

CREATIVITY, IMAGERY AND SCHIZOTYPY: AN EXPLORATION OF
SIMILARITIES IN COGNITIVE PROCESSING

A DISSERTATION

SUBMITTED TO MIDDLESEX UNIVERSITY

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF
DOCTOR OF PHILOSOPHY

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Abstract

The aims of this thesis were twofold: the first was to develop a reliable and valid measure of the control of mental imagery, second was to explore the links between imagery, creativity and schizotypy. The Image Control and Recognition Task (ICRT) was developed because a reliable and objective measure of mental imagery control was lacking in the field. Two trend analyses ($n = 29$ and 31) found the tool to effectively measure individual differences in imagery control and the ability to reinterpret mental images.

A series of related studies using over 300 participants investigated the construct validity and reliability of the ICRT and found that it provided an accurate measure of both mental imagery control and image recognition, and revealed these to be related, yet distinct dimensions of mental imagery. The tool may be used to indicate abilities on a number of imagery control abilities which appear to be related to enhanced creative performance, such as evocation, rotation, maintenance and transformation.

An investigation with 96 psychology students looked into interrelationships between performance-based imagery control (ICRT), self-reported mental imagery abilities (vividness and control) and four dimensions of schizotypy (unusual experiences, cognitive disorganisation, introvertive anhedonia and impulsive nonconformity). A multiple regression found that mental imagery control, unusual

experiences and cognitive disorganisation scores together predicted 28% of variance in creativity scores.

The final study, which recruited 40 visual artists and 56 psychology students, investigated relationships between mental imagery control, incommensurate schizotypal traits, and creative performance as measured by battery of creativity tasks and a self-report measure of creative achievement. Significant differences were revealed between the artist and non-artist groups in their creativity scores, but no significant differences were found between these groups on any index of schizotypy. Independent groups *t* tests showed that the visual artists had significantly more controlled mental imagery and enhanced recognition abilities when compared to the non-artist group. Multiple linear regression found that mental imagery control and unusual experiences scores, which included associated ratings of distress, distraction, and frequency, both explained variance in levels of creative achievement, suggesting that, together, magical ideation, unusual imaginal and perceptual experiences, and fantasy proneness, as well as the ability to control, manipulate, recombine, reinterpret and 'play with' mental images is implicated in achieving 'real-world' success in creative domains. Imagery control predicted 8% of the variance in the ability to conceive of conceptually unusual, and strikingly original alien creatures when assessed in experimental settings. The ability to control mental imagery shared predictive power with impulsive nonconformity in generating alternative uses for household objects explaining 10% of the variance.

It appears that mental imagery abilities are implicated in creativity as the abilities required to control mental imagery were strongly related to higher performance on measures of divergent thinking, creative strengths, conceptual expansion, and creative achievement. The results support assertions that all constructs are multidimensional and related in differential ways, and tentatively point to the possibility that the associations between unusual experiences, mental imagery and enhanced creative achievement may be explained in terms of controlled and uncontrolled imagery, for indices of unusual experiences may indirectly represent levels of schizotypal imagery.

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DEDICATION

This thesis is dedicated to my loving parents and to the memory of my grandparents.

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CHAPTER 1 THE RELATIONSHIP BETWEEN CREATIVITY & MENTAL IMAGERY

This chapter will review the literature surrounding the reported relationship between creativity and mental imagery. A selection of some of the historical accounts describing the link between creative production and mental imagery will be presented, followed by cognitive theories of both creative thought and mental imagery. A discussion of the operationalisation of these constructs and the literature focussing on measuring creativity and mental imagery in laboratory settings follows this. Inconsistencies in the literature surrounding mental imagery and creativity research will be outlined.

1.1 History of the Relationship between Mental Imagery and Creativity

There are numerous accounts of both eminent and non-eminent creative individuals exploring and manipulating the inner worlds of their mental imageries and utilising these abilities while engaged in creative pursuits (LeBoutillier, 1999; LeBoutillier & Marks, 2003; Perez-Fabello & Campos, 2007; Finke & Slayton, 1988; Finke, Pinker & Farah, 1989; Finke, 1990). Vivid and controlled mental imagery, dream-imagery, thought experiments and sometimes hallucinations, have been cited by scientists, poets, writers, artists and architects as methods of ‘playing’ with and reconceptualising ideas, theories and abstractions (Mavromatis, 1987; Weisberg, 1993; Ochse, 1990; Barrantes-Vidal,

2004). Some anecdotal reports of creative professionals utilising their mental imagery follow.

1.1.1 Anecdotal evidence of the relationship between mental imagery and creativity

Historically renowned scientists, poets, writers, sculptors, and visual artists have provided anecdotal evidence that controlled and vivid mental imagery, in the form of thought experiments, lucid dreams, hallucinations, and structured manipulations of images, played a significant part in their endeavours (Palmiero, Cardi & Belardinelli, 2011; Gooding, 2004; LeBoutillier & Marks, 2003; LeBoutillier, 1999; Miller, 1996). These individuals appear to engage in this type of thinking effortlessly, and this facilitative influence of enhanced mental imagery has been reported extensively by persons in a wide-range of creative professions (Barrantes-Vidal, 2004). The multifarious properties of mental images and the ability to easily control and manipulate them, have been noted by artists and scientists alike.

Shepard (1988) reports a “composite caricature of individuals who have reported extraordinary instances of visual-spatial creative imagery” (p. 49), and the anecdotal evidence supports the claim that many creators can imagine and manipulate complex and vivid forms in mental imagery with ease (LeBoutillier, 1999). Surrealist artist Salvador Dali took advantage of detailed, bizarre and elaborate ‘hypnagogic’ imagery, the often unusual imagery experienced in the period just as one is drifting into sleep (Mavromatis,

1987). Dali claimed he would fall asleep with his head propped on top of a wooden spoon so that once he entered into a hypnagogic state the muscles in his neck would relax causing his head to 'loll' thus waking him. The artist would take advantage of the often elaborate imagery which arose during these states, allegedly furiously painting these images upon waking (Weisberg, 1993; Mavromatis, 1987).

The poet Samuel Taylor Coleridge said he wrote the epic 'Kubla Khan', also known as 'A Vision in a Dream: A Fragment' (1797, cited in Shepard, 1978), in an opium-induced state, describing vivid images and fantasies which he says ultimately contributed to the elaborate imagery encountered in this poem. The novelists Joan Didion and Judith Guest stated that the pictures and images often arose in their minds before any narrative or specificity of character did. These anecdotal accounts highlight the utility of vivid and controlled mental imagery in creative and scientifically innovative pursuits. These abilities appear to allow free thought and abstract ideas. It should be noted that a small body of evidence exists to suggest that some creative individuals may have embellished certain details pertaining to their creative processes, and the reports lying behind this high acclaim may distort reality. For example, rough drafts of 'Kubla Khan' were found after publication, though the claim by Coleridge had been that the imagery for the piece presented itself to him as he wrote (Vernon, 1970). Findings such as these contribute to 'the myth of genius', a term coined to reflect the supposition that eminent creative individuals may at times have exaggerated the routes and means by which their works of

‘creative genius’ came to fruition (Weisberg, 1993). That some exceptional and mysterious thought processes result in the creative products mentioned previously is referred to as the ‘genius’ view (Weisberg, 1993), and being a genius has traditionally been viewed as being something of value (Guilford, 1967), in turn leading to status and prominence within society. The genius view may well be supported if the processes engendering such high creativity are exaggerated or romanticised, as the embellishments of many creative techniques leading to productivity which have been unmasked demonstrate (Ochse, 1990). Critiques of the anecdotal reports of historically creative people are cited by Ochse, who points out that both scientific and artistic eminence are treated as though they have the same underlying processes, and demonstrate the same kinds of creativity, despite their inherently different characteristics. That is, inventions or equations created by scientists and mathematicians are referred to in the same context as paintings and poems. Especially relevant to the following chapter are the suggestions that a certain ‘type’ of creative personality may commonly be endorsed, including that of the ‘eccentric’ or ‘mad genius’.

