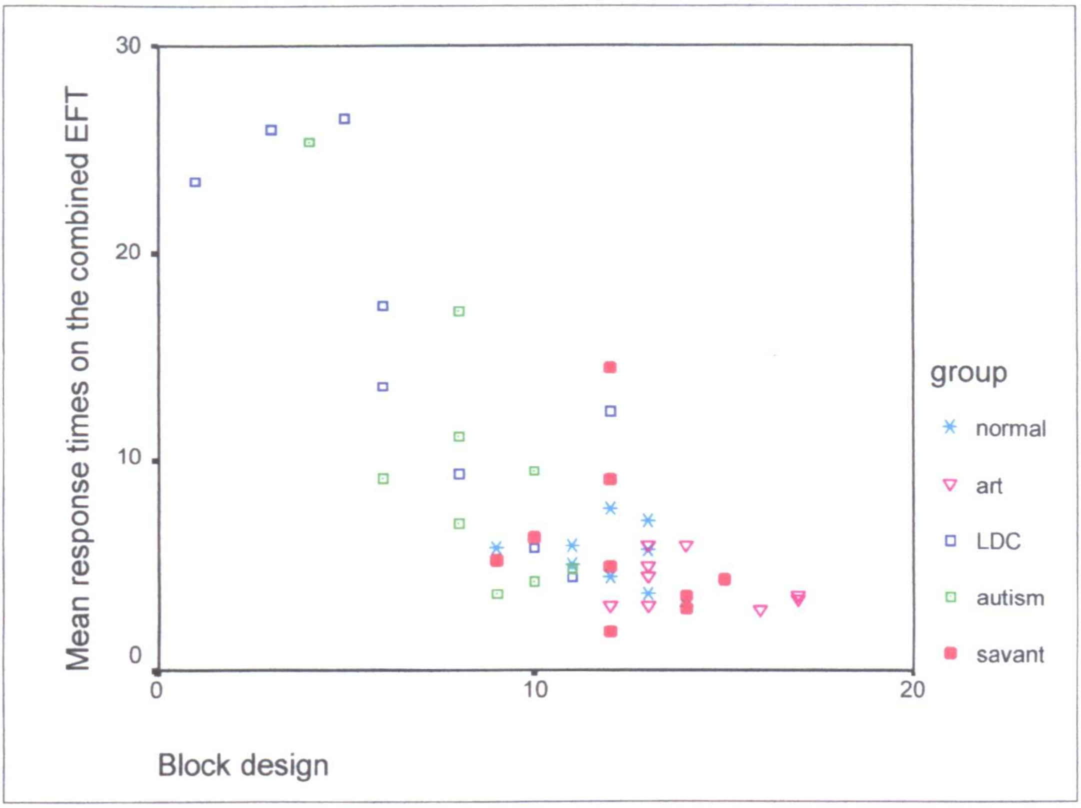
The results of the block design task are in accordance with the results reported by Pring, Hermelin and colleagues outlined in chapter 1, in that the savant artists were significantly faster than not only the LDC group, but also the autism controls. What is more, in further support of their hypothesis that segmentation ability might be a building block for artistic talent, the performance of the artists was up to the level of a group of artistically gifted controls (see Pring at al., 1995). However, this 'building block' appears only to be relevant to the artists with a diagnosis of autism as, contrary to previous findings, despite the art students producing faster responses overall than the IQ matched, non-gifted control students, this difference failed to reach significance. Likewise, there was no support for an autism-specific islet of ability on this measure. A full interpretation of these findings is presented after a discussion of the relationship between the two tests.

A comparison of the two tests

In the discussion of the EFT result it was suggested that the two tasks (the EFT and the block design) might tap different abilities. In order to investigate this suggestion the results of all participants were entered into a correlation matrix. As performance was consistent on the meaningful and abstract conditions, the median scores for combined performance on the meaningful and abstract conditions were calculated for each individual. Interestingly, although there was a strong correlation between the EFT and the block design in the autism and LDC groups[5] (Autism; $r = -.77, p < 0{,}01$, LDC; $r = -.84$, $p < 0.01$), there was no significant correlation within the three remaining groups. This is illustrated in figure 6.5.

[5] The negative relationship evident is a result of the differential scoring methodologies employed on the two tasks. On the EFT, where response time was measured, lower scores indicate superior performance. On the BD, however, the scores were scaled with higher scores representative of better ability.

Figure 6.5: Scatter plot illustrating the mean (median) response times for the four groups on the combined conditions of the EFT and the standardised scores on the block design.



In order to investigate the group differences between the five groups on the two tests, the combined meaningful and abstract means for the EFT and the block design standard scores were converted into z-scores these are illustrated in figure 6.6.

Figure 6.6: The z-scores for combined EFT and Block design in the five groups.

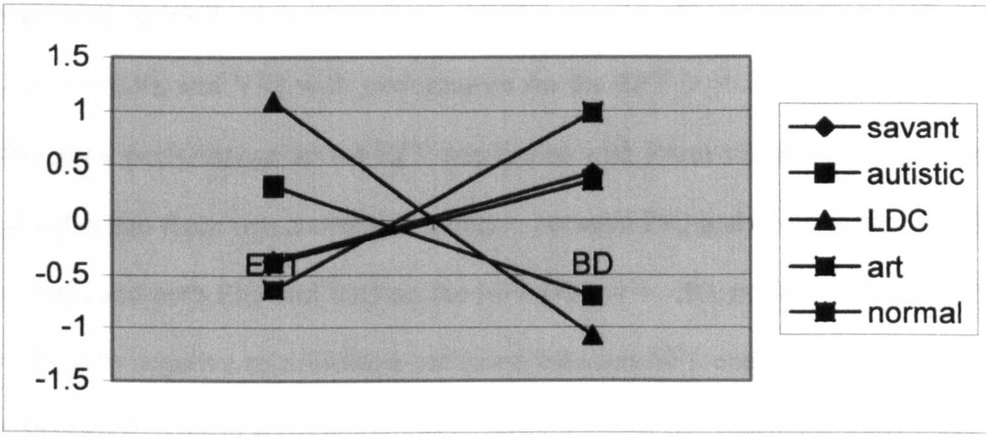


Figure 6.6 indicates an interaction effect between the two tests and different groups. It is important to reiterate at this point that the EFT and the BD were scored on opposite scales. That is a higher score on the EFT was indicative of poor performance as it was based on recognition time. On the other hand, the block design results were based on standardised scores, where a higher score represented poor performance. As figure 6.6 illustrates the standardised scores it is possible to see here that the performance of the LDC and autism groups produced scores over and under the mean scores on the EFT and block design respectively. The performance of the two students groups and the savant group, however produced scores under the overall group mean on the EFT and above this on the block design. In order to investigate a possible interaction effect the standardised scores were entered into a mixed ANOVA. A large significant interaction effect was found ($F_{(4, 40)} = 11.87, p < 0.01, \eta^2 = 0.56$) indicating that there was a meaningful difference in performance between the savant, art student and normal students and the LDC and autism control groups.

The IQ scores for the three mixed intelligence groups were also entered into the correlation matrix, there were no significant correlations within the savant group. In the autism control group block design performance positively correlated with PIQ (r = .59, p = 0.9), and VIQ with performance on the EFT (r = .71, $p < 0.05$), indicating that good performance on the EFT was linked with lower verbal ability. In the LDC group, again there was a strong correlation between PIQ and block design ($r = 0.71$, $p < 0.05$) and both PIQ and VIQ on the EFT (PIQ; $r = -.80$, $p < 0.01$, VIQ; $r = .69$, $p < 0.05$), the negative relationships indicated between EFT and IQ indicated higher IQ was related to faster recognition times, hence superior disembedding performance.

6.8 GENERAL DISCUSSION

The aim of this series of studies was to examine firstly, if this group of savant artists possessed a greater attention to detail as a result of either their diagnosis of autism or their artistic ability and secondly to investigate the nature of this processing style. Initially three modified versions of the EFT were presented to the savant artists and four control groups. Overall it was found that the performance of the savant artists, although up to the level of the normal art students and above the LDC group, did not differ from the autism controls. What is more, the lack of any significant interaction effect between groups on the meaningful and abstract conditions, indicated that none of the groups displayed any benefit from contextual independence, and superior performance appeared to result from the enhanced segmentation ability that would benefit both conditions.

When the results of the block design are studied in conjuncture with those gained in the EFT, the results become much more interesting. That the block design was a purely perceptual test, in that contextual cues could not be used to aid performance, again indicates good performance is due to a visual processing style rather than semantic independence. Overall the results gained by the savant group on this measure stand in contrast to those gained on the EFT, as on the block design they were found to produce significantly better performance than the autism control group. The difference in results on the two tasks is intriguing, especially considering the number of studies which have reported a high correlation between the block design and the EFT (Jarrold et al., 2000, Ropar and Mitchell, 2001), a result mirrored in the both the autism and LDC groups. If then, the two tasks are both measuring essentially the same ability, in this case possibly a focus on perceptual detail, why did the EFT fail to discriminate between the two groups with autism whereas the block design did?

In order to address the above question, it is necessary to look closely at the differential task demands of the two tests. Specifically it was suggested in the discussion of the EFT, that these two tasks may actually involve different processes for good performance. Here the hypothesis was proposed that whereas the EFT is a *passive recognition* task, the block design can be seen as an *active construction* task in that participants are constantly manipulating the blocks in order to achieve the end result. The lack of a correlation between the two tasks in the savant group adds further support to this suggestion. It may be that the superiority of the savant group compared to the autism controls on this task, results from the strong visual-motor component inherent in this task. Although participants were required to trace around the hidden figure in the EFT, this was only done after they had visually located the shape. This explanation fits closely with points made by Hermelin and colleagues in the chapter 1 (Hermelin et al., 1994; O'Connor & Hermelin, 1990). Here it was argued that drawing ability was dependent on the conversion of visual input into a motor output and several studies found that the savant group were superior to their control groups at recalibrating visual feedback into motor ability. In essence this is what is required on the block design task and it may be this motor element which distinguishes between the savants and the non-talented controls. To that end, it can be argued that local processing alone is not sufficient to produce superior performance in the savant group, if the task does not have a motor element.

It is recognised that the performance of both the normal and art students was also superior to the autism control group on the block design and this may in fact represent the robustness of the block design task comparative to the EFT, although it is the difference between the autism control group and the savants on this measure which is of particular interest here. It is also, nevertheless, interesting that neither performance on the EFT nor the block design appeared, on the whole, to be facilitated by artistic ability; shown in the failure to find a significant difference between the art students and the normal students. With regard to the EFT, this may reflect the comparative ease with which all students performed the task. Indeed the task demands on the abstract condition were considerably reduced, not only in an effort to make the two conditions comparable,[6] but also in order that the task be suitable for presentation to a range of individuals with learning difficulties. As such it may be that the task demands were not high enough to discriminate between individuals of normal intelligence and those with a specific developmental disorder such as autism (hence the failure to find a difference between any groups and autism controls on this task)

6 It is recognised that despite the efforts, outlined in the method section, which were made in order for the meaningful and abstract conditions of the EFT to be compared, that the two conditions were not necessarily of equal difficulty. However, the focus of this task was on within and between group

let alone between the two sets of students. As to why a difference was not evident on the block design between the two student groups, this could reflect the standardisation of scores on this measure, which reduces the intricacies of performance and the standard scores were higher amongst the art student group on the block design. These methodological concerns can thus account for the failure to highlight an art related superiority on this measure, despite previous positive findings and this does seem like a likely explanation given the good performance of the savant group, in particular on the block design task.

Another point that requires some discussion is the failure of both of the tests used in this study, to elicit a difference between the autism control group and the LDC group, especially considering the strong evidence towards the superior performance of individuals with autism on such tasks. One explanation for this finding is the large IQ range of participants in this study, which, combined with the small number of participants in each group, could have hidden any significant group differences. It is interesting to note, however, that whereas on both the EFT and the block design there was a strong correlation between performance and IQ in the LDC group, this was not the case in the autism control group. Indeed, although PIQ was found to correlate with block design, on the EFT the only correlation within this group was the positive relationship with VIQ. As was noted earlier, this indicates that those with higher verbal IQ produced slower scores on the EFT. Although the N was very small, meaning any conclusions are tentative, it appears that those individuals in the autism control group, with less verbal ability have weaker central coherence and more detail focussed processing strategies in the visual domain.

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differences, particularly any interactions which may have arisen, rather than to directly compare within group performance on the two measures.