As well as eminent visual artists and writers using elements of their mental imagery in different ways, many scientists have demonstrated an inclination to engage in similar techniques. In his seminal article on the mental image and its function, Shepard (1978) cites illustrious scientists relevant to this debate, two examples being Michael Faraday and James Clerk Maxwell. When contemplating the laws of electrical and magnetic

fields, Faraday claimed that visual images contributed to his theories, stating that the force fields “rose up before him” (Koestler, 1964; Tyndall, 1868, both cited in Shepard, 1978, p. 126). It is claimed that Maxwell in fact made this a habit, that every problem had its own “mental picture” (1957, p. 76, cited in Shepard, 1978). Maxwell developed Faraday’s work by mentally representing each of his mathematical formulae in this way, the longer and more elaborate images often leading to the answer. Reiber (1995) also looked at the techniques of scientists when problem solving. Engineer and inventor Nikola Tesla visualised problems and experiments in imagery so precisely that he would not put them to paper until they were finalised in his mind, saying “invariably the device works as I conceive it should and the experiment comes out exactly as I had planned it” (Tesla, 1919, cited in Towe & Randall-May, 1999, p. 499). The inventor Thomas Edison also utilised hypnagogic states to facilitate creativity and would fall asleep with a steel ball in his hand over a metal tray. The ball would drop onto the tray once his grip on it relaxed, alerting him to the hypnagogic phase of sleep (Weisberg, 1993), a phase in which he would semi-consciously work on problems by guiding the emotive and cognitive focus in imagery. In 1865 the chemist Friedrich August von Kekulé was supposedly dosing in a hypnagogic state, after previously considering the problem of how to understand the structure of benzene. In a dream, he encountered images of ‘snake-like’ atoms, and saw one of the snakes curve and bite its own tail, while whirling about in front of him (Weisberg, 1993; Holmes, Geddes, Colom, & Goodwin, 2008). The image encountered by Kekulé was so significant to him that he instantly awoke; he had ‘seen’ the answer he had been looking for and knew that the structure of benzene was a ring of

six carbon atoms. Another example comes from Albert Einstein's well-known quote "I rarely think in words", which hints at the use of imagery in his work. Creative individuals often allude to a certain 'special', indescribable quality to their internal images and thoughts (Miller, 1996). An interesting account regarding Einstein's imagery is provided by Shepard, (1978) and is related to his procedure for conceptualising mathematical formulae. Einstein stated that while developing his theories and equations he visualised "certain signs and more or less clear images which can be voluntarily reproduced and combined" (Claxton, 2006, p. 351). Many examples from Einstein's accounts which implicate the use of mental imagery exist, however, the above anecdote encapsulates particularly clearly the importance that mental imagery played in the formulation of his ideas and theories, and Einstein reportedly spent much of his time engaging in vivid thought experiments. For example, when tackling such complex matters as the Special Theory of Relativity, he imagined riding on a light wave, and considered what it would be like for passengers and onlookers to observe lightning striking a train in two places at the same time. Thought experiments such as this, which he claims often lead to his solutions (Shepard, 1978; LeBoutillier, 1999). In a letter to Jacques Hadamard in 1945 regarding visual thinking in human thought and reasoning, Einstein stated that "Combinatory play seems to be the essential feature in productive thought" (Mednick, 1962, p. 351, cited in Claxton, 2006). Indeed, he also stated that his particular skills lay in "visualising... effects, consequences, and possibilities" (Shepard, 1978, p. 126). Collectively these anecdotes suggest that the visual imagery utilised by these individuals is primarily of two types. The first typifies the use of controlled,

deliberate and precise visualisation, in which images can be voluntarily manipulated, and the second relates to more spontaneous and uncontrolled imagery, which may arise in moments of insight, and which appear to be, at least partly, out of the experient's immediate control.

Studying eminent creative and innovative individuals has revealed some common techniques utilised by them during the creative process (Burch, Pavelis, Hemsley, & Corr, 2006a; Simonton, 2003; Sternberg, 2005, 2006; Barron, 1966), and, as was just outlined, one of these is the use of mental imagery, with its fundamentality to the efficacy and even discovery of creative ideas and theories (Glazek, 2012; Palmiero, Nakatani, Raver, Olivetti, Belardinelli, & van Leeuwen, 2010; Kaufman & Kaufman, 2009; Perez-Fabello & Campos, 2007). Many of these cases are linked to unconscious altered states, introspection, dream-like or hypnagogic imagery and moments of insight, all of which may invoke different types of mental imagery. It appears that the ability to apprehend and control visual images in these ways is useful in these professions, professions which are generally considered inherently creative by nature, and which no doubt involve comprehending new ideas, theories, solutions, and essentially the transferral of imagined concepts and visualisations into forms accessible to others. What is less clear is how to study this relationship, and the reasons for this are considered in the following sections.

1.2 Operationalising Creativity and Mental Imagery

Both of the constructs under review in this chapter have been extensively studied and attempts to operationalise both are ongoing (Burton, 2003; Ganis, Thompson & Kosslyn, 2004; Batey, 2012; Silvia, Kaufman & Pretz, 2009; Runco, 2009; Ward, 2007; Silvia, Kaufman, Reiter-Palmon, & Wigert, 2011; Kim, 2011; Claxton, 2006; Sternberg, 2005). This section will review theories of creativity and mental imagery and attempts at definition.

1.2.1 Defining creativity and attempts at operationalisation

Early investigators saw creative problem solving as a context for studying creativity and focused on several stages which utilised unconscious processing of ideas for creative success (Poincaré, 1826 and Hadamard, 1945, both cited in Welling, 2007; Wallas, 1926). In his creative problem solving model, which was adapted from Poincaré's theory, Wallas described these stages. 'Preparation' refers to the utilisation of prior knowledge and practice in problem solving where some expertise is beneficial and is thought to be the crucial first stage of creative production. During 'incubation', the unconscious mind works freely in a way that perhaps it cannot do whilst consciously focussing on a problem and that this time away from the task can ultimately lead to creativity (Runco, 2004; Boden, 2004). Periods of incubation, where conscious attention to the problem is temporarily halted and the unconscious mind is free to "associate and restructure" ideas (Aldous, 2007, p. 177), may, according to Wallas, precede a phase of

‘intimation’ where the creator feels the solution will soon be reached. The penultimate stage is ‘illumination’ which may be experienced as a sudden insight or the solution suddenly entering consciousness, as was briefly described in section 1.1.1. Hadamard (1945) called this the *Aha* moment in his classical model of creative problem solving, which also incorporated these phases. Perhaps the most famous example of illumination is the (perhaps apocryphal) tale of Archimedes and his bathtub. When he got into the bath, Archimedes’ body displaced the water and caused it to overflow. This led to a sudden realisation of the solution to the problem of calculating the volume of an irregularly shaped object, in this case a crown, and he leapt out of the bath (Schooler & Melcher, 1995). The ‘verification’ phase which involves conscious, controlled problem-solving then takes place. Here the solution is checked for efficacy and necessary alterations or elaborations. A return to an earlier phase may ensue should unworkable solutions arise. As we have seen, a great number of creative individuals have certainly described their creative solutions and insights as coming to fruition in this way.

In Guilford’s 1950 Presidential address to the American Psychological Association, claimed that there was considerable agreement regarding the existence of these four “important steps” in the creative process (Lubart, 2000-2001, p. 295). These steps were based on the introspective reports of von Helmholtz (1896, cited in Simonton, 2003), and on Poincaré’s (1908, cited in Ghiselin, 1985) observations that unconscious ideas are combined and then brought to the conscious mind. In his address, Guilford called for

more research into other creative-relevant abilities such as fluency and flexibility of ideas, reorganisation of ideas and evaluation skills (Lubart, 2000-2001). This call has been answered and these facets of creativity, along with other abilities contributing to this multifaceted construct, such as divergent thinking and insight problem solving, have since been investigated (Simonton, 2000; Naderi, Abdullah, Aizan, Sharir, & Kumar, 2010; Kaufman, Pumacahua, & Holt, 2013; Gansler et al., 2011; Gilhooly, Fioratou, Anthony, & Wynn, 2007; Joy, 2008; Batey & Furnham, 2006; Burch, Pavelis, Hemsley, & Corr, 2006a; Burch, Hemsley, Pavelis, & Corr, 2006b; Baas, De Dreu, & Nijstad, 2008; Gelade, 2002; Csikszentmihalyi, 1996; Boden, 2004; Dietrich, 2004).

Barron (1965) defined creativity as multidimensional and related to its product, the person or the processes lying behind it, with novelty, unusualness and aptness crucial for receiving a label of 'creative' (Neihart, 1998; Runco, 2014). Especially relevant here is Barron's definition of the creative process as being one which involves intention, form, inspiration, and temporal and emotional phases, as it appears to acknowledge the importance of imagery in this process. Boden (1996) distinguishes between two types of creativity, with 'psychological' (P) creativity pertaining to novelty to the individual, and 'historical' (H) creativity encapsulating a new way of thinking about a theory or phenomenon which changes the way it is regarded from then on. Her model encapsulates three creative mental processes which are used to navigate "conceptual space" (Boden, 1999, p. 352). These are combinatorial, exploratory, and transformational creativity, the

former involving the unconstrained combination of familiar ideas in unfamiliar ways, the latter two processes allowing these newly combined ideas to be explored and adapted (Boden, 2004). By investigating examples of Boden's 'P' creativity, also termed 'little c', (referring to products that are creative to the individual, which is in contrast to 'Big-C' creativity, which relates to eminent creativity, see Kaufman & Beghetto, 2009) it is possible to look at creative abilities of non-eminent individuals in experimental settings. This facilitates a better understanding of creative people in general, and of the processes underlying creativity.

Despite such a breadth of research there still appears to be no single agreed definition of creativity, possibly due to its many manifestations and the respective influences of cultural settings over time. As recently as 2012 it was stated by Batey that an unequivocal definition and clear operationalisation of creativity as a psychological construct are still not reached. Stoneham and Coughtrey (2009) stated that the processes underlying creativity and the resultant products "remain subjective in definition and elusive to objective measurement" (p. 827). The necessity of two components is consistently implicated however, those of *originality* and *usefulness* (Mumford, 2003). For this reason, tools which measure divergent thinking abilities are often used to assess creative ability as they require the generation of unique and appropriate responses which are scored along on both of these indices. The originality score is usually calculated statistically taking into account the whole sample's set of responses and is a measure of

how infrequent each answer is in relation to other answers provided for the same problem. The index of usefulness is usually based on whether the solutions, or as is more common in these tasks, the inventions (Finke et al., 1992) are appropriate for that particular task's constraints and impossible ideas are disregarded. A number of well-researched divergent thinking tasks are available, and this thesis will utilise such tasks, a more thorough description of the tools which are used to tap divergent and creative thinking is presented in Chapter 4 and Chapter 5. However a brief introduction to tasks of this nature follows.

The Torrance Tests of Creative Thinking (TTCT; Torrance, 1974) are one of the most commonly used measures of creative ability and will be described fully in Chapter 5. This battery assesses figural and verbal creative abilities where responses are scored along the following dimensions: *fluency*, *originality*, *abstractness of titles*, *elaboration*, *resistance to premature closure*, and *creative strengths* (Torrance, 1974; Torrance 2008, cited in Acar & Runco, 2012). The subscales in this battery can be used to look more closely at specific creativity-relevant skills (Kim, 2011). Claridge and Blakey (2009) observe that a large number of researchers tend to equate creativity solely with divergent thinking, however, they describe eight categories of creativity measurement: divergent thinking (DT) tests; attitudes and interest inventories; personality inventories; biographical inventories; ratings by peers; judgements of products; ratings of eminence, and self-report creative activities. These serve as “an indication of how creativity has

been and may be assessed” (p. 58) and reflect again the multifaceted nature of the construct. Kaufman, Plucker, and Baer (2008) state there to be five categories of creative measurement, namely creative products, creative cognition, creative traits, creative behaviour, and creative accomplishments. Divergent thought is an important component of the creative process, though importantly Runco states (1991) it cannot be equated with creativity but rather can predict creative potential.

When one thinks of what constitutes ‘creativity’, a variety of things may spring to mind such as art, poetry, sculpture, scientific innovation, dance, and literature, and it is clear that there are indeed many ways to measure it, as was just described. In addition to traditional ideas of what creativity actually is, non-eminent individuals, even those who do not consider themselves to be creative, have the potential to exhibit creative thought in various ways, for example, in the generation of alternative uses for common household objects such as a paperclip, a newspaper or a brick (Guilford, 1967), by producing varied solutions to open-ended problems, through generating remote consequences of hypotheses (Barrantes-Vidal, 2004), or writing ‘associative poems’ (Joy, 2008). Alternate uses for everyday items are then scored for fluency (the number of meaningful uses), flexibility (production of varied responses from conceptual categories), originality (the far from obvious ideas), and elaboration (the number of additional detail embellishing the initial response). Additionally, creative artefacts may be scored for creativity by trained judges. One particular approach which will be outlined and

described at length throughout the thesis is that of creative cognition (Smith, Ward, & Finke, 1995) which requires individuals to combine random shapes into meaningful patterns or objects in their visual imagery. Taken together, the aforementioned review suggests that some progress has been made, at least in the approaches to assessing creativity, as these new approaches appear to acknowledge the multifaceted nature of the creativity construct and more researchers appear cognisant of the importance of developing useful and accurate methods of studying it.

1.2.2 Defining mental imagery and attempts at operationalisation

Individual differences in mental imagery is something which have been investigated ever since Greek philosophers wondered as to its nature and purpose, noticing its importance in thinking and the similarities between visual imagery and visual perception (White, Sheehan, & Ashton, 1977). The metaphor of an internal artist “painting pictures in the soul” was used by Plato (Philebus 39c, cited in Ganis, Thompson, & Kosslyn, 2004). Another early area of interest was the ability to control and manipulate mental imagery, with pioneering experimental psychologist Gustav Fechner observing distinct individual differences in imagery controllability and writing about “imagination images” in *Elemente der Psychophysik* (1860, cited in White, Sheehan, & Ashton, 1977). He stated that while some individuals were able to bring to mind detailed images of objects which were ‘percept-like’, others were only able to imagine “momentary glimpses” of these images (Fechner, 1800, cited in Kosslyn & Jolicouer, 1980).

Early theorists put forward many ideas as to the function of mental imagery. In her chapter entitled 'A Very Private World', (in Sheehan, 1972), Rosemary Gordon claimed that imagery may function in order to aid selection and organisation of sensory stimuli thus eliciting appropriate instinctual responses. She claimed it may enable the classification of these stimuli and may facilitate the relation of past to present experience, and that it was the basis of abstract and symbolic thought. Gordon discussed characteristics of visual imagery as being phenomenological experiences which varied from person to person. It was suggested by Gordon and others (for example, Richardson, 1969) that different modes of imaging might result in "intolerance, misunderstanding, and lack of communication" (p. 70) at the outset when studying imagery. Gordon asserted that one problem inherent in the way some researchers treat mental imagery is that many limit the term to refer only to visual experience, and not other modalities like gustatory imagery (imagining tastes) and auditory imagery. Gordon adopted a definition of imagery of perceiving forms, colours, sounds, smells or movement while no such external stimuli are present. An important distinction that she made was between the words 'image' and 'imagination', which are clearly etymologically linked. She noticed that many theorists treat the terms as interchangeable, however made the claim that one cannot utilise imagination without using visual images. It is also conceivable that one can have an image without having an 'imagination', in the common sense of the word.

White, Sheehan, and Ashton (1977) maintained that adequate definitions of imagery were not formulated at the time of writing their paper, and stated that definitions ranged “widely from Richardson’s (1969) emphasis on quasi-perceptual experience to Neisser’s (1972) explanation of imagery in terms of planned construction” (p. 45). Imagery is viewed by Paivio (1990) as synonymous with visualisation, consisting of mental representations which have spatial, non-arbitrary (picture-like) qualities and resembles actual objects or events, and as something which is ‘continuous’. Paivio calls this an ‘all-in-oneness’ quality (Paivio, 1990). Mental imagery has since been defined as occurring when perceptual information from memory is accessed, leading to the experience of “seeing with the mind’s eye” and as involving a collection of abilities (Kosslyn, Ganis, & Thompson, 2001, p. 195).

Roe (1951) found that different types of mental imagery were utilised in different scientific arenas, with psychologists and theoretical physicists preferring verbal imagery (imagining speech) and symbolisation, while biologists and experimental physicists engaged in more visual imaging processes such as the manipulation of their mental images. In 1880, Francis Galton published a research paper which he concluded by saying that scientists were largely deficient in their mental imaging abilities (cited in Brewer & Schommer-Aikins, 2006). Brewer and Schommer-Aikins (2006) carried out a replication of Galton’s original study and found this claim to be false, according to the responses from their participants at least. All of the scientists in their investigation

reported using mental imagery strategies whilst completing a visual memory task, Galton's (1880) *Breakfast Table Questionnaire* (to be described below), and found that scientists' imagining abilities were no different to the undergraduates who took part. Despite Galton's findings being refuted by the authors of this investigation, and others (to be outlined in Chapter 4), his contribution to the scientific investigation of visual imagery remains a meaningful one.

Quantitative assessment of visual imagery was born when Galton devised his Breakfast Table Questionnaire in (1880, cited in Richardson, 1999), which required recall of details relating to a previously perceived image, a breakfast table containing food items being one example. Questions were asked about elements of the mental image such as illumination, colour, extent of the field of view, distance and command of images, with participants also being free to describe their mental experiences in their own words, and psychometric tools utilising similar protocols continue to be developed (D'Ercole, Castelli, Giannini, & Sbrilli, 2010).

Investigations in this field tend to employ one of the great number of tools which purport to measure mental imagery ability of various types, for example, imagery control, imagery vividness, and rotation of objects in imagery. A thorough review of these tools and this research is presented in CHAPTER 3, section 3.1.1., and so a selection of the most widely-used imagery measures are briefly outlined below.

The first tool to receive prominent usage was Betts' (1909) Questionnaire upon Mental Imagery (QMI), evaluating seven different sensory modalities (visual, kinaesthetic, tactile, auditory, gustatory, olfactory, and organic), and assessing the vividness of evoked images of scenes. This instrument was adapted and shortened by Sheehan (1967), and was subsequently known as the Betts' QMI (Richardson, 1969). Gordon's (1949) Test of Visual Imagery Control (TVIC) is another early measure of imagery ability and requires participants to follow oral instructions regarding their ability to manipulate visual images (White, Sheehan, & Ashton, 1977). Richardson (1969) adapted the format of this tool by introducing an 'unsure' option and by advocating a pen and paper task. It was claimed to be internally consistent, to enjoy adequate test-retest reliability, and to correlate with other pencil and paper imagery tools (White, Sheehan, & Ashton, 1977). However, more recently evidence has been found which demonstrates that response sets are a problematic outcome when using this tool (LeBoutillier & Marks, 2001-2002). The TVIC (Gordon, 1949) and Bett's QMI Vividness of Imagery Scale (Richardson, 1969) also appear to tap different aspects of mental imagery, the TVIC attempting to measure how controlled one's mental imagery is, the QMI assessing vividness (Khilstrom et al., 1991; Kaufmann, Plucker, & Baer, 2008). Di Vesta, Ingersoll, and Sunshine (1971) purport that Betts' QMI and Gordon's TVIC may represent diverse facets of the same process, namely, 'image evocation' (White, Sheehan & Ashton, 1977), and this notion of multiple imagery abilities is one that will be returned to throughout the thesis. Another self-report tool is