Finally, it is important to add that attributing superior performance on these two tasks to a perceptual ability related to segmentation rather than a semantic independence, does not immediately dismiss the notion of central coherence as proposed by Frith and Happé (Frith, 1989; Frith & Happé; 1994; Happé, 1999). Rather, as several other researchers have suggested (Jolliffe & Baron-Cohen, 1997; Mottron & Belleville, 1993), it is argued that on low level, visual tasks such as the EFT and the block design, the performance can be attributed to perceptual factors, in this case the recognition of a hidden shape and the segmentation of a visual array. Indeed this suggestion is in keeping with several studies which indicate that the processing of visual information in individuals with autism does not differ from that of non-autistic control participants (Ameli et al., 1988; Brian & Bryson, 1996; Pring et al., 1994). However, while the results of this study provide no evidence that individuals with autism experience less capture by meaning on a visual perceptual task, they may still exhibit less '*drive for meaning*' on more active tasks (see Pring et al., 1995).

To conclude, the aim of this study was to investigate the nature of visual processing in savant artists. It had previously been shown that good performance on tasks such as the block design and the EFT was not only associated with autism, but also artistic ability. Although it has consistently been found that savants gifted at art are better at a variety of both abstract and meaningful picture puzzle tasks, no attempt had previously been made to measure ability at identification of a hidden figure. On this task there was no effect of either autism or artistic ability at facilitating performance. The savant artists were significantly faster than the LDC group overall, indicating that a combination of the two factors may have arisen. The main aim of the EFT experiment was, however, to investigate the nature of this perceptual ability, namely was it related to semantic independence or perceptual segmentation? The failure to find a significant interaction effect illustrates that none of the groups experienced less capture by meaning and that any superior performance is likely to result from perceptual factors. This suggestion is supported by the finding that the savant group produced superior responses to the LDC group on the abstract block design. What is more the savant artists were also found to be significantly better than the autism control group on this task. The interesting contrast between the failure to find a difference between the two groups with autism on the EFT and the clear superiority of the savants on the block design is attributed to the different abilities tapped by each tasks. Although both tests measure segmentation ability, the block design can be considered an active task with a motor element and it is this which allows the savant artists to produce responses out of line with their autism and their general level of cognitive functioning.

Chapter 7:

Executive Function; a question of monitoring?

7.1 INTRODUCTION

The term executive function was initially coined to describe the impairments found in frontal lobe patients (Duncan, 1986). It can be defined as the set of abilities necessary for the maintenance of appropriate problem solving set (Welsh & Pennington, 1988). Such abilities include; being able to disengage from external context, inhibit incorrect but prepotent responses, plan and generate sequences of actions, monitor performance using feedback and flexibly shift attentional set (Russell, 1997).

Executive impairments have been found to be evident in autism, with deficits reported on tasks measuring planning ability (Ozonoff et al, 1991), set shifting and flexibility (Ozonoff, et al., 1991, Hughes, Russell & Robbins, 1994), inhibition (Hughes & Russell, 1993) and monitoring behaviour (Russell & Jarrold, 1998). As discussed in detail in chapter 2, some authors have suggested that the difficulties individuals with autism display on tasks of generativity or creativity are executive in nature (Leevers & Harris, 1998; Turner, 1997, 1999). Jarrold (1997) argues that the generative and creative deficits exhibited by individuals with autism are a result of poorly specified or represented goals. As discussed in detail in chapter 2, he argues that problems with selection of appropriate goals or adequate representation, would result in individuals with autism producing less responses overall, as well as more perseverative or incorrect responses. This pattern of behaviour is especially evident on tasks requiring novel behaviour and with few environmental guides. Such a pattern of results was indeed reported in Turner's (1999) investigation, again detailed in chapter 2.

So far the executive abilities of the savant artist have yet to be investigated, making this investigation particularly important. However, despite the lack of direct empirical evidence available, it is possible to glean some indication of the executive skills of this group. These savant artists all produce their artistic outputs spontaneously, indicating initially that they do not appear to suffer from an activation impairment. More interestingly the actual process of drawing can itself be considered an executive function, in that it involves the conscious control of behaviour (Lezack, 1995; Mottron, Belleville & Ménard 1999). What is more the activity of generating a piece of artwork involves planning, goal setting and monitoring (Thomas & Silk, 1990). As Van Sommers (1989) argues, the construction sequence itself depends on depiction decisions that involve a variety of planning operations. Several authors (Mottron & Belleville, 1993, 1995; Sacks, 1995; Selfe, 1977, 1983) have pointed out that savant artists rarely, if ever, make any mistakes in their artwork, which require altering or erasing. From this observation one could conclude that the planning skills possessed by savant artists in the domain of their ability, are intact and that they are very good at monitoring their behaviour as they draw. Moreover, there is experimental evidence that this group of savant artists are better than controls at constantly monitoring their motor behaviour on a mirror drawing task (Hermelin et al., 1994).

Taken together, the above points indicate that savant artists may show spared executive abilities comparative to their non-talented autistic controls, at least regarding visual-motor control or in the domain of their ability. But, there is some evidence that casts doubt onto this hypothesis. Firstly, the observation that savant artists rarely amend their artistic outputs, does not mean that they do not make errors and this lack of correction could actually be seen as evidence of a lack of monitoring. What is more, in relation to the planning accuracy outlined above, both Sacks (1995) and Selfe (1977, 1983) pointed out that Stephen and Nadia respectively, paid no attention to drawing their outputs in the centre of the page. Rather they began drawing anywhere on the page and frequently drew off the edges, not behaviour one would associate with a well-planned approach. It may be then, that the accuracy and ability evident in their artistic outputs results from factors such as semantic independence (drawing what is seen rather than known, with no interest in the viewer's perspective) or accurate visio-kinaesthetic programming, rather than executive abilities in areas such as planning or monitoring. Finally, similarly to Lewis and Boucher's (1991) observation that the children with autism showed less thematic variation in their artwork, possibly due to a lack of flexibility, it has been noted (Hermelin et al., 1999; Pring et al., 1997; Sacks, 1995) that savant artists do tend to stick to a restricted range of topics in their art work, although this limitation in topic is associated with many artists.

As the above discussion illustrates, a full investigation of the executive abilities of this group of savant artists is necessary. In particular it is important to identify if savant artists suffer from the same impairments as their non-talented controls or whether their artistic ability results in a sparing of these processes. There are many different measures of executive function, each with a focus on a different area, although the measured abilities do overlap considerably, for instance the Tower of Hanoi (Anzai &

Simon, 1979), and later Tower of London (Shallice, 1982), are primarily tests of planning ability, though, they also assess monitoring and working memory (Ozonoff & Jensen, 1999). It appears to be processes such as monitoring, inhibition and fluency that are particularly relevant to creative performance (see chapter 2). It is thus important that a test of executive function which measures these areas is utilised. Moreover, as the question of executive performance is a hitherto neglected topic in savant investigations, it is important that performance is measured, in the first instance, in the domain of the ability. One measure which appears to be of particular use in this instance is the design fluency task.

The design fluency task

The design fluency task was formulated by Jones-Gotman and Milner (1977) as a non-verbal analogue to the commonly used word fluency tasks. As such it was a very good test to use in order to measure fluency performance in a group of individuals with language difficulties. In this task participants are required to draw as many abstract or meaningless designs or patterns as they can in a given time period. Performance on the design fluency task is measured on a number of factors over and above that of a simple fluency score. Like the word fluency tasks, outlined in chapter 2, it is possible to look at monitoring ability and perseveration by looking at the participant's ability to produce a variety of different responses.

The design fluency task has previously been used with a group of individuals with autism (Turner, 1997, 1999). Turner's findings are discussed in more detail in chapter 2, however, it is necessary at this point to briefly recap the main conclusions of her study. Turner used the design fluency task with four groups of participants; two groups of autistic participants, a low and high-functioning group, and their non-autistic IQ matched controls. She found, contrary to the findings on verbal measures, that there was no overall autism deficit with regard to the overall number of responses produced. However, despite generating a comparable amount of responses overall, the two groups with autism were found to produce significantly more inappropriate responses and more repeats or redundant responses. This, Turner (1999) argued, was because participants did not have to preformulate their drawings, due to the lack of a semantic or verbal element in the task. She argued this finding was consistent with a primary impairment in the appropriate regulation of response behaviour in these two groups; that is they were unable to effectively monitor their responses.

The design fluency task has several advantages in the current context, beyond simply testing executive ability in the domain of drawing. Firstly, it is an open ended task, in that participants are required to draw as many responses as they can in a given time limit, thus fluency performance can be measured and it is possible to fully assess the generative ability of the participants. Moreover, as the designs must be entirely abstract the task can be seen to tap true generative ability, in that participants are not able to rely on stored knowledge and the task itself is free from semantic influence. In the design fluency task, participants must generate their responses from scratch, there being no starting prompt, as discussed previously initial stimuli figures may in some cases aid performance, especially in groups of participants with detail focussed processing styles. Finally, this task allowed perseveration to be investigated by looking at redundant or repeat responses and monitoring ability to be measured by looking at the number of acceptable responses produced in a task with several complex rules.

The use of control participants on measures of executive function

Throughout this thesis a variety of control groups have been used in order to test the various hypotheses. In this instance the two mixed intelligence control groups will be included (the autism control group and the LDC groups). Still, as mentioned previously executive function deficits have been found in a variety of different disorders (Lezack, 1995; Ozonoff, 1997; Temple, 1997), as such it may be that several of the participants in the LDC group have executive deficits as a result of their individual disorders. For this reason, the LDC group are included in analysis for comparative purposes, but it is the performance of the savant group relative to the autism control group which is of particular importance in this instance. As such, the focus of interest in this study is on whether the savants possess the same impairments as the non-talented, autism control group, rather than on the executive performance of individuals with autism in general.

Aims

The purpose of this study was thus to investigate the executive performance of a group of savant artists, with particular focus on fluency, inhibition and monitoring behaviour, in a visual-motor based task.

Experiment 5: The Design Fluency

7.2 METHOD

7.2.1 Participants

Three groups of participants took part in this experiment; the savant artists, the autism control group and the LDC group. A full description of these participants is presented in chapter 3.

7.2.2 Procedure

The procedure for this experiment followed that outlined by Jones-Gotman and Milner (1977). The task consisted of two conditions, a free and a fixed condition. The free condition was always administered first in line with Jones-Gotman and Milner. This was followed by a short break of several minutes after which the fixed or four line condition was presented. A time limit of four minutes was imposed on both conditions.[7]

Participants were informed that they were to take part in a pattern drawing task and that they were to draw as many simple patterns as they could in four minutes. They were instructed not to draw real shapes or real objects but to make up the patterns or designs themselves and not to scribble. The experimenter depicted the instructions by drawing two allowable designs and two unacceptable designs, while explaining why these designs were not allowed. Participants were then told to draw as many patterns

[7] In the Jones-Gotman and Milner study a time limit of five minutes was imposed on the free condition but this was reduced to four minutes on the fixed condition. The reasoning behind this variation was that the responses drawn in the free condition were more complex. Pilot testing this study indicated that the responses produced in both conditions were very simple. In an effort to make performance on both tasks comparable a time limit of four minutes was set for both conditions.

or designs as possible, with emphasis on making each drawing different to the last. As the aim of this task was in part, to look at monitoring performance and perseveration in the light of negative feedback, participants were given three warnings for each type of mistake[8] as suggested by Turner (1999), rather than the single warning method adopted by Jones-Gotman and Milner (1977). An example of the verbal warning given to participants following the production of a recognisable response would be "*that looks like a ____, remember, each drawing must not resemble a real object*". Participants were praised for all acceptable responses.

For the fixed condition, participants were informed that they were to do the same again, but this time each response must only have four lines. A line was described as single line that did not involve a sharp corner. The experimenter explained the task demands further by illustrating what was accepted as a line (for instance a circle, curve or spiral could also be counted as a line) and drawing several acceptable and unacceptable responses. Further comprehension of what designs were acceptable in the fixed, four-line condition was tested by asking participants to name which of several examples were acceptable in terms of consisting of the correct number of lines. Again participants were given three warnings of each type and praised for all correct responses.

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[8] The types of mistake issued with a warning were: the production of a recognisable shape or object; scribbling; drawing identical or very similar designs; drawing very elaborate designs. In the later fixed condition warnings were also issued for using the wrong number of lines.

7.3 SCORING AND RESULTS

7.3.1 Fluency: The Total Number of Responses

Fluency: Scoring

According to the procedure outlined by Jones-Gotman and Milner (1977) and used by Turner (1999), all produced responses were included in this measure. Thus the fluency score consisted of the total number of responses generated, irrespective of any repeats, scribbles or inappropriate responses.