the Vividness of Visual Imagery Questionnaire (VVIQ) (Marks, 1973), which includes the five visual items from Betts' Questionnaire upon Mental Imagery (Richardson, 1969) and requires participants to introspect and rate whether they consider their internal images of people and places to be 'perfectly clear and vivid', if they have 'no image at all', or if their image lies somewhere between these points. It is completed under two conditions, once with the eyes open and once with them closed, though the rationale for this feature of the VVIQ is unclear, and Dowling (1973) revealed no difference between the two versions. Previous research on the VVIQ has indicated that it is a valid and reliable measure of vividness of mental imagery (McKelvie, 1995), McKelvie reporting split-half reliability of .88, and test-retest reliability at .74. However, this measure is not without its critics, content validity issues being most prominent, with alternate form and test-retest proving problematic (McKelvie, 1995), and the context in which the tool is completed influencing results. For example, different vividness ratings are revealed when participants visualise their mothers compared to their fathers (the 'unvividness paradox', Ahsen, 1990). Socially desirable responding has also been an issue with this tool, and indeed with many other self-report measures of imagery (Allbutt, Ling, & Shafiullah, 2005-2006; Allbutt, Ling, Heffernan, & Shafiullah, 2008; LeBoutillier & Marks, 2000-2001). Marks (1983) did however find that VVIQ scores correlated with response times on a visual memory recognition task, which asked for specific details about a memorised picture, which arguably requires similar cognitive processes to that of the VVIQ and asks participants to evoke an image from memory and rate details about its

qualities. Evidence supporting the use of self-report imagery tools is mixed, but there are other ways to assess mental imagery abilities which are more objective.

Mental rotation tasks have been found to be effective tools for assessing spatial ability, that is, the ability to rotate shapes and images in one's imagination (Zacks, 2008), and this type of task is more objective than some self-report measures. According to Zacks' (2008) meta-analysis, stimulus sets for mental rotation tend to include the following: 2- or 3D shapes as originally used by Shepard and Metzler (1971), alphanumeric characters, drawings or photographs of objects, hands, or bodies, abstract 2D line figures and 3D cubes. According to descriptions of the 'cracking' of the genetic code and the revelation of the double helix structure of DNA detailed in James Watson's (1968, cited in Shepard, 1978) *The Double Helix*, it can be deduced that mental rotation was utilised while considering this Nobel-Prize winning discovery. As was discussed in section 1.1.1, anecdotal accounts of the benefits of imagery ability are cited by many eminently creative individuals. However, failure to acknowledge differing aspects of mental imagery may complicate its' investigation.

Kosslyn suggested that the collection of abilities which contribute to mental imagery mean it may be most beneficial to study these aspects separately (1980, 1994). These abilities include the level of detail, clarity, proportion and relative size of images (Dean & Morris, 2003). Participant ratings of image *evocation, detail, clarity, maintenance,*

proportion, vividness, ease of rotation, proportion during rotation, and vividness during rotation are strongly inter-correlated due to the fact that some of the properties and processes involved in these aspects of the task are prerequisites of others, where facets of imagery such as mental rotation are found to be ‘rate-limiting’ factors in tests measuring spatial ability, meaning that mental abilities other than those which the test proposes to measure may influence performance on that test. Kosslyn (1980) conceives of visual imagery as comprising of three broad processes; *image generation* (formation), where ‘stored information’ is used to create an image, *image maintenance* (inspection), where qualities of the images are inspected, and *image transformation* (rotation), where mental images are manipulated and their appearance altered (Kosslyn, Brunn, Cave, & Wallach, 1984; Kosslyn et al., 2004). Kosslyn (1980) suggests that this collection of differentiated constructive processes work to form a mental image, and that these processes work with the visual buffer to give rise to the phenomenological experiences of the image. Limited resolution and spatial extent are the main surface properties of the visual buffer (Kosslyn et al., 1984), and it may be that these limitations are reflected in the clarity of respective elements of the visual image. Evidence has been found that has shown it is possible to accurately introspect on these processes and to scrutinise internal images, answering questions on the properties of these imagined forms and patterns (D’Ercole, 2010; Mast & Kosslyn, 2002; Denis, 2008; Bischel & Roskos-Ewoldsen, 1997; Kosslyn, 1973, cited in Dean & Morris, 2003). One can inspect ‘structural’ elements of mental images and can manipulate them in order to make these observations (Shepard, 1978; Kosslyn & Jolicoeur, 1980). This has implications for imagery tasks requiring the holding of visual

information in memory as it is theoretically related to the control of mental images. Dean and Morris (2003) suggest that problems with some ‘introspective’ measures of mental imagery, to be discussed in Chapter 3, may be due in part to the implication of long-term memory in these tasks. Such tools often require the evocation of images from long-term memory, such as a familiar face or place, and it is suggested that the cognitive processes required simply may not be used when imagining recently perceived or new items which are located in visual short-term memory (Baddeley, 1986, 2000). This is especially relevant here because, as we shall see in section 1.3.2, there exists a disparity between mental imagery abilities as measured by introspective, self-report questionnaires and scores on performance-based measures. Logie’s (1995) claims are also relevant. Logie suggested that visual stimuli are “placed in the visual or spatial short-term stores via long-term memory representations of visual form or spatial information” (p. 248), suggesting an overlap between these two types of input to STM in terms of the underlying cognitive processes. As shall be discussed in section 1.3.2, differences in the nature, quality and experience of mental imagery, in methods of investigation, as well as some researchers not considering (or not being aware of) these differences, may have hindered the operationalisation of the construct.

The view that imagery is a unitary construct is now considered by many theorists to be a false one (Kosslyn, 1980; Kosslyn et al., 2004), and indeed much empirical evidence has been published to support the claim that it is multidimensional and involves a collection

of abilities (Kosslyn, Ganis, & Thompson, 2001; Kosslyn, Thompson, & Ganis, 2002). Blajenkova, Kozhevnikov, and Motes (2006) suppose that imagery involves a collection of abilities and have purported that visual imagery is comprised of at least two distinct subsystems, *object imagery*, and *spatial imagery*, which are involved in encoding and processing. Blajenkova and her colleagues' investigations followed work by researchers who also suggested the existence of related yet distinct types of imagery (Farah, Hammond, Levine, & Calvanio, 1998 and Levine, Warach, & Farah, 1985, both cited in Blajenkova et al., 2006; Kosslyn, 1994). Object imagery involves seeing properties such as the form, size, colour, shape and other aspects of literal appearances of objects in imagery, such as 'brightness'. Spatial imagery on the other hand refers to the ability to apprehend spatial relations in image such as its individual parts, the location of objects and their movement, in addition to the quality of abstract representations and transformations between imagined objects (Kozhevnikov, Kosslyn, & Shepard, 2005). Kozhevnikov, Hegarty and Meyer (2002) found that the self-reported imagery styles of scientists and engineers were different when compared to visual artists, the former tending to image using spatial imagery, the latter utilising object imagery more often, which, incidentally, is yet more evidence that Galton's early observations were inaccurate. Blajenkova and her colleagues have since replicated these findings in a later study (Blajenkova, Kozhevnikov, & Motes, 2006). This suggests that, as well as eminent creative individuals using mental imagery and visualisation techniques when problem solving, people providing creative solutions in everyday situations tend to employ these techniques too (LeBoutillier & Marks, 2003; Finke et al., 1988, 1989;

Ward, Smith, & Finke, 1999). Reiber (1995) gives the example of directing someone who is lost to their desired location, stating that visualisation tricks are extemporaneously employed when ones gestures and outlines the route while considering it in their mental imagery. More relevant here is the imagery exhibited by creative professionals, and also the imaginal process utilised and adopted by individuals when their creativity is tested experimentally. Non-eminent individuals tested for creative ability often claim to use controlled mental imagery and synthesis while performing creative tasks in the laboratory (Daniels-McGhee & Davies, 1994; Durndell & Wetherick, 1976). When engaging in exercises which require them to combine imagined shapes in order to create a recognisable image, participants are able to internally change the shape combinations, and recombine them in different ways before settling on a final combination, and this observation will be returned to in section 1.3, but first a review of how relationships between creativity and imagery are typically studied is presented, followed by a discussion of issues may have impeded progress in investigating the seemingly deepening complex relationship between creativity and imagery.

1.2.3 The lack of relationships between different tools measuring mental imagery

In addition to problems with the psychometric properties of many self-report imagery questionnaires discussed in section 1.2.2, it has been found that indices of imagery ability measured through introspective means, such as the VVIQ (Marks, 1973), regularly fail to correlate with scores on spatial imagery tasks previously described (Dean & Morris,

2003; McKelvie, 1995). In a study investigating mental imagery vividness and ‘unvividness’, Richardson (1988) states that one has “epistemological priority with regard to their mental imagery” (p. 119), reflecting the belief that the qualities of mental imagery are only really accessible to the experient. This paper cites numerous studies which also show that self-report mental imagery questionnaires do not bear any consistent relationship with spatial thinking tests, (for example, Ernest, 1977; Danaher & Thoresen, 1972; Richardson, 1978; Starker, 1974, cited in Richardson, 1988; Durndell & Wetherick, 1976). Dean and Morris (2003) also state that “the functional role of imagery in spatial ability tests is unrelated to the vividness of imagery” (p. 247). Slee also pointed out in 1988 that when measured in isolation imagery vividness was an unsatisfactory indicator of mental imagery ability, yet it continues to be widely used as such. There seemingly exist problems with the measurement of mental imagery, such as the contradictory findings revealed in studies utilising the same tools, and the lack of relationships between tools purportedly measuring the same constructs. These will be further outlined in Chapter 3 as this has implications for investigations seeking to understand the relationships of types of mental imagery to creativity.

The problems of operationalisation of mental imagery may seem unavoidable due to its introspective and subjective nature, and indeed, this has presented clear obstacles to its investigation. It is possible that imagery control and vividness represent different facets of the same process (Kihlstrom, Glisky, Peterson, Harvey & Rose, 1991), namely image

evocation, though they are often used as interchangeable terms. A psychometric analysis of mental imagery vividness and imagery control tools concluded that the majority of measures included in Kihlstrom et al.'s study confused the dimensions of vividness and control, did not define either attribute satisfactorily and did not measure individual differences in imagery ability (Kihlstrom et al., 1991), though as will be outlined below, recent studies have begun to rectify these methodological issues.

1.3 Measuring the Relationships between Creativity and Mental Imagery

The evidence described so far, from both inside and outside of the laboratory, points to a complex and nuanced relationship between creativity and mental imagery. Researchers in this field have developed a number of methods of investigating mental imagery in relation to creativity, including employing measures of divergent thinking, self-report measures and creative imagery tasks, and these are outlined below.

1.3.1 Investigating creative imagery

An increasingly common approach to the investigation of mental imagery and its links to creativity in laboratory conditions is the image generation approach (Finke, Ward, & Smith, 1992, Finke, 1996; Finke & Slayton, 1988). This looks at the emergence of creativity through visualisation and mental synthesis of (usually) geometric and alphanumeric shapes and lines or 3D objects such as brackets, wheels or bowls. Finke

and his colleagues (1992) popularised the *creative cognition* approach to creativity, demonstrating that particular mental processes and conceptual structures often guide creative pursuits. Creative cognition is defined as the ability to create original, novel and useful products in the absence of concurrent stimuli, that is, the shapes are imagined rather than being present in front of them. The mental synthesis task (Finke, Pinker & Farah, 1989) and its subsequent variants were developed by Finke and Slayton (1988; Finke, 1990) and requires participants to combine and manipulate common geometric forms to create something new, sometimes according to pre-defined object categories. These images can then be rated for creativity, correspondence (how much the image produced looks like what the respondent intended it to look like), and appropriateness (whether any of the shapes have been altered or changed). Finke, Ward and Smith's (1992) Geneplore model consists of discrete 'generative' and 'exploratory' phases, two distinct processes making up creative cognition, and demonstrates how participants are able to produce unique, elaborate and previously unanticipated inventions and creations through 'mental synthesis' (combining forms in imagery), and 'restructuring' (separating and then recombining shapes in imagery), in a cyclical 'combinational play' of mental images (Finke & Slayton, 1988). Creative products generated through these methodologies can also be scored on the basis of a number of additional dimensions relevant to creativity and its measurement, namely *originality/novelty*, where points are awarded on a scale from 1 being '*very poor originality*' to 5 '*very high originality*', with the same scale being used for the *practicality/usefulness* ratings. In studies employing mental synthesis protocols, participants are sometimes asked to combine the shapes, and

only afterwards to allocate their image to a category, ascribing some use and a title. Interestingly, these responses are often rated as more creative than those requiring participants to design something fitting into a predefined category, such as ‘furniture’, or ‘weapon’. Ward, Smith and Finke, (1999) state that these ‘emergent patterns’ in mental images may be central to the imagery-creativity link for creative ideas are more likely to arise from skilled combination and recombination of images in novel ways. Morrison and Wallace (2001) also cite several imaging abilities important for creativity, such as spatial visualisation, image vividness, and ‘absorption’, which refers to the engagement of perceptual, enactive, imaginative, and ideational resources in creative productivity. Of course, to accurately research these abilities requires accurate tools, and, as has been discussed, the controversies in measuring the respective constructs are multifarious.

Despite difficulties with definitions and operationalisation of both constructs, individual differences in mental imagery abilities and the implications that these cognitive facets have for creativity have been researched using traditional statistical procedures. LeBoutillier (1999) and others (Campos & Gonzalez, 1995; Gonzalez, Campos, & Perez, 1997; Anderson & Helstrup, 1993; Ward, 1994; Antonietti, Bologna, & Lupi, 1997; Morrison & Wallace, 2001; Palmiero, Cardi, & Belardinelli, 2011) have conducted extensive investigation into the relationship between self-reported mental imagery and creative performance. LeBoutillier (1999) and LeBoutillier and Marks (2003) found relationships between self-reported mental imagery and creativity as measured by

divergent thinking tasks such as the Alternative Uses Tasks (AUT; Guilford, 1967), however, the effect sizes were small (0.05 and 0.15). The AUT, a measure of verbal fluency, requires the generation of as many uses as possible for common household objects such as a brick or a paperclip, and tasks such as these are often used in creativity research, along with creative synthesis tasks of the type which have been described above, where stimuli must be combined to create new ideas, sometimes according to pre-defined categories (Finke & Slayton, 1988; Finke, Pinker & Farah, 1989). The controllability of mental imagery was responsible for a larger association than was the vividness measure, suggesting that while vividness is important for generating alternative uses for household objects, the controlling and manipulation of these mental images was more beneficial to the creative process. Mast and Kosslyn (2002) revealed that participants who could easily rotate mental images were more likely to correctly reinterpret their rotated image as something new and previously unseen, and this has clear implications for utilisation of mental imagery in creative engagement, as novelty is considered by many to be a requisite of true creativity (Sternberg, 1999; Boden, 1996; Finke & Slayton, 1998). The ability to rotate items in imagery, Mast and Kosslyn claim, may have been a rate-limiting step in the task, in that mental image rotation largely determined whether the participants were able to make new ‘discoveries’ from their imagery.

In conclusion, thorough inspection of the literature on the relationship between creativity and mental imagery has highlighted problems relating to the operationalisation of both constructs, further clouding the nature of this relationship and chances of elucidation. These issues are scrutinised in Chapter 3 (Introduction section 3.1), and findings published in the past decade which support a collection of imagery abilities are also outlined. As has been seen, vague definitions and connotations in imagery task items, the raft of psychometric problems and issues with terminology incorporated in questionnaires measuring both imagery and creativity tasks and the treating of separate imagery constructs as though they measure the spectrum of imagery abilities, despite evidence of a multifaceted construct utilising disparate cortical areas (see Chapter 3, Introduction section 3.1), appear to have interfered with the untangling of these relationships.

CHAPTER 2 RELATIONSHIPS BETWEEN CREATIVITY AND PSYCHOPATHOLOGY

In this chapter, a review of the literature surrounding the relationships between creativity and psychopathology is presented. Attempts by theorists to define the constructs will be outlined, and the subsequent discussions relate to creative products, measured through creative visualisation tasks, creative writing and drawing tasks, and to the thinking styles characteristic of those people typically successful in creative domains. The chapter ends with a new argument outlining ways in which the three multidimensional constructs of creativity, imagery, and schizotypy may overlap in terms of cognitive processing. This is followed by an outline of the intended approach to studying these intricate relationships.

2.1 Creativity and Psychopathology

As was discussed in Chapter 1, it is apparent that there is no conclusive definition of creativity as a construct (Batey, 2012; Fink, Benedek, Grabner, Staudt, & Neubauer, 2007). It is, however, conceived by many to be multidimensional and measurable in a number of ways (Claridge & Blakey, 2009). Creativity may be measured as an aspect of personality, as a trait, or may be based on achievement in creative domains (Barrantes-Vidal, 2004). Barron (1993) states that the creative process involves intention, form, inspiration, and temporal and emotional phases, but of particular interest is his conception of ‘controllable oddness’ as being a resource for creativity because he suggests that the

idiosyncratic thoughts of creative persons arise from the ability to control and ‘take hold of’ bizarre ideation and experiences, while Martindale’s (1999) theory of ‘cognitive disinhibition syndrome’ supposes that broad associations and defocused attention may lead to creative performance through oscillation along a cognitive continuum between analogical, free-associative thought at one end, and logical, reality-oriented thinking at the other. As is to be discussed below, these differential types of cognition, ‘top-down diffusion’, controlled attentional processing and lack of inhibition may be creatively beneficial only in some circumstances.