Fluency: Results

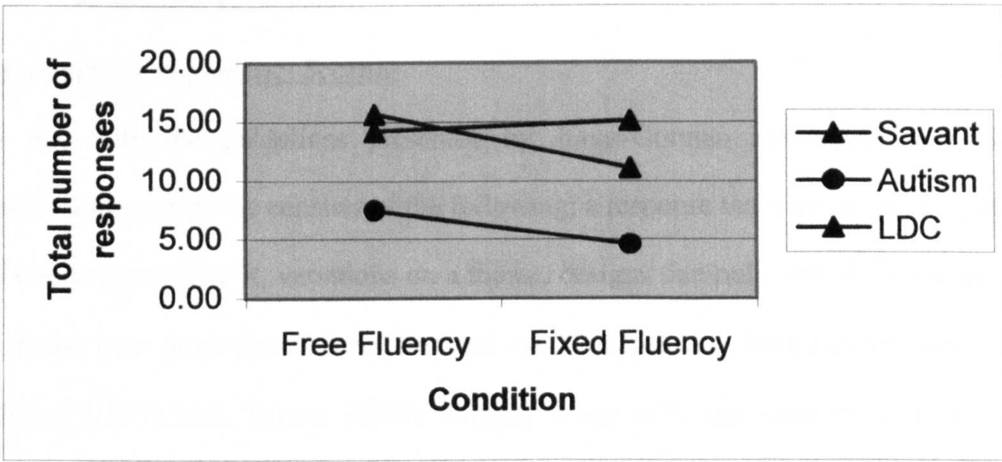
The mean scores and standard deviations (SD) for the two conditions of free and fixed, and the overall fluency measures are shown in table 7.1.

Table 7.1: The mean scores (SD) for the measure of overall fluency in the design fluency test

	Free Fluency	Fixed Fluency	Total fluency
Savants	14.22 (8.20)	15.11 (8.20)	29.44 (14.54)
Autism	7.44 (4.69)	4.56 (2.51)	12.33 (6.40)
LDC	15.67 (8.23)	11.11 (7.82)	27.56 (15.59)

The mean scores indicate that the performance of the autism control group is particularly poor, with participants in this group producing less than half of the number of responses produced by the savant group and the LDC group. The performance across the two tasks differs quite noticeably between the three groups as illustrated in figure 7.1. Here the performance of the two non-talented groups decreased in the fixed condition, but improved slightly in the savant group.

Figure 7.1: The mean scores for the three mixed intelligence groups on the two conditions in the design fluency test.



In order to investigate any interaction effect, the results of the three groups were entered into a mixed 2 x 3 ANOVA, with condition (free, fixed) the within group variable and group (savant, autism, LDC) as the between-participants factor. A main effect of condition was found ($F_{(1,24)} = 4.35$, $p < 0.05$, $\eta^2 = 0.15$), indicating that overall, participants produced less responses on the fixed condition, however this effect was only small. Despite figure 7.1 indicating a possible interaction effect, with the savants producing more responses in the fixed condition, this interaction did not reach significance ($F_{(2, 24)} = 2.36$, $p = 0.16$, $\eta^2 = 0.16$). Finally, a small significant effect of group was found ($F_{(1,24)} = 4.78$, $p < 0.05$, $\eta^2 = 0.15$). As discussed in the introduction it is the contrast between the savant group and the autism controls that is of particular interest in this instance, thus an independent t-test was conducted on the scores produced by these two groups. The savant artists were found to produce significantly more responses than the autism control group (t = 3.23, $p < 0.01$, d = 1.56).

7.3.2 Perseverative Responses: The Number of Repeats of Visually Similar Responses Produced

Perseverative responses: Scoring

In line with the guidelines presented by Jones-Gotman and Milner (1977), a perseverative response consists of the following; a response that was simply a rotation of one that preceded it, variations on a theme, designs that only varied from a former response by a single detail, scribbling and exact repetitions. Both Jones-Gotman and Milner (1977) and Turner (1999) suggest using only the percentage scores for discussion in order to reduce the confounding effect of a low fluency score.

Perseverative responses: Results

In order to maintain the suitable power in the analysis of the error scores, only the combined scores for the two conditions will be discussed, this is in keeping with the methodology previously employed in such this task (See Turner 1999). The percentage of responses classed as perseverative on the two conditions combined, are illustrated in table 7.2.

Table 7.2: The total percentage (SD) of perseverative responses produced by the three groups on the design fluency task

	Perseverative %
Savant	27.26 (21.32)
Autism	29.27 (22.12)
LDC	26.53 (16.55)

As table 7.2 illustrates there was very little between groups variance with regard to the percentage of perseverative responses produced, nevertheless, as the high standard deviations indicate, there was a great deal of individual difference within groups. Kruskal-Wallis analysis indicated that there were no significant group differences on this measure ($\chi_2 = 0.05, p = 0.97$).

7.3.3 Novel responses: The Amount of Acceptable Responses

Novel responses: Scoring

The perseverative error score only incorporated errors that were markedly similar to previous responses, yet, as outlined in the procedure section, there were several other types of error that were possible on this task. Firstly, any responses which resembled real shapes or objects were disallowed and in the fixed condition, any responses comprising of the wrong number of lines were counted as errors. Such errors were relatively rare and hence did not warrant individual discussion but, when combined with the perseverative error score, give an indication of how capable participants were at adhering to the rules given to them at the start of the task and their overall monitoring ability. In order to investigate this monitoring behaviour a novel response score was calculated. This score consists of the total number of responses produced, minus any perseverative errors, any recognisable responses or any designs with the incorrect amount of lines.

Novel responses: Results

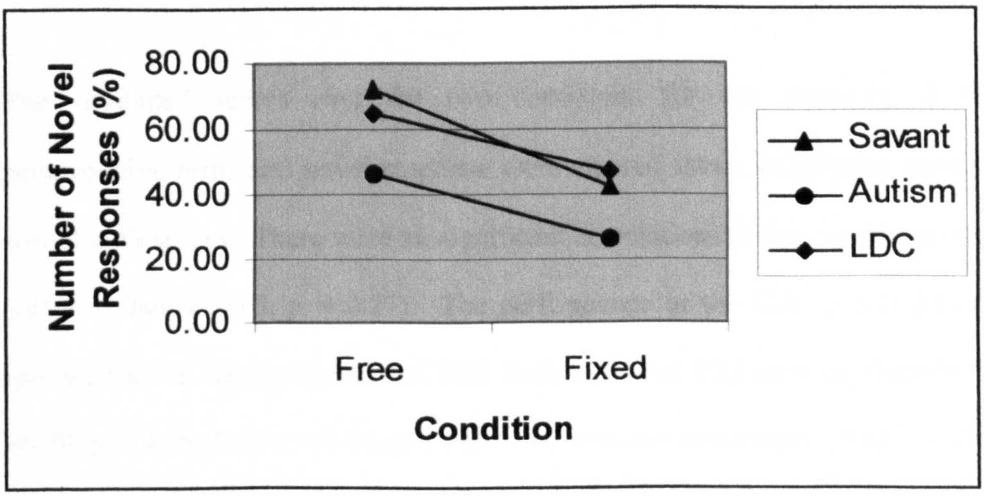
Again, in order to investigate monitoring performance independent of the total number of responses produced, the percentage scores were calculated for each individual. The percentage of novel, or acceptable, responses produced by each group and the standard deviations (SD) are presented in table 7.3.

Table 7.3: The percentage of novel responses (SD) produced by each group on the design fluency task

	Free Novel %	Fixed novel %	Total novel %
Savant	72.37 (28.76)	42.10 (28.46)	57.06 (23.70)
Autism	46.57 (25.20)	26.79 (25.35)	37.92 (14.38)
LDC	64.68 (26.12)	47.09 (28.89)	57.20 (21.62)

Here again the performance of the savant group is almost equal to the LDC group and noticeably above that of the autism control group. The percentage scores for the two conditions are illustrated in figure 7.2.

Figure 7.2: The percentage of novel responses produced on the free and fixed conditions of the design fluency test



As figure 7.2 illustrates, the performance of all groups decreases in the fixed conditions, revealing that participants in all groups made more errors in total in the fixed, four line condition. A mixed 2 x 3 ANOVA was conducted on these percentage scores with condition (free, fixed) as the between groups factor and group (savant, autism, LDC) as the within group factor. As indicated in figure 7.3, a significant main effect of condition was found ($F_{(1,24)} = 11.40, p < 0.01, \eta^2 = 0.32$). There was no significant interaction between group and condition ($F_{(1,24)} = 0.34, p = 0.72, \eta^2 = 0.03$). Tests of between participants effects narrowly missed significance however a small effect size was indicated ($F_{(2,24)} = 2.66, p = 0.09, \eta^2 = 0.20$). As mentioned in the introduction to this chapter, it is the performance of the savant group, comparative to the autism controls, that was of particular interest in this investigation, and the small effect size indicated on the group measure highlights the need for further investigation. As such, an independent t-test was conducted on the combined percentage scores for the two conditions of the two groups with autism. The results of the t-test for percentage of responses indicated that the savant artists produced significantly more responses that were recognised as acceptable, and therefore less errors, than the autism control group ($t = 2.07, p < 0.05, d = 0.98$).

The combined scores over the two conditions for the measures of fluency, perseverative error and novel response were entered into a correlation matrix along with the IQ scores. There were no significant correlations within the two groups with autism (r below 0.43, $p = 0.27$). The performance of the LDC group, by contrast, appeared to be largely associated with both VIQ and PIQ on total fluency (VIQ: $r = 0.70, p < 0.05$; PIQ: $r = 0.69, p < 0.05$) and total novel response (VIQ: $r = 0.84, p < 0.01$; PIQ: $r = 0.75, p < 0.05$).

7.4 DISCUSSION

The aim of this present experiment was to investigate the executive performance of savant artists in the domain of their ability, with particular emphasis on the areas of fluency, perseveration and error monitoring. Although both non-talented control groups were included in this study, due to the mixed aetiology of the LDC group and the prevalence of executive function deficits in a variety of disorders, it was the performance of the savant group compared to the autism control that was of interest in this instance. Specifically this test was incorporated to conclude whether the savant group showed the deficits associated with autism on executive measures (Jarrold 1997; Ozonoff et al., 1991; Turner, 1999) or whether their artistic ability resulted in a sparing of these processes.

Dealing firstly with the fluency dimension, the two most comprehensive investigations of fluency performance in autism (Jarrold, 1997; Turner, 1999) both found evidence of a pervasive generativity deficit associated with autism. The results of this investigation not only support their conclusions, but also indicate that, at least in the domain of their ability, savant artists do not display a deficit in this area. What is more, as the abstract nature of this task called for participants to generate responses completely from scratch and without the use of stored memory associations, it can be seen to measure true generative ability. From these results one can conclude that the savant artists show no fluency deficit with regard to the total number of responses produced, in the domain of their ability.

The fluency result outlined above does, nevertheless, need to be looked at in the context of the other measures gained on this task, as Turner (1999) found when she presented participants with the same task. In Turner's task, although the overall fluency was comparable between the autistic and non-autistic controls, the participants with autism were found to produce significantly more perseverative errors and inappropriate responses. The results of this study are at odds with Turner's results, here there were no group differences with regard to the number of perseverative errors reported. The lack of an autism-specific deficit in the non-talented controls, is also inconsistent with previous studies that maintain that problems with set shifting and perseveration are consistent amongst individuals with autism (see Liss, Fein, Allen, Dunn, Feinstein, Morris, Waterhouse, Rapin, 1999; Ozonoff & Jensen, 1999). One possible explanation is that the design fluency task is not a good measure of perseveration, for instance it does not require an individual to overcome a previously reinforced or prepotent response. However, as noted by both Turner (1997, 1999) and Jarrold (1997), perseverative errors are more apparent in tasks which provide few environmental cues, regardless of previous feedback. Furthermore, when one compares the mean scores produced by the savant and autism control groups in this study, to those obtained by Turner (1999), they are very similar If one combines the performance of the HFA's and the LFA's in Turner's study, and obtains an overall score for perseveration, rather than looking at repeats separately, a perseveration score of approximately 25% can be estimated. This compares to the scores produced by the participants in this study, with the IQ range within this study and between all the participants used in Turner's study being very similar. In this instance then, using the scores produced by participants in Turner's study as a comparison, it appears to be the performance of the LDC group which is particularly poor, rather than good performance by the two groups with autism. As such it is difficult to draw any conclusions from this result. Nevertheless, it is important to recognise that the savant group showed no sparing of ability comparative to the autism controls.