When considering ways to study the relationship between creativity and psychopathology there have been several approaches; biographical and survey studies into eminent creative individuals, family studies (Appels, Sitskoorn, Vollema, & Kahn, 2004; Nuechterlein et al., 2002), studying the creativity of psychiatric patients (Keefe & Magro, 1980; Santosa et al., 2007), looking at the correlations between creativity and liability to psychopathology (Schulberg, 2000-2001; Richards, Kinney, Lunde, Benet & Merzel, 1988), and the psychometric assessment of individuals in creative pursuits (Burch et al., 2006a; Tsakanikos & Claridge, 2004). In terms of its relation to creativity, psychopathology was defined by Schulberg (2000-2001) as behaviours relating to positive or negative schizotypal cognitive symptoms, and negative schizotypal affective symptoms, such as hypomania, depression, and impulsivity. Some have reported an inverted U-shaped model representing the relationship between creativity and

psychopathology (Akiskal & Akiskal, 1988), while a recent historiometric study revealed differential patterns for scientists compared to artists (Simonton, 2014), with more extreme psychopathology showing a detrimental effect for the scientists only. What this means is that those with low levels of psychopathological-type thought may only rarely use this to their creative advantage and that, as these symptoms and characteristics increase, so does the capacity for creative output. However, should this psychopathology become too severe then creativity suffers and individuals may be unable to make use of these characteristics. Nelson and Rawlings (2010) also reported a quadratic pattern (inverted U-shape) whereby creativity increased along with moderate schizotypy. However, as the severity of psychopathology worsened, a detrimental effect on creativity was observed. The notion of the ‘mad genius’, a concept to be outlined later in this chapter, is not supported by these accounts as the research appears to suggest that the creativity-psychopathology debate is far more convoluted.

Barron’s (1993) two-factor approach to creativity looked at ‘ego strength’, which, when measured by the Barron Ego Strength Scale (BESS, 1953, in Barron, 1993), attempts to differentiate between the presence or absence of psychopathology. Those high on this scale report feelings of self-adequacy and Barron found that, when combined with deviant or psychopathological traits, ego strength was a mediating factor that determined output in two very different ways. This combination either leads to damaging symptoms or healthy creative output in individuals. Fodor (1995) also found that those high in ego

strength but who were also prone to psychosis were able to produce highly creative responses in creativity tasks, further strengthening the supposition of a clear-cut psychopathology-creativity link.

Baer (2011) provides an overview of some of the conclusions that have been drawn regarding the relationships between creativity and mental illness. These “vary greatly across domains” (Kaufman & Baer, 2002, p. 311), and Baer espouses the domain-specific view of creativity. This view states that, with the possible exception of some early innovative thinkers, for whom it was more common to possess a plethora of specialisations, for example, Leonardo da Vinci who explored science, mathematics, engineering, anatomy, and who was also a painter, sculptor, architect, botanist, musician and writer (Pevsner, 2002), most contemporary creators rarely excel in more than one domain. Baer (2011) outlines one example of genetic research which looked at the relationship and reported a genetic link between creativity and psychosis (Kéri, 2009). Kéri’s study looked at the possibility of shared ‘genes for psychosis and creativity’ and used as the sole measure for creativity a subscale of the Torrance Tests of Creative Thinking (TTCT, 1974), the ‘Just Suppose’ task, which requires consideration of the outcome to a series of unlikely situations. There are controversies around using the TTCT in this way (to be reviewed in Chapter 6), and it is likely Kéri was unaware of these. Essentially, the issues arise when one treats the TTCT as a tool to measure ‘general creativity’, rather than providing an indication of ability in a number of areas.

Baer states that “By claiming to be domain-general measures of creativity, the TTCT promote... loose thinking and problematic conclusions” (p. 311). There is much to be disentangled, but before undertaking this, a review of the history of the relationships between creativity and psychopathology is presented.

2.2 History of Creativity and Psychopathology

2.2.1 Creativity and mental illness - an ancient association

The often mysterious nature of creativity, and the characteristics and circumstances which are related to its production, have been of interest to psychologists for many years (Barron, 1966; Wallace & Gruber, 1989; Vernon, 1970; Ochse, 1990; Finke, Ward, & Smith, 1992; Andreasen, 1987, 2008; Amabile, 1983; Fisher et al. 2004; Simonton, 2000; Folley & Park, 2005; Joy, 2008). The ancient Greeks were interested in what makes a person creative, Plato viewing it as the result of divine intervention (Albert & Runco, 1999; Ludwig, 1995). Aristotle supposed that more natural processes were at work, with innovation instead being important for survival (Rothenberg & Hausman, 1976). Of particular significance here, however, was Aristotle’s impression, which was to be shared by many others following him, that “there was never a genius without a tincture of madness” (422-384 BC, Pridmore, 2004). In ‘Problemata xxx’, he asks “why is it that all those who have become eminent in philosophy or politics or poetry or the arts are clearly melancholics...?” (Klibansky et al., 1979, p. 18, cited in Akiskal & Akiskal, 2007). Also apparently noticing this connection, Dryden stated of fellow poets in 1681 that “Great

wits are sure to madness near allied...And thin partitions do their bounds divide”, with Lord Byron noting in 1834 that “we of the craft are all crazy” (Nettle, 2001, p.10). The view of the roots of genius changed during the Renaissance as it was thought more likely to be influenced by genetic factors, not God (Dacey, 1999, cited in Glaveanu, 2010). The Romantic era allowed great strides in art and imagination, while reason and the scientific method led to great advances during the Age of Enlightenment (Weiner, 2000, cited in Glaveanu, 2010). An interesting point here is one made by Becker (2000-2001) which is that during the Romantic era, those considered ‘mad’ were said to be ostracised from society, whilst the obvious creative eminence that many of these individuals subsequently meant that both them and their supposed ‘madness’ were viewed in more favourable lights during the Age of Reason which followed.

This seemingly natural curiosity into the creative genius, more specifically, the inkling that something related to ‘madness’ is occurring, has indeed occupied some of the greatest minds, with many esteemed thinkers being seemingly cognisant of the relationship. That disorders within the schizo-affective spectrum are linked to a disproportionate number of creative writers, scientists, and visual artists is well documented (O’Reilly, Dunbar, & Bentall, 2001; Baas, De Creu, & Nijstad, 2008; Becker, 2001; Nettle, 2001, 2006; Andreasen, 1987, 208; Morrison & Wallace, 2001; Richards, 2000-2001; Burch, Pavelis, Hemsley, & Corr, 2006a). Depression is observed in a disproportionate number of creative individuals (Jamison, 1993; Nettle, 2001) with

up to 54% of 291 creative men studied by Post (1994) possessing traits resembling personality disorder, and 69% having a psychiatric diagnosis. One problem in interpreting anecdotal reports is the possibility of *role expectation*, with researchers postulating that over time it has, in some cultures, come to be assumed and accepted that creative people are necessarily ostensibly essentially ‘mad’. It has been suggested that some may even conform to these types of behaviours due to this expectation (Becker, 2000-2001; Glaveanu, 2010). Glaveanu points out that the view of creators as outstanding and insightful, revered for their individuality and creative genius has resulted in an account of creativity that is “*elitist and essentialist*” (Glaveanu, 2010, p. 81) which detaches creators from reality and ultimately paints them in a ‘pathological’ light. Glaveanu (2010) cites Montuori and Perser (1995) who state that “the fate of the genius is often represented as that of a person who is misunderstood, eccentric and even anti-social” (p. 76). From this sociological viewpoint it is suggested that mental suffering has become a constitutive element of creative inspiration. It may even be expected. This may have influenced the biographical accounts of eminent creators. The relationship is indeed far from clear-cut, as the often debilitating nature of ‘full-blown’ mental disorder understandably hinders productivity and motivation for many (Brod, 1997). Becker points to problems with some early research in the area which relied upon the self-endorsement of psychiatric symptoms by the creative individuals themselves, rather than medical records, or ‘certified’ diagnoses (for example, Jamison, 1993). Studies such as those relying on self-report measures are problematic as they further complicate interpretation of creativity-psychopathology research.

2.2.2 Shared traits of creative individuals

Investigations into creativity have focused on a number of dimensions of personality while trying to uncover what assists or shapes the creative individual (Miller & Tal, 2007; Simonton, 1999a; Barron, 1993; Rawlings & Locarnini, 2008; Shepard, 1978), and these are relevant due to the differential results that are found. One of these traits includes intelligence. It has been argued that creativity and intelligence have a high correlation up until IQ level 120, after which the two appear to become independent (Eysenck, 1995). A curvilinear relationship between knowledge and creativity has also been purported, which states that to achieve eminence in creative fields requires enough knowledge to advance that field, however, should one acquire too much knowledge it may cause entrenchment in current trends in the field thus resulting in difficulty ‘seeing things in a different light’ (Batey & Furnham, 2006; Stenberg & Lubart, 1995, cited in Kim, 2011). Others have asserted that neuroticism is another shared trait of creative individuals, a trait which itself is related to psychoticism (Burch, Hemsley, Pavelis, & Corr, 2006b), psychoticism being particularly pertinent to this thesis. Extroversion and openness to experience are also common amongst both eminent and non-eminent creative individuals (Miller & Tal, 2007; Silvia, 2008). Interestingly, Götze and Götze (1979) provided early evidence for domain specificity of creativity when they showed differences between artistic and scientific creativity, with neuroticism being positively related to the former but negatively related to the latter. Tolerance of ambiguity is

another trait which has been posited to be possessed by creative persons (Kirton, 1976), that is, creators are happy to try things for which the outcome is unknown. This allows for the reconceptualisation and reformulation of ideas and theories in the face of, for example, new or conflicting evidence, or some such barrier, as is often required. Finke, Ward and Smith (1992) refer to this process as ‘combinatory play’, or mental synthesis, in their theory of creative cognition, as was seen in Chapter 1, and this type of thinking was famously utilised by Einstein (Claxton, 2006), and is likely to entail both controlled mental imagery, and a certain ‘comfortableness’ with uncertainty. This comfortableness is important as it is possible to conceptualise a scenario where, whilst engaged in some creative activity or pursuit, there may be a period in which solutions or creative output of other types may seem far off to the creator, and so being able to tolerate this state of ‘not knowing’ would be beneficial because the alternative action may be to abandon the task altogether, thus failing to find creative solutions which may have arisen otherwise.