Whereas the two groups with autism were found to produce an equal number of perseverative errors, this was not the case when the total number of errors was looked at by analysing the novel response scores. Here the savant group were found to produce significantly more acceptable responses than the autism control group. The novel response score has often been used as an overall measure of monitoring ability (Jones-Gotman & Milner, 1977; Turner, 1999) and in this case it appears that the savant artists have a spared ability in this area, at least when the output is drawn. This sparing of ability may arise from the fact that the design fluency task had no semantic element, particularly as individuals with autism have been shown to exhibit less benefit from semantic processing (Pring, et al., 1995; Shah & Frith, 1993). However, this explanation cannot account for why performance was so good amongst the savant group, but not amongst the autism controls. It may thus be that the savant artists showed superior monitoring ability on this task as the response output was drawn, indeed this is in keeping with the results of Hermelin and colleagues in which the savants were found to have spared ability in tasks which took place in the drawn domain (O'Connor & Hermelin, 1987b, 1990) or which require them to monitor motor performance (Hermelin et al., 1994).

If the savant artists do indeed show a spared ability when it comes to effectively monitoring their motor behaviour, the question arises as to whether this is found only when the tasks have a drawn, or motor element, or do they show better monitoring performance in general compared to the autism control group? One useful measure which not only looks at monitoring ability but also perseveration and flexibility is the Wisconsin Card Sort Test (WCST, Grant & Berg, 1948; Heaton, 1981).

The WSCT requires participant to sort a pack of cards according to a set of rules which are not disclosed by the examiner. Indeed, participants are not informed of the purpose of the task, only that they are to sort the cards and after each card has been placed the examiner will tell them whether they were correct or incorrect. The rules (colour, shape and number) are alternated after the participants have correctly sorted six or ten cards correctly, but they are not informed that the rule has changed and must utilise the examiner's feedback to guide them to the correct response. The WCST can be scored on a number of measures; the amount of correct categories, which gives a measure of cognitive flexibility and general task understanding, the amount of perseverative errors, showing cognitive inflexibility and inhibition, non-perseverative errors, which can be taken as evidence of monitoring and the use of feedback.

Although studies including participants with autism have consistently reported deficits, such studies have, on the whole, used high-functioning individuals (Griffith, Pennington, Wehner & Rogers, 1999). This is no doubt due to the abstract nature and overall complexity of the task, making it very difficult to comprehend in individuals of lower overall IQ. Indeed pilot testing indicated that both individuals with general learning difficulties and those with autism, with a VIQ of around 70, found the task very stressful and frustrating and failed to understand what was required of them. The outcome was that the results provided little information with regard to the types of errors made. The aim of using the WCST in this instance was to investigate the types of errors made by the savant group in comparison to their controls. As has been illustrated throughout, the IQ range of the groups involved in this series of experiments was very wide. For this reason, the task demands as they originally stood were too high for those at the lower end of the IQ range and, for this study to be meaningful, it was of paramount importance that the task demands were understood initially. This point has been raised by several researchers investigating executive function in areas other than autism (Goldman, Axlerod & Tomkins, 1992; Nelson, 1976; Rossell & David, 1997) and several modifications have been suggested. These modifications, although resulting in more clarity at the outset still, nevertheless, show sensitivity between groups with executive difficulties and those without.

Test modifications

One of the most common modifications was suggested by Nelson (1976). Firstly, each card sharing more than one attribute with a stimuli card was removed from the pack, meaning that there was no ambiguity regarding sorting principle employed by the participant. The removal of such cards left a pack of 24 cards, with a total of 48 if two packs of stimuli cards were used as suggested. Nelson (1976) asked participants to sort the cards and after six cards had been sorted to a single rule participants were clearly informed that the rule had changed and they were now to work out a new rule. A further variation found useful with some patient groups is to inform them of the sorting principles at the start of the test and to explain that the sorting principle could change at any time, yet not explicitly stating when (Goldman et al., 1992). This later modification is advantageous in that participants still have to use feedback effectively in order to sort correctly, rather than the explicit instruction employed by Nelson (1976). Indeed several researchers have criticised Nelson's modification, stating that it is too simple and does not distinguish between levels of mild cognitive deterioration (Hart, Kwentus, Harkins & Taylor, 1988).

Aim

This next experiment sought to measure executive ability on the WCST, a standardised test, specifically looking at inhibition and monitoring. To reduce the overall task complexity any cards sharing more than one attribute with a stimulus card were removed. Further to this participants were informed of the sorting principles at the start of the test.

Experiment 2: The Card Sort

7.5 METHOD

7.5.1 Participants

The same participants who took part in the design fluency task, took part in the card sort.

7.5.2 Materials

The stimuli was taken from the WCST (Grant & Berg, 1948; Heaton, 1981). The WCST consists of two packs of 64 cards, and 4 stimuli cards, differing in colour, form and number. Following Nelson (1976) all cards sharing more than one attribute with a stimulus cards were removed. This led to 24 cards from the original set being suitable. In order to make the test of adequate length two packs were combined resulting in 48 test cards.

7.5.3 Procedure

Participants were tested individually in a quiet room at their day centres. The task was introduced as a puzzle task. The experimenter began by laying down the four stimulus cards, participants were instructed that that they needed to sort the cards using three rules; colour, shape or number. The experimenter then illustrated the three rules by sorting two cards according to each rule and explaining why the cards were sorted that way. Next, to illustrate that participants fully comprehended these results, the experimenter gave the three cards to each participant and instructed them to match one card to the stimulus cards according to each of the three rules. All participants were able to complete this initial task and the removal of any cards sharing more than one attribute with a stimulus card ensured that participants were sorting to the correct principle.

Following this training task all practice cards were added back into the original pack and participants were given the following instructions: "*I want you to try to work out which rule I am thinking of, I will tell you whether you are wrong or right when you have placed each card. Sometimes the rule I am thinking of will change, then you need to work out which rule I am thinking of again. I will tell you after you have laid each card if that is the rule I am thinking of.*"

Participants were then given the pack of cards and the experimental session began. After each card the participant was given the following feedback; for correctly placed cards they were informed "*that is very good, that is the rule I was thinking of*". For incorrectly placed cards participants were informed "*that is not the rule I am thinking* *of, try again*" and given a new card. After each card had been laid it was left in place and incorrect cards were not returned to the pack.

The sorting principle changed after six cards were consecutively placed correctly, following the colour, number, shape order, however, in line with Goldman et al. (1992) participants were not explicitly instructed when to change principle. Following Nelson (1976) the test was discontinued after six categories had been successfully sorted, or the pack of 48 cards was exhausted.

7.6 SCORING

Firstly the total number of correct categories was calculated. As stated above, a category consisted of six correctly sorted cards in order. The maximum number of categories was six. Next the total number of incorrectly sorted cards was counted, giving the total error score. The categorisation of errors followed that outlined by Heaton (1981). Firstly the number of perseverative errors was calculated. A perseverative error was defined as a response that would have been correct at the previous stage. There were two exceptions to this rule, the first related to perseverative errors that occurred before a category had been completed. In this case participants could perseverate on the basis of the first incorrect card placed. The second type of perseverative error related to which arose *within* a single stage of the test. This occurs when the participant begins to sort incorrectly and then perseverates on this incorrect response, even though the incorrect response was not the preceding correct response. For example, the previous sorting principle was colour, the current sorting principle is shape, yet participants continue to sort to number even though they are given negative feedback. In these instances, the 'perseverated to' principle changes after three cards have been incorrectly placed in the way outlined above. The number of perseverative errors is then subtracted from the total number of errors, to give the number of non-perseverative errors.

As all participants sorted the same amount of cards, the total error scores are illustrated rather than using percentage scores.

7.7 RESULTS

The mean scores and standard deviations (SD) for each of the measures obtained on the WCST are illustrated in table 7.4 .

Table 7.4: The mean scores (SD) for the three mixed intelligence groups on the WCST

	Categories	Total Error	Perseverative Error	Other Error
Savant	3.41 (2.79)	18.22 (12.66)	10.22 (8.18)	7.00 (5.74)
Autism	2.79 (2.81)	20.21 (10.49)	14.11 (7.11)	7.78 (3.56)
LDC	2.89 (2.20)	17.44 (13.08)	11.56 (10.25)	5.89 (6.51)

A one-way ANOVA conducted on the category, total error and other error scores indicated no significant group differences (categories: $F_{(2,24)} = 0.55$, $p = 0.55$, $\eta^2 = 0.04$; total error: $F_{(2,24)} = 0.50$, $p = 0.50$, $\eta^2 = 0.04$; other error: $F_{(2,24)} = 0.28$, $p = 0.28$, $\eta^2 = 0.03$). Due to the high standard deviations with regard to perseverative errors a Kruskal-Wallis was used to analyse these scores. Despite the scores of the autism control group appearing noticeably lower than the scores of the savant and LDC group, this difference failed to reach significance ($\chi^2 = 0.89$, $p = 0.64$).

As mentioned at several points throughout this chapter, due to the poor discriminative validity of tests of executive function, it is the performance of the savant group comparative to the autism control group which is of particular importance in this investigation. Despite this, independent t-tests conducted on categories, total error and other error and a Mann Whitney test on perseverative errors, failed to highlight a difference (categories: t = 1.10, p = 0.29, d = 0.22; total errors: t = -.98, p = 0.34, d = -0.17; other error: t = -.35, p = 0.73, d = -0.16; perseverative errors: U = 31.00, p = 0.41).

The results of these measures were entered into a correlation matrix. In all groups there was a strong correlation between the various measures, indicating that those good at the task overall produced less errors overall and less perseverative errors. In the LDC group performance was determined mainly by VIQ, with highly significant correlations on all measures other than the perseverative errors (categories: r = 0.75, p 0.05; total error: r = -0.76, $p < 0.05$; other error: -0.65, $p < 0.05$; perseverative errors: r = -0.55, p = 0.34). There were no significant IQ relationships in the two groups with autism (r below 0.34, p = 0.32).

7.8 DISCUSSION

The main finding from the WCST was the failure to find any significant group differences on any of the measures. Initially this result might appear somewhat surprising, especially considering that the WCST has proved in the past to be one of the more consistent measures in identifying executive deficits in autism (Liss et al., 1999). There are a number of reasons for this result. Firstly, as has already been mentioned, poor performance on executive tasks has been associated with a variety of disorders. The LDC group in this series of studies were drawn from a day centre catering for individuals with a variety of needs including patients with disorders such as schizophrenia, a disorder found to result in particularly poor performance on the WCST (Rossell & David, 1997). It may then be that the mixed aetiology of this control group masked any significant findings.

An even more important point relates to the effect that overall IQ has on these sorts of tasks. A number of researchers have pointed out the relationship between VIQ and performance of executive tasks. As Griffith et al. (1999) point out, tests of executive function often fail to discriminate between groups with lower IQ's, with consistent results only obtained using individuals with normal range intelligence. In this study the mean VIQ for the three clinical groups was around 80. A score of 80 is often the mean used for lower functioning control groups (see Turner, 1999) as such it is not surprising that the executive tasks used in this study failed to find a difference between those with autism and those without.

The main reason for the inclusion of the WCST in this series of experiments was then to identify whether savant artists show any spared performance on a classic test of executive function, compared to a non-talented, autism control group, as a result of their artistic ability. This was not the case, despite producing slightly less perseverative and overall errors than the autism controls, this difference did not reach significance. The failure of the WCST to differentiate between groups in this context and the differences that arise between the groups in the design fluency task warrant some further discussion, provided below.

7.9 GENERAL DISCUSSION

The aim of this set of experiments was to investigate the executive performance of the savant artists, firstly on a task in which the output was in the domain of their ability and secondly on a classic task of executive function. Firstly, the performance of the savant artists was found to be significantly above that of the autism controls on the measure of fluency in the design fluency task. Indeed, the performance of the non-talented autistic group was also lower than that found in the LDC group. This supports previous findings pertaining to pervasive fluency deficit in autism (Jarrold, 1997; Turner, 1999). However, the savant group did not show such a deficit, indicating that, in the domain of their talent, they are more generative than their non-talented controls.

The second topic for discussion, that of perseveration, was measured on both the design fluency test and the WCST. In Turner's (1999) study of fluency performance, she made the distinction between low (repeats) and high (redundant) level perseveration. In this investigation the rate of repeats was very low[9]. As such the errors made on this task can be seen as evidence of stuck in set perseveration, or a lack of flexibility, and are comparable to the type of error measured in the WCST, a specific test of cognitive flexibility. Here the savant artists were found to produce the same proportion of perseverative errors as the autism controls on both the design fluency task and the WCST. Hence, not only did they fail to show any sparing of ability overall, but also there was no domain-specificity found on this measure of the design fluency task. The finding that the savant artists showed similar performance to the autistic controls on this measure is not entirely surprising. Flexibility deficits are a robust finding in autism, not only on tasks such as the WCST and the ID/ED (Hughes et al, 1994; Ozonoff & McEvoy, 1994; Ozonoff et al., 1991; Rumsey & Hamburger, 1990), but also on their generative output (Lewis & Boucher, 1991). Indeed the same could be said about savant artists who, as mentioned in the introduction of this chapter, often stick to one topic in their art work.

The third area investigated on this task was monitoring performance. In the design fluency task, monitoring performance was measured by looking at the total number of novel, or acceptable, responses. In the WCST monitoring performance was measured by looking at the total number of non-perseverative errors, although total error can also be seen as evidence of a monitoring impairment, as participants still fail to use the feedback provided by the experimenter to modulate performance. It is here that the most interesting contrast between the two tasks arises. Whereas on the WCST the savant artists produced the same number of errors as the autism control group, on the design fluency task they produced significantly less. As Jones-Gotman and Milner (1977) mention, the more responses produced, the more likely errors will occur, as the more likely it will be that responses either resemble real things or previous patterns. Yet, despite producing more responses overall, as indicated on the fluency score, the savant artists did not produce a higher proportion of errors.

This result may occur as a result of the savant group possessing superior monitoring behaviour, in that they were better able to relay the visual information of what they were drawing back to motor control, in order to produce acceptable responses. This suggestion is consistent with the points raised by Turner (1999). She maintained that

[9] A total of four repeats were recorded, between two participants, one from the autism control group and one from the savant group.

due to the abstract nature of the task, participants were not required to preformulate a response, hence are more reliant on visual feedback to monitor their responses. In her study the individuals with autism were particularly poor at this, indicating an autism-specific monitoring deficit. This appears not be the case in the savant group. What is more, the view that the savant artists are more able at monitoring their responses and feeding back visual information to motor control fits in with previous results obtained with a savant group, on tasks such as mirror drawing (Hermelin et al., 1994).

The finding that individuals with autism have difficulty in action monitoring and error correction was also raised by Russell and Jarrold (1998). They suggested that the problems encountered by this group arose from difficulties in generating visual schemas and utilising visual feedback effectively. They cite two studies in support of this view. Firstly they refer to a finding by O'Connor and Hermelin (1975) in which children with autism were found to be as poor as those with a serious visual impairment at reproducing a distance movement. They argue that the poor performance of the children with autism results from their inability to construct a visual schema to accompany their motor movement, as a result they have to rely on visual input only. They then cite a study by Frith and Hermelin (1969) in which children with autism were found to rely on motor feedback rather than visual feedback, on a tracking task. While initially these two results do not gel together, Russell and Jarrold maintain that the children with autism are unable to utilise both the visual and motor feedback, which would result in optimum performance on this task. This, they maintain, is because children with autism have, as a result of their impaired ability to generate visual schemas, learned to rely on motor feedback in order to avoid confusion from the two input sources.

In testing this hypothesis Russell and Jarrold (1998) found that children with autism were less able than controls at correcting visible errors (external) and those which had yet to become an apparent error (internal errors) on a computerised missile shooting task. They concluded that the failure to correct internal errors resulted from their failure to generate an adequate visual schema for the action taken, whereas they failed to correct external errors as they were more efficient at using motor feedback rather than visual input. The results of Russell and Jarrold's study, fit well with the results obtained on the design fluency task and with the style of drawing favoured by savant artists, in which they rarely amend outputs by rubbing out. The superior performance of the savants on this task then, and the incredible accuracy associated with their artwork, may then result from their ability to construct visual schemas. This explanation is certainly consistent with previous findings in which savant artists have superior motor programming capacity (O'Connor & Hermelin, 1987b) and are better at recalibrating novel visual feedback with motor ability as evident in Hermelin et al.'s (1994) study. The ability of savant artists at generating visual schemas from motor input is especially evident in O'Connor and Hermelin's (1990) finding that savant artists were better than controls on a visual-kinaesthetic matching task and also at reproducing tactically presented figures. It may thus be that as a result of the savant artists being able to generate better visual schemas, based on motor or visual input, they are superior at internally monitoring their motor outputs. Whether their failure to correct external errors arises from their visual schemas being so accurate that they do not need to make any corrections, or a failure in external error monitoring remains to be seen.

The main aim of this investigation was to gain a measure of the executive abilities of the savant artists with specific reference to inhibition and monitoring. Following the paradigm used throughout, performance was measured firstly in the domain of ability, this study this was then followed by a more general task. On the WCST, a task taking place outside of the visual-motor domain, the performance of the savant artists was comparable to the non-talented control groups. This is in contrast to the results that were gained on the design fluency task. Here both overall fluency and the amount of acceptable responses were talent dependent, as evident in the superior performance of the savant artists compared to the autism control group. This indicates that in the domain of their ability the savant artists are both more generative and more able to correctly monitor their responses. This superior monitoring behaviour is only evident where the task is drawn and appears to result from the savant group being more able to generate visual schemas based on motor movements, which may result in increased accuracy in their art work.

Chapter 8:

General discussion

8.1 THE AIMS OF THIS THESIS

The aim of this thesis was two fold; firstly to attempt to measure the creative and generative capacity of a group of savant artists both in and outside of the domain of their ability and secondly, to uncover the processes that underlie their creative performance. This was investigated with specific regard to their diagnosis of autism, their artistic ability or their overall level of cognitive functioning. On the whole, until recently, studies that have looked at creative ability have been taken less than seriously by the scientific community. Some have argued that creativity is not a valid psychological area and others have criticised the subjective nature of research endeavouring to measure this concept (see Finke et al., 1992). However, despite these criticisms, investigations into the processes considered to underlie original or novel thought in everyday thinking have been steadily increasing over the past decade and the study of creative ability is finally becoming recognised as a viable area for objective, scientifically based research.

The change in viewpoint regarding research into creativity is mirrored in autism research. Until the mid 1990's, there had been only a handful of investigations into this area (Frith, 1970; Jarrold et al., 1994a,b,c; Lewis & Boucher, 1988, 1991), despite a lack of imagination making up one third of the triad of impairments, along with communication and socialisation, which characterise autism. Nevertheless, despite this increase in interest, creative performance in autism is still a comparatively neglected topic, making the investigations outlined in this thesis very important in furthering our understanding. The creative and generative capacity of savant artists is an area that has, until this point, been almost entirely overlooked. Several single case study papers (Hermelin et al., 1999; Pring et al., 1997) have attempted to investigate creative transformations in spontaneous artistic output produced by several, individual savant artists, although thus far not one attempt has been made to actually measure such abilities and processes comparative to non-talented control participants. This is an interesting paradox as most savant artists have received a diagnosis of autism.

The relative lack of previous investigations into this intriguing topic naturally resulted in a number of challenges early on in this thesis, first and foremost was to define the terminology that would be used throughout. Unlike other processes that have been the subject of investigations with similar groups (for instance memory or manual dexterity) creativity is a term with many, often sceptical, connotations. As the aim of this series of experiments was to objectively measure creativity and generativity and the processes underlying these, rather than make judgements regarding the creative nature of the savant artists' output, no assumptions have been made regarding the historical or aesthetic importance of their spontaneous productions. Chapter 2 provided a number of definitions that have been proposed throughout the years. As mentioned, there appeared to be a division between those accounts which place emphasis on the end *product* and those placing importance on the *process*. This thesis takes both factors into account, the first two experimental chapters (the TTCT and the figural synthesis task) look at the product, with the focus on objective measurement, whereas the final two experimental chapters provide further insight into the processes that may underlie such performance. A further distinction was also made, for the purpose of this study, between creativity and generativity. Creativity was defined as the capacity to produce *new or original* ideas. Generativity on the other hand, is seen as the production of a number of ideas, with little regard as to the value of these products. In view of this, an emphasis on both quality and quantity of output is critical. These two aspects of production are independent and although they may, they do not necessarily co-exist. For instance, an individual may produce a number of mundane, everyday responses or ideas, thus illustrating high generativity but low creativity, whereas a highly creative individual may only produce a small number of highly original responses.

8.2 THE CREATIVE PRODUCT

As mentioned above a distinction was made throughout this thesis, between the product and the cognitive processes that might influence this. The initial aim of experiments 1 and 2 was to identify the creative and generative capacity of the group of savant artists who participated. In order to assess their ability, performance was compared to three control groups; two IQ matched groups, a group with autism and a group with general learning difficulties, and a group of talented A-level art students. The inclusion of these three groups allowed comparisons to be made between performance and conclusions to be drawn as to whether this was a result of an autism-specific impairment, general cognitive functioning or artistic ability.

8.2.1 The Torrance Test of Creative Thinking

The next step was to find a measure suitable for administration to participants with a range of IQ scores, from borderline up to high-functioning. Furthermore, as this was the first attempt to measure savant creative ability, it was important to assess this initially in the domain of their ability. As such, the Torrance Test of Creative

Thinking (Torrance, 1974) was chosen. At the outset this appeared to be a very useful test; not only did it require only minimal verbal instructions but it also provided a set of standardised norms, a detailed scoring guide and importantly for a study of this sort, it broke down separate areas of creativity into four dimensions. It was the use of the different dimensions that made this test particularly appealing, as not only did the dimensions measured correspond with areas previously found be deficient in autism (such as *flexibility*), but it clearly differentiated between *generativity* as measured by the *fluency* dimension, and *creativity* as measured by *originality*.

Despite early indicators as to the suitability of the TTCT for this study, the results were disappointing. The over-riding result was the far superior performance of the group of art students whom, despite having comparable levels of artistic ability to the savants, far out performed the three clinical groups on every measure. This result highlights the importance of overall intelligence on this test and as a result, brings into question the TTCT's usefulness as a valid measure of creative performance.

Generativity: The amount of ideas produced

Although the TTCT made use of four dimensions, it was fluency and originality that were of specific interest here. Throughout, fluency performance has been equated with generativity, yet here the results were inconclusive despite the generative problems associated with autism. This is partly due to a decision that was made to reduce the number of stimulus figures in the repeated figures task to the same amount as was presented in the incomplete figures task, thus allowing performance on the two tasks to be compared. This decision was taken in order to reduce the overall task demands and to allow the investigation of each of the dimensions without the added demands of producing many different responses. This meant, however, that the task was a closed test and as many participants performed at ceiling, there was little differentiation between groups. Notwithstanding, the performance of the autism control group was somewhat lower than in the other three groups but this difference did not meet significance.

Creativity: How original were the responses

Aside from the problems concerning the measurement of generativity by the TTCT, it was initially thought to be very useful for measuring originality, in that it tapped how statistically rare a response was. Again no group differences arose on this task between savant artists and the two IQ matched control groups. One important criticism that can be aimed at this measure, however, is that a *visual response* is scored on *semantic title*, thus any unusual visual representations will go unrecognised as scoring is on the basis of response title only. This criticism is especially valid considering the unusual visual, perceptual characteristics associated with autism (Turner, 1995).

Elaboration: A critical factor

Regardless of the criticism levelled at the TTCT it is still possible to glean some interesting findings from this study, especially with respect to the performance of the savant group on elaboration. Here the savant artists were found to produce significantly more elaborate responses than both the autism control group and the LDC group. Although it has been stated above that it was performance on the measures of fluency and originality that were crucial in this task, the dimension of elaboration can be seen to pick up on each of these. Elaboration measures the amount of *new* details added to a response, and to gain a high score individuals need to be both generative (to generate a number of details) and creative (to make each detail different). Therefore simply drawing a tree with lots of leaves would not have gained a high elaboration score unless each of the leaves was clearly drawn in a different, meaningful style. On this measure then, the savant artists do show a greater creative and generative capacity than other individuals of equal cognitive ability.