Barron (1966) points out the many levels by which creativity may be expressed, from everyday creativity, to “flights of genius, and the many gradations in between” (p.183). Analysis of the lives of well-known creators through the psychobiographical method, studying documents such as memoirs, diaries, letters, doctor’s notes and interviews, have offered further suggestions for distinguishing qualities and similarities of creative individuals (Kottler, 2005; Kaufman & Beghetto, 2009, Barrantes-Vidal, 2004). In 1931, Lange-Eichbaum scrutinised biographies of and interviews with well-regarded ‘geniuses’

and noted the following: "...it cannot simply be a chance matter that among geniuses the healthy constitute only a small minority" (cited in Kyaga et al., 2011, p. 351). The concomitance of psychopathology and exceptional giftedness within an individual helps to facilitate creative genius, according to Lange-Eichbaum. Also cited by Kyaga et al. (2011) is Juda's (1949) study which revealed elevated incidences of psychopathology ('psychic abnormality') in a sample of 294 highly gifted artists and scientists born between 1650 and 1900. These early investigations hint at a relationship between creativity and states of psychological health. However, a limitation to this approach is that the interpretations and subsequent categorisations which may include 'bipolar', 'unipolar', 'schizophrenic', 'schizotypal', and 'schizoaffective', were obviously made retrospectively, and it is of course difficult to assess the efficacy of authors' diagnostic judgements (though inter-rater reliabilities of these diagnoses are increasingly being reported). These classifications may result from the previously mentioned tendency to attribute characteristics which may be described as 'mad' to creative individuals because to some extent it is expected of them to behave this way (Rothenberg, 1990). Additionally, these are largely correlational studies and so interpretations of the findings should be made keeping this in mind.

Another area of investigation in creativity research is whether similarities in cognitive styles appear across different creative disciplines, for example, whether prolific visual artists have distinctly differing creative styles compared with scientists (Nettle & Clegg,

2005). Nettle makes the claim that different types of cognitive process lead to different types of creativity so, for example, convergent thinking and thought processes typical of autistic individuals are more frequently related to mathematics, with divergent thinking, affective and schizophrenic-type thought being more commonly reported by poets and artists, a claim also made by Barrantes-Vidal (2004).

Simonton (2014) found evidence for a distinction in levels of psychopathology between individuals specialising in different types of creativity. His investigation found that, of the 204 eminent creators included, the artists and writers had a significantly higher prevalence of psychopathology than the scientists, composers and ‘thinkers’ (for example, philosophers). Further, the results showed that the curve representing the relationship between eminence and psychopathology was positive monotonic, indicating that higher eminence was positively associated with higher psychopathology, while a nonmonotonic, single-peaked function emerged for scientists, composers and thinkers, revealing ‘optimum amounts of psychopathology’ in the curves for the former two types of creative. This is a striking finding, and highlights the differences in both the prevalence and even the benefits of psychopathology between artists and writers on the one hand, and scientists on the other. For scientists, much lower levels of psychopathology were associated with high eminence, and as psychopathology increased past the level of what Simonton labelled ‘moderate’, scientific success fell sharply. By contrast, as was hinted at just now, for writers and artists, more ‘madness’ appears to be

associated with more eminence. An interesting observation by Simonton was that “scientists are the only group in which those with severe psychopathology are worse off than those with none at all” (p. 57).

This section has highlighted some psychological and personality traits which are relevant to the study of creativity in order to further illustrate the complexities with conducting research in this area. While this thesis does not concern personality *per se*, it is important to note that there are many constructs which have been found to be associated with creativity. One must acknowledge these because they may contribute to the convoluted interpretations which pervade the literature. Focus now turns to the purported relationship between creativity and the schizoaffective spectrum.

2.3 Creativity and the Schizoaffective Spectrum

2.3.1 The cognitions of the creative

There are many famous creative individuals of whom it has been claimed that they had mental health problems. A handful of examples listed by Nettle (2001) are presented below.

Table 1.1

Famous creative individuals with 'psychotic' traits

Creative group	Name
Poets	Baudelarie, Lord Byron, Coleridge, T. S. Eliot, Keats, Sylvia Plath, Robert Lowell, Ezra Pound, Shelley, Dylan Thomas, Tennyson, Walt Whitman
Writers	J. M. Barrie, Joseph Conrad, Noel Coward, Charles Dickens, Fyodor Dostoevsky, William Faulkner, F. Scott Fitzgerald, Ernest Hemingway, Victor Hugo, Henry James, James Joyce, Franz Kafka, Immanuel Kant, Marcel Proust, Jean-Jacques Rousseau, Robert Louis Stevenson, Leo Tolstoy, Evelyn Waugh, Tennessee Williams, Mary Wollstonecraft, Virginia Woolf
Composers/Musicians	Schumann, Beethoven, Berlioz, Bruckner, Chopin, Dowland, Elgar, Handel, Hjolst, Mahler, Rachmaninov, Rossini, Tchaikovsky, Wagner
Visual Artists	Borromini, Cézane, di Chirico, Gaugin, Goya, Van Gough, Kandinsky, Michelangelo, Modigliani, Munch, Picasso, Jackson Pollock, Mark Rothko

Note. Taken from Nettle, 2001.

An impressive list of impressive minds is presented in

Table 1.1, and there are other well-known names that are not listed here. An interesting finding by Schaller (1997) indicated that creative eminence may actually lead to a higher prevalence of psychopathology amongst these groups, alcoholism and substance abuse being especially implicated. There is another possibility which is that researchers may interpret behaviours otherwise viewed as ordinary as somehow *extraordinary*, thus committing a classic example of confirmation bias (Nettle, 2001). However, as Nettle was also careful to point out, when interpreting lists such as these it is important to note a number of things. Firstly, they suggest a relationship between psychopathological thought and creative *recognition* more so than creative capacity or ability; these individuals have been specifically selected for these so called ‘eminence studies’ because of their enhanced creativity rather than a general capacity for creative production. Second is a point which has already been stated: there are millions of people who experience the often entirely disabling and all-consuming realities of mental disorder who never achieve creative ‘greatness’. Nettle expresses it well: “To pluck the flower of art from the nettle of psychosis takes unusual intelligence and discipline, and most people high in psychoticism do not possess this” (2001, p. 149). Psychoticism (often known simply as ‘P’) is an inherited personality trait which gives someone a vulnerability to psychosis (Eysenck, 1993; Nettle, 2001). This is said to exist on a continuum, so the further up the psychoticism scale one goes the more likely they are to develop a form of psychosis, though this is not guaranteed as triggers and environmental factors are also involved. It is also worth noting the sizeable number of individuals listed in Table 1.1

and elsewhere who underline their tumultuous lives by committing suicide at the end of them, a finding reported disproportionately amongst poets and writers (Kottler, 2005).

Bipolar disorder is frequently reported in a disproportionate number of creative individuals (Andreasen, 2008; Kottler, 2005), and the thinking styles resembling symptoms of schizophrenia have also been associated with unique and creative output (Nettle, 2005; Claridge, Pryor, & Watkins, 1990; Kinney et al., 2000-2001). Schizophrenia is less frequently linked to literary creativity than the affective disorders (Post, 1994), though more literature in support of a relationship has appeared more recently by Sass (2000-2001) and Glazer (2009). An astute observation is made by Sass about the differences between schizophrenic and bipolar thought and the respective effects these have on creators. Sass claims that symptoms of schizophrenia may include detachment, nonconformity, and a sense of alienation, all of which go against the philosophy of the Romantics, which is reflected in the paucity of ‘schizophrenic-type’ symptoms and behaviours observed during that time. As mentioned above, there exist many observations of ‘affective-type’ symptoms and behaviours during the Romantic period. Schizophrenic thought, however, has been said to resemble some 20th century thought which, as put by Glazer “demanded an identical removal of the individual from the constraints of social norms” (2009, p. 757), a behaviour which essentially defines the *impulsive nonconformity* subscale (Claridge & Beech, 1995). Sass (1992) observes that these distinct historical differences between the Romantic and Post-Modern eras, as well

as being correlated with distinct psychopathologies of bipolar disorder and schizophrenia, respectively, they have also influenced changes in accepted notions of what is regarded as ‘creative’.