8.2.2 The Figural Synthesis, Construction Task

The next step was then to look at performance *outside of the domain of drawing*. As discussed in chapter 5, although the question of domain-specificity is an important one, savant artists do show superior scores to controls in related areas, usually in the visual-motor domain. This study thus attempted to investigate if creative and generative ability also extended beyond responses that were drawn. Further to this it was also important to pick up on the shortcomings of the TTCT as an adequate measure of creative and generative ability. One of the most critical problems with the TTCT was the failure of this test to pick up on unusual representations of common objects, hence the next task used needed to recognise this type of visual creativity. Moreover, it needed also to gauge generative ability by gaining a true measure of fluency. For this purpose a paradigm used by Finke and Slayton (1988) was modified in order for it to be applicable for use with a mixed intelligence group. Participants were presented with a variety of simple shapes with which they were required to generate recognisable representations, these responses were named by the participant and then drawn by the experimenter. Responses were scored on three factors; *fluency*, the *number of recognisable* responses and *originality*. Importantly, this figural synthesis, or construction task, was also very useful as it required participants to generate their responses without the use of a given starting figure or prompt. Although there was very little difference between groups on the two and three-figure conditions, it was on the four-figure condition that the patterns were found to emerge. It was suggested in chapter 5, that the reason that the four-figure condition was crucial was because participants were not able to draw on stored memory representations (such as a square with an inverted triangle for a house) to aid their responses. The four-figure condition, therefore, required participants to be both more generative and more creative.

The quality vs. quantity distinction.

In contrast to the inconclusive results gained on the TTCT, a clear autism-specific deficit was found on fluency in the figural synthesis task. Here the performance of the savant group did not differ from that of the autism control group and was below that of the LDC group, although this difference narrowly missed significance. This result thus provides further support for a general generativity impairment pervasive in autism, which affects savant artists similarly when responses are outside of their domain of expertise. While performance on the measure of fluency seemed to be determined by diagnosis, in contrast the result of the originality measure was *talent related* and the performance of the savant group mirrored that of the art student group. A point does need to be raised at this time regarding the measurement of originality in the two tasks used to investigate the creative product. Namely that in both cases originality has been measured by comparing the *number* of original responses produced, thus confounding the measures of creativity and generativity. Although throughout, a fluency independent score has been calculated, is may still be argued that it is inappropriate to measure a qualitative product using quantitative means.

However, for the results to be subject to statistical analysis it was important to look at creativity in a quantifiable way. It is perhaps important to point out though, that on the crucial four figure condition of the construction task, six of the nine savant artists produced at least one response seen as original, compared to only four and two participants in the LDC and autism control groups respectively.

8.2.3 The Creative Product: Some Conclusions

What conclusions can be drawn then from this first set of studies as to the generative and creative product? Although a variety of measures were taken on these first two investigative tasks, it is the contrasting findings on the measures of fluency and originality which are of most interest regarding the generative and creative capacities of this intriguing group of artists. These two areas will now be discussed individually.

The decision to reduce the number of stimulus figures in the TTCT, repeated figures task, meant that it was difficult to draw any suggestions regarding generative ability on the TTCT and this has meant that any conclusions on this measure are still tentative. Nevertheless, the savant group seemed to be subject to the same deficit as the autism control group on the fluency measure of the construction task. This indicates that the savant artists do share the generative impairment that characterises autism performance on this task. However, a further measure of generativity was obtained by looking at the results of the design fluency task reported in chapter 7. Here the performance of the savant group was equal to that of the LDC group and clearly above that produced by the autism control group. This supports the suggestion that in the area of their special ability, autistic savants do not show the general autism fluency impairment. This inconsistency between performance on the two tasks can then be seen as evidence of the domain-specific nature of savant talent. It appears that the generative capacity of the savant artists is unhindered on tasks in which the response is drawn. Conversely, on tasks where the response takes place outside of this modality, the artistic ability of the savant group, and the generative nature associated with this, do not spare such individuals from the deficit resulting from their diagnosis.

In contrast to the above discussion, the pattern of results is reversed regarding *creativity*. Here there is no difference between the savants and their IQ matched controls on the TTCT and performance is far below that of the art students, even when the fluency independent scores are analysed. Yet, on the figural synthesis task, a task that takes place *outside* of the drawn domain, the creative performance of the savant group is more similar to that of the art students than the two non-talented groups. Initially this result is somewhat unexpected, why does the creativity difference only arise on the non-drawing task? The reasoning for this may be in the superior sensitivity of the construction task at picking up *visual* originality or creativity. Further to this, the presence of a stimulus figure in the TTCT may actually have reduced creativity, in that individuals found it difficult to over come the initial representation prompted by this stimulus figure. It was noticed by many of the participants that some figures in the TTCT were easier to incorporate than others, indeed it may have been that those 'easy' figures that prompted immediate and common responses were the reason behind the large *within-participant* variation found on this task. In the construction task, conversely, there was no initial starting point and participants needed to generate the response totally from scratch.

With regard to the original responses produced in the construction task, although the difference between the savant group and the LDC group only approached significance on the crucial four-figure condition, this is likely to be more a result of the low power of the analysis due to the small number of participants in each group. Thus it is the pattern of data which is most important here, with the savant group producing exactly the same pattern of results as the art students. This is a stark contrast to the difference between these two talented groups on the TTCT. Creativity as measured by the figural synthesis is thus seen to be facilitated by artistic ability even though the mode of output does not involve drawing. This result is important as it illustrates that artistic ability goes beyond this simple act of putting pencil (or paint brush) to paper and is also evident in other domains.

Conclusion on the creative product

The poor discriminatory power of the TTCT was disappointing and this test on the whole can be criticised for being little more than a measure of general cognitive ability, as evidenced by the very strong correlation between performance on the various measures and IQ in the LDC group. This aside, conclusions can be drawn on the basis of the far superior tests of generativity used thereafter, namely the figural synthesis task and the design fluency. Here we can conclude that the savant artists show a fluency deficit on tasks where the modality of response is not drawing that is characteristic of their diagnosis of autism. However, on tasks where the response is drawn, the performance of the savant group is equal to, or in some cases above, that of the IQ-matched non-autistic control group. It can be argued that this is only evident on a non-meaningful task such as the design fluency task, however, this is unlikely to be the case as evidenced by the superior elaboration scores reported in the TTCT; dependent on the addition of *meaningful* new details.

In terms of creative ability, when this is measured by looking at the originality of a visual response rather than a semantic title, the performance of the savant group is equal to that of talented art students with no cognitive impairment. It is interesting that this result is apparent on a task which takes place outside of the direct domain of their ability. One can conclude from this that in terms of creativity, the savant artists' ability extends beyond simply representing images by drawing or painting and extends to those which are constructed. The next question to address is thus, what processes can be seen to underlie these results?

8.3 THE CREATIVE PROCESS: ASSETS AND DEFICITS

There are, as described briefly in chapter 2, many processes seen to underlie creative performance. As such, the aim of this thesis was not to attempt to uncover all of these processes, but to attempt to identify those underlying the performance of the savant artist. A good place to start therefore, was by looking at the unusual processing style evident not only in autism, but also associated with talent and in some cases creativity.

8.3.1 Segmentation: Perceptual, Visual Style or Semantic Independence?

Chapter 6 set out to investigate if the segmented processing style, often referred to as weak central coherence (Frith, 1989) or segmentation (Pring et al. 1995), was stronger in savant artists. A second aim was to examine the nature of this processing style, specifically if it was related to a semantic or contextual independence or whether it was related to a visual processing style. One particularly appealing quality of this approach from a theoretical point of view, is that this theory is able to account for both the deficits and the assets associated with autism (Happé,1999) At several points throughout the discussion of the TTCT and the figural synthesis task, it was suggested that a segmented processing style might result in both the superior performance of the two autism groups as well as the autism-specific deficits they exhibit.

On the TTCT it was suggested that the performance of the two groups with autism may benefit from the initial presentation of a stimulus figure. This prediction was not supported, although this was possibly due to the limitations of the test. However, the proposal that this processing style may account for both the deficits and assets associated with the performance of the participants with autism on this measure, was more relevant under the discussion of the originality scores produced in the figural synthesis task. Here it was proposed that the particularly strong segmentation skills of the savant group allowed them to produce results in keeping with the talented art student group. Further to this it was also suggested that this processing style may account for the poor performance found in both the savant group and the autism control group, with regard to representational fluency. This was seen to be due to either problems in generating meaning, associated with the difficulties individuals with autism have displayed *extracting* meaning, or alternatively the result of a heightened segmentation leading to responses that were so unusual they were unrecognisable.

It was therefore necessary to investigate if the savant artists in this group did indeed show a stronger bias toward this detail focused processing, and if so, did this style result in a lack of contextual awareness? In order to do this two versions of the embedded figures test were generated, based on the original stimuli. The results indicated that, although the savant group did differ from the LDC group overall, their performance was not above that of the autism controls, despite a trend towards the savant group producing faster responses. What is more, none of the groups appeared to show any sort of semantic independence, as indicated by the lack of any interaction between the meaningfulness of the condition and nature of the group. The lack of any semantic independence in the groups with autism, as evidenced by the lack of any relative superiority on the meaningful condition, indicates that it is unlikely that the lack of representational fluency is due a semantic impairment.

That the performance of the savant group did not differ significantly to that of the autism control group appears to indicate that it is unlikely that superior segmentation abilities in the savant artists can account for the positive results gained on the originality measure in the figural synthesis task. However, the finding that individuals with autism perform above controls on the EFT is not a consistent one (Brian & Bryson, 1996; Ozonoff et al., 1991). Hence if the discriminatory value of this task is questionable *between* groups of individuals with and without autism, it may not be the most appropriate test to use to investigate differences *within* different groups of autistic individuals. Therefore, before any conclusions could be drawn it was necessary to look at performance on another task associated with this processing style, but which has consistently been found to differentiate between talented and non-talented groups of autistic individuals such as the block design.

The results of the block design task presented here, supported previous findings (Hermelin et al., 1994; O'Connor & Hermelin, 1987a; Pring at al., 1995) by indicating that the savant artists were indeed superior to both IQ matched control groups at this task. This is interesting as many studies have reported strong correlations between the two tests (Jarrold et al., 2000; Ropar & Mitchell, 2001). It brings us to question what it is about the savant artists' ability that results in superior performance on the block design, but not the EFT? The reasoning behind this relates to the differential task demands. In the EFT participants are required to draw around the hidden figure only after it has been identified, on the block design, however, the test itself has an inherent motor element in that participants are required to continually manipulate the blocks until the correct design is achieved. As such the EFT can be considered a *passive recognition task*, whereas the block design appears to be an *active construction task*. It is also interesting that the two tasks appear to be mirror versions of each other, in that in the EFT, the aim is to find a part within a whole, whereas the block design requires the generation of a whole from parts. Although both measures are facilitated by a cognitive style favouring attention to parts or details, only the test involving a generative aspect, with a motor element, distinguished between the performance of the two groups with autism.

The results of EFT and the block design, as discussed above do support the view that a segmented, although *not* semantically independent, processing style may facilitate performance in the savant artists, especially on tasks with an active, constructive element. As illustrated here in the EFT, there was no evidence of an autism-specific, semantic independence. Hence the hypothesis that the poor representational ability of children with autism was a result of a deficit in the generation of meaningful responses, was not supported. A second explanation was that the poor performance of the savant group on the representational fluency measure of the figural synthesis task might also be due to this unusual processing style, in that their visual processing is so detailed that the responses were unrecognisable to anyone else. While appealing in the first instance, this explanation can be brought into doubt when one considers that neither the block design nor the EFT differentiated between the LDC group and the autism control groups. As the autism controls did not display this segmented processing style it is unlikely then that it could account for the number of non-recognisable responses produced on the construction task. Thus, in looking for an acceptable account for the autism-specific deficits found on measures such as fluency and representational fluency, attention must focus on a different area, one which seems to affect both savant artists and non-talented individuals with autism equally.

8.3.2 Monitoring: An Explanation for a Deficit?

The finding that neither a semantic deficit nor heightened segmentation is likely to account for the autism-specific deficits reported on the figural synthesis task, indicated that there were other factors at play leading to the poor performance of these participants. One area proposed to account for the difficulties shown by individuals with autism on tasks of generativity relates to their executive abilities. A comprehensive account of these deficits, which places the pattern of performance associated with individuals with autism into a theoretical background, was suggested by Jarrold (1997). He argued that the poor generative and creative performance shown by individuals with autism was a result of their poor goal representation or specification, within the Supervisory Attentional System. The suggestion was that poorly represented goal states would result in reduced generativity, increased inhibition and perseveration and a lack of behavioural monitoring.

With regard to the generativity displayed by the savant group here, the results were mixed and explanation of this pattern of results is proposed later in this chapter. However, it can be concluded that where the response is not drawn, the savant artists suffer from the same generative impairments as individuals with autism. This supports previous findings discussed throughout and it is likely that the root of this deficit is executive in nature and related to the Supervisory Attentional System, as suggested by Jarrold (1997). A similar response pattern was indeed reported by Turner (1997, 1999) in her thorough investigation into the generativity performance of individuals with autism.

An autism-specific deficit was also indicated on the representational fluency measure of the figural synthesis task. In some ways this poor performance can be considered a monitoring deficit, in that the participants in the two groups with autism seemed unable to produce a variety of acceptable results. It is interesting that on this task the scores produced by the LDC group were consistently poor across all four conditions. This contrasts with the performance of the two groups with autism, who only displayed a clear drop in performance as the number of figures increased. In the case of the LDC group it is likely that their consistently poor performance was due to the effect of IQ distribution on performance, with the participants at the lower end of the IQ rarely producing any recognisable responses. This suggestion is supported by the strong correlation between IQ and representational fluency in this group. It was proposed then, that a deficit in monitoring performance may account for the poor performance of the two groups with autism on this task, in that they were less able to distinguish between acceptable and unacceptable responses. Again this supports the results of Jarrold (1997) and Turner (1999). It would appear that individuals with autism are unable to amend a response when it is incorrect, as a result of external or internal feedback. Thus, even when reminded that their answer must resemble a real object, they continued to produce unrecognisable responses. To investigate the suggestion that a monitoring impairment might result in poor performance on tasks of generative and creative ability, it was necessary to test this process directly.

In order to investigate the executive abilities, with particular reference to monitoring behaviour, two tests were presented to the three mixed intelligence groups. Initially the design fluency task was used. This was a very useful task not only because it had previously been found to discriminate between individuals with autism of both high and low-functioning, but also as it took place in the domain of the savant's ability. It was found that the savants made significantly less errors than the autism control group on this measure. Indeed, the poor performance of the autism control group on this task is consistent with previous reports of a monitoring impairment associated with the disorder. What was interesting was that the artistic ability of the savant group seemed to spare them from this. The next step was then to look at monitoring on a task where the response was not related to the savant artists domain of ability. Here the WCST was used and the performance of the savant group found to be equal to that of the autism control group. It appears that when the output is drawn the savant artists are able to monitor their outputs effectively, however, on tasks with no drawn element they exhibit the same impairments as those with autism but without any special artistic ability. This explanation neatly accounts for the autism-specific deficits found in this group on the figural synthesis construction task whereby participants did not appear to be able to monitor their responses effectively.

8.4 THE WIDER PICTURE

The contribution of this thesis goes some way in extending our understanding of artistic savants and their creative and generative capacities, however, there is the need for some further explanation. The distinction made throughout this thesis between creativity and generativity is an important one, as it appears that there is a play off in savant artists between creating novel, original outputs and generating a number of acceptable responses. These two results will now be discussed in more detail as related to the savant artists' spontaneous artistic productions. Firstly, this group of artists do appear to produce more creative responses than their IQ matched control groups, a conclusion based mainly on the results of the figural synthesis task. While a critique of the methodology behind the TTCT has already been proposed there is one more important criticism concerning the use of this test and this relates to the specialist nature of savant artists' talent, specifically that the TTCT was designed as a general test of creativity and thus may not pick up the specialist , visually based, skills found in savant artists.

It is then interesting that their creative ability was picked up in the figural synthesis task. The figural synthesis task has many similarities to the block design, a test where savant artists have been consistently found to produce higher scores than non-talented, autism control participants. As mentioned, both tasks require the individual to create a whole out of parts and it is thus likely that the heightened segmentation, the capacity to use this skill creatively and their superior manual dexterity, in part result in the savant artists' ability. Indeed several case studies (Hermelin et al. 1999; Pring et al., 1997; Sacks, 1995; Selfe, 1983) have reported the superior transformational abilities apparent in several of these artists' productions. The heightened segmentation ability possessed by these individuals may allow them to highlight different elements in their outputs, resulting in more aesthetically appealing end products. Although many of these artists need a constant visual aid to help them with their outputs, their artwork is rarely a exact replica of what they see (Sacks, 1995). What is more, the production of a piece of art work is dependent on the artist combining several elements in order to produce a meaningful whole. As Hermelin et al. (1999) discuss in their case study of artist Richard Wavro, he built up each element of a painting piece by piece, often painting over images in the background.

Clearly, the creative aspects of these savants' spontaneous artistic productions are quantifiable using scientific tests, as long as these tests are designed to pick up creativity in the visual domain and not reliant on strong verbal responses. Furthermore, this creativity is also apparent on tasks which do not involve an output which is drawn. This final point is an important one; the creativity the savant artist possesses is a perceptual one, it has a limited conceptual component and it is for this reason that while these artists may be able to produce exceptionally accomplished drawings and paintings, it is unlikely that they will ever produce a meaningful piece of art. As Hermelin (2001) points out, despite an outstanding artistic ability the savant artist will never produce a great masterpiece, in the same way that a savant musician will never become a great composer. While their diagnosis of autism might in many ways add to their ability, ultimately it is also the factor restricting them from achieving true greatness.

As discussed in detail, domain-specificity is an area very important to this investigation. Several researchers have suggested that creative discovery or production can only occur within the narrow field of an individual's expertise (see Finke et al., 1992). However, certain cognitive strategies may promote creativity in related areas. This certainly seems to be the case initially in the series of experiments outlined here. Savant artists are often found to produce superior results to their non-talented controls on tasks that involve a drawn response, as well as those with a strong visual-motor component (see Hermelin, 2001 for a review). The explanation of creativity above is in line with this view, however, while initially the results regarding generative ability also support this notion, the explanation is not as simple as first appears. The next discussion focuses on the autism-specific deficits found throughout.

It was suggested that the superior creativity scores produced by the savant artists on the figural synthesis task were related to their segmentation ability, and parallels were drawn between this task and the block design. In line with the above points concerning domain-specificity in creative performance, it can be argued that very similar cognitive processes are at play in the two tests and that the processes are also integral to artistic ability in general. However, while performance on the originality measures relate to talent, performance on representational fluency and generativity was determined by the savant artists' diagnosis of autism. The question then arises, if this group of savant artists do posses superior segmentation skills on constructional tasks and are better than non-talented controls at generating a whole out of parts as measured on the block design, why is their performance on the other two measures of the figural synthesis task so poor? Surely if an overall monitoring deficit could account for the poor performance on the figural synthesis task, as a result of participants being unable to utilise visual feedback on a task that was not drawn, this would also affect performance on the block design, regardless of the positive facilitation that may arise as a result of their heightened segmentation?

The answer to the above question can be found in the emphasis of the two tasks discussed above, in particular whether they are convergent or divergent. Support for this view can also be found in the reported literature. Specifically it is suggested that the tasks on which the savant group have produced superior results to the controls (such as in the mirror drawing, the movement in 3-D space and the block design) all have clearly outlined end goals. In the case of the mirror drawing task the goal was to draw around a simple figure using the reflection in a mirror. For the movement in 3-D space, participants were required to move a ring around a metal frame and on the block design, they were required to create a 3-D construction of a visible 2-D image (Hermelin et al., 1994; Pring at al., 1995). The key factor in each of these tasks, above that of motor control, was that in each the goal of the task was clearly stated, responses were either correct or incorrect and as such the tasks are considered convergent. This was not the case in the figural synthesis task, here there were no clearly defined right or wrong answers, it was the responsibility of each participant to make a choice as to whether each response was a clear representation. As such the performance of the savant group dropped in line with the autism control group. A similar result was also gained on the WCST, a test of monitoring ability but with no continuous motor component.

The suggestion that the savant artists display autism-related deficits with monitoring behaviour in accordance with a goal state, is consistent with Jarrold's (1997) explanation of the generativity deficit found in autism and also with the finding of a generativity deficit in the savant artists. Nevertheless, while this explanation is compatible with the results reported on measures of fluency and representational fluency on the figural synthesis task, it cannot account for the fact that savant group did not show any generative deficits on drawn responses. The finding that savant artists produce superior results on tasks that include an element of drawing is consistent with previous research (see chapter 5 for a full discussion of these tasks), although there has yet to be a fully conceptualised account of this finding. The results of this investigation indicate this ability is also generative in nature. So again, the question arises, what is it that allows the savants to produce more generative responses with less errors when the response is drawn?

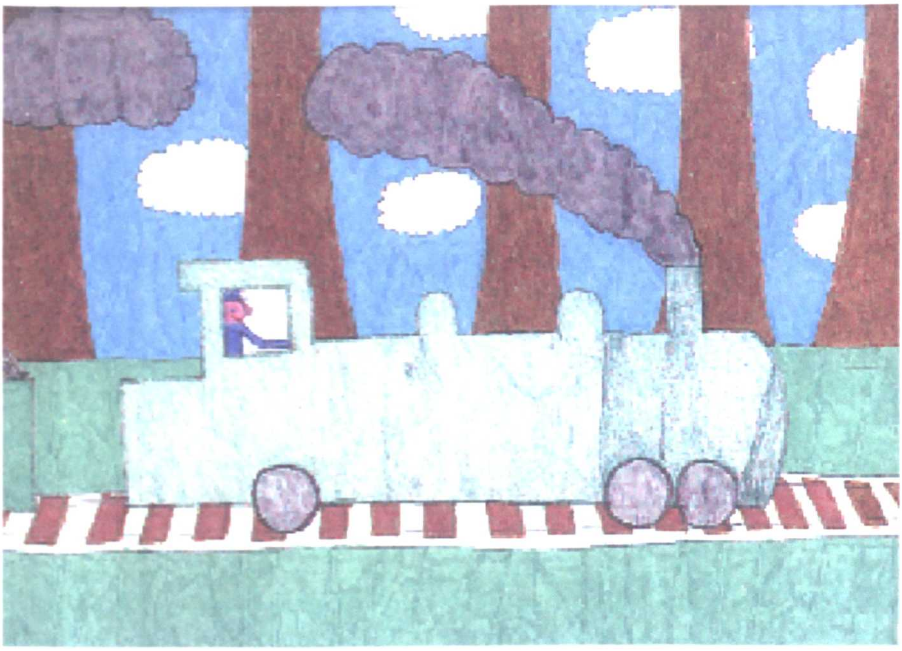
Perhaps it is easier for this group of talented artists to set themselves goals in the drawn domain. Certainly, as Thomas and Silk (1990) suggest, the act of producing a piece of art work requires a goal to be set, even if that goal is as simple as to represent an image on paper. Art is by definition a generative activity, therefore perhaps it is not surprising that the savant artists are able to generate more in this domain, even if they are generating images with no semantic associations, such as in the design fluency. This may be in part due to them having a larger pictorial lexicon, or visual dictionary (Hermelin, 2001), which certainly one would expect given their artistic ability. They may also have better hand-eye co-ordination and as such are more able to amend what they are drawing as they are drawing it.

This last point brings us to the finding that the savant artists also produced fewer mistakes in the design fluency task. This is interesting considering the points raised above with regard to clearly specified goals, since as Turner (1999) states, the design fluency task requires a considerable amount of monitoring. As the savants appeared to have a problem with this on the figural synthesis task, it seems strange that their performance should be so much better than the autism controls on the design fluency. It is possible that the savant artists' familiarity with monitoring their drawn outputs and their superior manual dexterity, may impact in a positive manner on their performance. What is more, there is a qualitative difference, observable in the performance of the figural synthesis and the design fluency tasks. In the design fluency participants were required to draw consecutive responses until the time limit had expired. Consequently it could be seen that the savant artists set themselves short, individual goals, compared to the constantly changing role of the figures used in the figural synthesis task. Perhaps the impairment arises because the participants with autism were unable to update rules effectively in their minds, a necessary process as they were required to use the same figures throughout.

Interestingly, a further difference between the two tasks relates to the points made at the end of chapter 7 in which a study by Russell and Jarrold (1998) was discussed. Here it was suggested that individuals with autism may show deficits at amending internal and external errors. Although this hypothesis was not directly tested, it is possible to extrapolate on the basis of the results gained in this series of studies that the savant artists are able to internally monitor their drawn outputs. This may occur as a result of the savant artists' superior visual schemas, but possibly being less able to amend responses after they had been completed. What is fascinating in line with this suggestion is the observation made in chapter 5, where it was recognised that both groups with autism made less use of the 'trial and error' method when producing their responses. That is they did not appear to internally monitor and simply named most of the responses produced on the figural synthesis task, a result that could be seen as evidence of an external monitoring deficit.

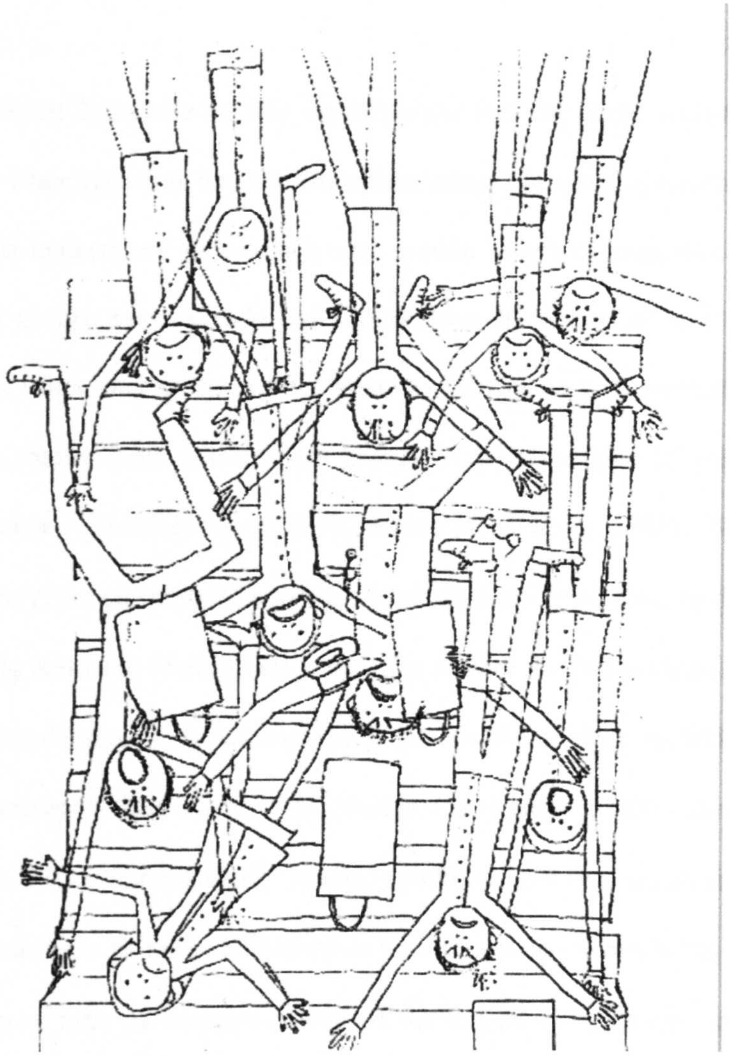
In relating the above discussion back to the spontaneous artistic outputs produced by the savant artists, this account can go part of the way toward explaining why many of the savant artists need a constant visual aid in order to help them paint and rarely draw from imagination. As discussed in chapter 3, of the nine artists involved in this research, only two regularly drew from their imagination or even from memory. The remaining seven all require constant visual aids such as an image which they could refer back to. It may be that only when the goal of their art work is immediately apparent are they able to draw to the best of their ability, without this visual aid many of the savant artists seem unable to set themselves goals regarding what to portray in their output. A perfect illustration of this can be seen in the two examples of artwork shown below produced by savant ML. The first, shown in figure 8.1, was produced by ML following instruction from his art teacher to draw something that reminded him of a recent holiday he had just returned from. Clearly the quality of this output is nowhere near that of his usual standard, when he draws from photographs he has taken.

Figure 8.1: 'A holiday memory' produced by ML from memory



Unusually for ML, the image in figure 8.2 was also drawn from his imagination, however, this was drawn after being told a very detailed story about a broken escalator. Following this story he was talked through what this scene might look like by his art teacher and ways in which he could draw it. The final outcome still retains ML's unique artistic style and can thus be seen as evidence of the creative nature of his artistic ability. It also shows that with clear goal-setting he is able to draw effectively from his imagination. It is unfortunate that this goal setting needs to be governed by another person, rather than ML being able to do this by himself.

Figure 8.2: 'Falling down' an original drawing produced by ML from imagination



8.5 LIMITATIONS OF THIS STUDY

One criticism that could be aimed at the studies reported in this thesis is that only visual or drawing tasks were used to assess creative and generative capacity. Indeed, there were several verbal tests that could have been used in this instance to gain a wider picture. However, the measurement of generative ability on a verbal task, when these savants have visual skills, would have been inappropriate and the equivalent of judging the creativity of a musician by asking him to paint a mural. As such the focus of this thesis was on the area thought to be associated with the talent expressed.

The most significant limitation of this investigation was the large within-group IQ range. Usually when research into the processes related to developmental disorders such as autism is undertaken, individuals with similar levels of cognitive ability are included. Such groups may include individuals with IQ scores of well below the average or, more often, due to the ease of testing, individuals with normal IQ scores are used. Some studies have utilised both groups at the same time in order to asses the overall influence of intelligence on performance (see Turner, 1999). Never, or at the very least rarely, are papers published reporting studies of non-talented individuals with wide ranging scores in intelligence tests. The reason for this is clear; in order to be sure that the results are due to autism related processes, all other variables must be reduced. Unfortunately this study, like similar investigations into savant ability before, could not follow that protocol. Savant syndrome is a rare occurrence, and as such all individuals who fit the profile need to be included in research. In actual fact this investigation of nine participants is one of the largest samples ever undertaken. As autism is a severe developmental disorder affecting individuals of all levels of cognitive functioning it is only natural to expect a wide range of IQ scores. To have excluded any participants because of their intelligence in order to make the group more homogeneous would have resulted in distorted results, which were unrepresentative of the savant population, however small.

The effect of overall cognitive functioning on performance is clear when the performance of the LDC group across the tests is studied. Here, on almost every test there was a very strong correlation between performance and IQ. Interestingly, such correlations were never apparent in the savant group and very rare in the autism control group. The range of IQ and it's effect on performance within the LDC group is clearly visible when one looks at the large standard deviations that characterised the results of this group, more so than the savant artists and the autism control group. Of course, this wide IQ range had implications for the tasks used in this set of experiments and in some cases it was felt that reducing the complexity of the task, in order for it to be presentable to individuals at the lower end of the IQ range, actually prevented group differences from occurring, such as on the EFT. However, it was felt that in this instance the end justified the means, and as was discussed throughout, the group differences on many of the tasks indicate that performance is not wholly a result of intelligence. Indeed the lack of a general IQ to performance correlation in the two groups with autism illustrates that deficits are found at all levels of cognitive functioning, indicating deep-rooted impairments within these groups.

A further, associated limitation relates to the small number of participants in each group and again there was little that could be done to rectify this. Some attempt was made at the beginning of this study to include a larger group of savants by contacting schools affiliated to the National Autistic Society, asking if they had any children at the school who displayed a precocious artistic ability. While several positive replies were received it was decided that it would be methodologically more sound to use a group of adults for this study, rather than confusing matters more by using a mixed range of ages and IQ's. It is nevertheless accepted that the small group numbers did have serious implications on the statistical analysis presented throughout and, coupled with the large standard deviations, often meant that full statistical investigations could not be undertaken. One possibility for future research with less time constraints would be to include control groups twice the size of the savant artist group to reduce any variance and increase power. As it was, however, the participants were closely matched on both verbal and performance intelligence in the two IQ matched control groups. This was no mean feat in itself, and very time consuming to achieve.

With regard to the tests used in this investigation, a full critique has been presented throughout in particular regarding the TTCT, which despite statements to the contrary by Torrance (1974) appears be greatly influenced by general cognitive ability. Also recognised were problems with the LDC group in the investigations into executive function, particularly as several of the participants in this group were diagnosed with mental health disorders associated with poor executive performance. While it would have been possible to get results from different participants it was felt that it was better in this instance to maintain consistency in the groups. Moreover, on tasks such as the WCST, it was the performance of the savant group comparative to the autism controls that was important. Finally, with hindsight it is accepted that there were some tasks that might have been preferable to the WCST to measure monitoring ability. However, in this instance it was necessary to use a task with no motor element and as such the WCST seemed most appropriate. Also the WCST did look at other areas of executive ability that were of interest and conclusions could still be gleaned from the results gained on this task despite the limitations associated with it.

8.6 FUTURE DIRECTION

So what can finally be concluded with regard to the creative and generative capacity of these artists? How does this relate to their spontaneous artistic output? And where does one go from here? From the experiments outlined in this thesis the following conclusions were drawn with regard to the creative and generative capacity of this group of savant artists. Firstly they only appear more generative than their non-talented controls when the task is in the domain of drawing. They are also more creative than those with similar intelligence but no artistic ability, possibly as a result of their unusual processing style; a style favouring segmentation. However, their performance on non-drawing tasks seems subject to the same deficits as found in non-talented individuals, possibly as a result of their failure to monitor their performance correctly when a clear goal is not set.

In chapter 2 several accounts of the creative process were outlined. Two which seem particularly apt in this instance were presented by Perkins (1981) and Lehmann (1997). Firstly Perkins argues that creativity involves four factors; planning, abstracting, undoing and making means into ends. Lehmann proposed a three-factor model of high ability; goal setting, evaluation and feedback. As such planning and goal setting appear to be analogous and, as Trehub and Schellenberg (1998) argue, savant artists do not seem to plan, evaluate or use feedback in their outputs. The findings presented here indicate that savant performance was poor when the goals were unspecified, indicating they have difficulty in selecting appropriate goals. However, in their drawn outputs they did not show the same impairments as the autism control group. It would appear then, that in their drawn output there is some evidence of goal setting, if only as simple as to represent an image on paper.

The other evaluative processes referred to by both Lehmann and Perkins do still seem missing in this group, as evidenced by their lack of evaluation, and anecdotal accounts that they do not amend their art work or actively seek to make it better (Hermelin, 2001). Finally, several descriptive case studies have referred to the creative transformations which occur in their art work and this could be due to the unusually segmented perceptual style that they exhibit, a style also associated with artistic ability in general. It appears, from the results presented here, that this perceptual style actually enables them to produce more creative responses, even outside of the domain of their ability. Returning to the earlier point regarding goal-setting in autism, it is interesting to note that of this group of savant artists, only one individual consistently drew using pure imagination. The lack of purely imaginative outputs without direct stimuli, may be the result of this poor goal specification. It may be that the savants are unable to set themselves achievable goals to follow unless they know what they are to draw, based on a visual input. Further research is warranted to look at the actual artistic productions of the savants in this group and to identify how their creativity may be manifest in their actual output. It is interesting in this respect, and in line with the points made regarding the influence of IQ on creative ability, that the savant artist who regularly draws only from imagination and often produces abstract pieces, PM, has the highest IQ of the group.

One further area of experimental interest would be to look at the monitoring performance of this group of savant artists on tasks which involve drawing following specific feedback, or to assess their ability to use evaluation and monitoring in this domain. Related to this and also of interest would be to investigate the points raised by Russell and Jarrold (1998); specifically to examine how this fits in with Jarrold's suggestions that the impairments shown by individuals with autism relate to goal representation or selection, and to attempt to assess if they do indeed show superior visual schema's as a result of motor movement. Finally, further investigations are warranted regarding the co-existence of a segmented visual processing style and planning ability. Indeed planning was one area which was not covered in this set of studies, mainly as it was not thought to be an underlying process associated with the production of creative thought; nevertheless if planning affects the production and output of creative thought then is it an important area for study.

These investigations will give us more insight into the processes underlying the performance of these fascinating individuals.

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Appendix 1: Individual IQ scores and personal characteristics of the autism control group

Match for	Year of Birth	Diagnosis	PIQ	VIQ
CH	1962	Autism	55	73
CM	1968	High functioning autism	98	78
DP	1955	Asperger's	72	63
MD	1978	Asperger's	94	92
ML	1965	Autism	90	84
PM	1965	Asperger's	105	110
SQ	1966	Autism	72	73
SW	1975	Autism	65	80
TM	1970	Asperger's	87	103

Appendix 2: Individual IQ scores and personal characteristics of the LDC group

Match for	Year of Birth	Diagnosis	PIQ	VIQ
CH	1969	Downs Syndrome	55	68
CM	1965	Epilepsy	106	104
DP	1965	Down's Syndrome	82	68
MD	1980	Mental Health	100	98
ML	1967	Mental Health	88	91
PM	1965	Dyslexia	118	120
SQ	1963	Global Learning Delay	76	83
SW	1973	Down's Syndrome	68	87
TM	1970	Mental Health	78	114