Forrest (1976) claimed that a certain metaphorical language is frequently and purposely used by people with schizophrenia and that this is analogous to the creative processes of many artists. Forrest also stated that these cognitive processes were likely shared by creative people and those with schizophrenia. Nettle (2001) illustrates the parallels between delusional thought and creativity, especially literary creativity. He conveys a delusion described to him by a person with a diagnosis of schizophrenia. The tale involved conspiracy, deceit, was relayed with intricate detail, and included its own made-up, yet highly sophisticated scientific theories. According to Nettle, the delusion appeared as good as any ‘whodunit’, and similarities of this nature are palpable (Nettle, 2001; Kottler, 2005), and elegantly reinforce the associations between the constructs. Nobel Laureate and mathematician John Nash is one example of a renowned creative individual diagnosed with schizophrenia, (the book, and later film, ‘A Beautiful Mind’ portray his story). The parallels between the dimensional constructs of both creativity and psychosis, that is, that they both exist on respective continua, are also noted by Glazer (2009), however it is suggested that concentrating on the oversimplified question of whether schizophrenia *or* affective disorders are linked to creativity, that is, the ‘either/or’ type distinction that is often made, it would be more beneficial to look at the

dimensional nature of these constructs and to study them with this in mind. Claridge and Blakey (2009) cite evidence to suggest that creativity may be related to both affective disorders and schizotypy due to them being different manifestations of a common underlying process (unitary theory). It is easy to see how bizarre ideation and associative ‘leaps’, typical of schizotypal thought, in the absence of a psychiatric diagnosis, could aid various types of creativity, be they storytelling, elaborate poetry or prose, complex narratives and plays, or intricate theories and works of art. However, as will be discussed in more detail in the next section, it is more difficult to imagine this in someone with schizophrenia, with the cognitive constraints that often go hand-in-hand with such a diagnosis.

Nettle (2001) provides evidence to support the notion that healthy individuals in creative professions have an overlapping profile with individuals with schizophrenia in terms of their underlying cognitive processing. These individuals sample a wider range of stimuli than those who do not have schizophrenia, and can cope with and integrate several signals being fed to them, with material entering consciousness which they were supposed to ignore being used for creative solutions. When investigating a sample of artists and architects Nettle found that both groups had increased scores on the schizophrenia subscale of the Minnesota Multiphasic Personality Inventory-2 (MMPI-2, 1989). What was suggested was that these individuals perhaps possessed the same

capacity to take leaps of the mind in order to reach different and out-of-the-ordinary outcomes.

Prentky (2000-2001) went some way to try to understand the link between creativity and mental illness, providing two explanations as to why there are such disproportionate numbers of creative individuals with symptoms of psychiatric disorders. Firstly, the positive symptoms (such as aberrant perceptions and beliefs, paranormal experiences) and the negative symptoms (social withdrawal and an inability to experience pleasure) do not have the same 'life cycle'. That is to say, positive symptoms such as hallucinations and delusions are shorter lived than negative ones such as flat affect and 'anhedonia', which is a deficit of positive feelings (Nettle, 2001). The fact that affective symptoms are more enduring has implications for creativity because a low mood can result in low motivation. Secondly, the base rates for schizophrenia and bipolar disorder vary significantly from country to country, meaning data from studies conducted in different countries may not be comparable. Prentky (2000-2001) states that symptoms related to depression and 'schizotypy', subclinical traits which resemble these disorders (to be defined fully in section 2.4), are more common in non-clinical populations when compared to symptoms relating to schizophrenia and bipolar disorder. Barrantes-Vidal (2004) suggests the paradox that is found whereby psychoses are related to creativity (but not milder neuroses), despite the severity of symptoms, could result from the dimensional nature of mental illness, a view which supposes that all mental disorders are connected

with ‘normality’ (Claridge, 1998; Poulton et al., 2000; Johns & van Os, 2001). This dimensional view sees psychoses as “extreme pathological variants of otherwise normal personality dispositions” (Eysenck & Eysenck, 1976, cited in Barrantes-Vidal, 2004, p. 60), and states that the difference between psychoticism, the temperamental basis of psychosis, and clinical psychosis itself lies in the quantitative difference between these dimensional traits. These traits are said to be stable and “possibly adaptive” (Barrantes-Vidal, 2004, p. 61).

Prentky (1979) claimed that creativity and psychopathology were alike in terms of similar, shared cognitive processes, and evidence from neuropsychology and cognitive psychology has been found for this since that time (Claridge & Blakey, 2009). These shared processes include the intuitive acceptance of large amounts of information along with more detailed analysis of a limited body of information. Prentky’s discussion of the type of thought process common to pathology and creativity allowed the development of experimental operations for testing such research questions with some degree of specificity. Hasenfus and Magro (1976) noticed the similarities between measures of creativity and those used to measure a so-called ‘schizophrenic performance deficit’ and thus postulated a correspondence between the empirical constructs of schizophrenia and creativity. They argued that the “operational definitions of creativity are often *virtually identical* to the operational definitions of schizophrenia” (p. 347), and highlight that ‘ideational fluency’, that is, increased flow of ideas, and ‘overinclusive’ thought, the

tendency to make unusual links and connections, were both facets of the same cognitive propensity. Earlier studies looking at this issue also found that the equivalence could result from both processes being involved in the sampling of a wide range of stimuli (Dykes & McGhie, 1976), an ability to express imagery freely (MacKinnon, 1961, cited in Keefe & Magro, 1980), and being adept at engaging in pictorial thinking, which is the “sampling of multiple cues and combining them into statistically rare combinations” (Bogen, 1969, cited in Keefe & Magro, 1980, p. 396). Keefe and Magro (1980) studied the creative performance in 10 paranoid schizophrenia patients, 10 non-paranoid patients, 10 non-psychotic psychiatric controls, and 10 ‘normal’ patients. Non-paranoid patients were significantly more creative than paranoid patients and psychotic controls, and generated a significantly higher percentage of ‘highly creative’ responses on the Alternative Uses Task and other creative thinking tasks. Keefe and Magro suggested that more unusual thought processes, impulses and imagery were demonstrated by the participants with schizophrenia, along with a willingness to express these, and that this pattern was reflected amongst the more creative people in the sample.

The associations between psychopathology and creativity, though well-researched remain somewhat unclear, though general agreement of this relationship exists and empirical evidence continues to be found in support of this. However, there are a number of other relevant factors which must be acknowledged when reviewing and presenting this age-old relationship between creativity and psychopathology.

2.3.2 *Are the creativity-psychopathology relationships causal?*

There is certainly empirical literature which seems to suggest links and interrelationships between elements of psychopathological and creative thought. However, to state that where there is psychopathology there is creativity would be entirely false, as the relationships described in previous sections are not always present (Acar & Sen, 2013). The claim that mental illness somehow facilitates creativity may also appear to some as counterintuitive. If one is lost in a deep depression, low and lacking motivation, or is in a period where symptoms of schizophrenia are particularly severe, complete with disorganised thought, impulsive behaviour and lack of enjoyment in life, then how can one take the steps necessary to produce exceptional works or formulate passages of brilliance? Poet Sylvia Plath put it well: “When you are insane you are busy being insane – all the time... When I was crazy that was *all* I was” (cited in Barrantes-Vidal, 2004, p.64). The supposition that nonclinical thought processes are useful in creativity is concretised by the finding that those who are diagnosed with psychosis or depression are rarely creative during these periods, instead exhibiting optimum creativity during their periods of ‘wellness’ (Barrantes-Vidal, 2004; Ramey & Weisberg, 2004). There are too of course a great number of eminent creative individuals who never exhibit any form of psychopathology at all (Burch et al., 2006a), not to mention the sizeable number of people who have, or have at some time been affected by psychopathological complaints who demonstrate no creative abilities, or indeed inclinations, at any time in their lives

(Nettle, 2001). Perhaps these creative artefacts come to fruition during ‘well periods’ because these minds are able to somehow ‘take hold of’ or control this inherently chaotic thought. Barron’s (1993) notion of ‘controllable oddness’ again springs to mind, a personal quality which he posits may be important in understanding the creative person and their creative processes. These periods are in stark contrast to the bouts of depression which must accompany the manic phases of bipolar affective disorder, which usually amount to no creative production whatsoever, with many instead describing periods of frustration and sadness at this sudden lack of flair. This lends further support to the contention that it is not the disorders themselves that are responsible for these robust links, but the cognitive styles and processes underlying them.

An elegant and less rigid model than has been seen accounting for the relationship comes from Glazer (2009), in her attempt to rephrase ‘the madness-creativity debate’, which incorporates the huge body of empirical literature in the area. This model views the creativity construct as existing along two continua; one between *everyday* and *eminent creativity* (Axis A), the other from *science domain* to *art domain creativity* (Axis B). This persuasive model does indeed rephrase the debate, for it addresses the differences in creative production, be they everyday or eminent, and it recognises the differences between creative domains. Taking into account a vast body of literature, the model postulates that the closer a person is to the *eminent creativity* end of Axis A, the more likely it is that they may possess psychopathological traits, and states that

psychopathological traits interact with Axis B influencing the discipline that person is likely to work in. The model is persuasive because it also acknowledges cultural and environmental influences on this combination of factors and is supported by a body of empirical evidence (Simonton, 2014; Sass, 2002; Simonton, 2000; Claridge & Blakey, 2009; Fitzgerald, 2004, cited in Glazer, 2009).

2.3.3 Traits and characteristics of the relatives of psychiatric patients

Many researchers have noted the similarities in thinking style between psychotic and creative individuals, however, as has been noted, psychotic patients themselves are rarely exceptionally creative. Mounting evidence suggests that studying the relatives of persons with mental disorders can tell us something more about this complicated and intricate relationship (Richards et al., 1988). These relatives exhibit higher creativity when measured in laboratory settings, and are overrepresented in professions which would be considered to be creative in their nature. What the literature seems to suggest is that particular cognitive styles coupled with a lack of psychiatric diagnosis is what sets these particular individuals apart from others. This research is reviewed below.

The notion that the relatives of persons diagnosed with schizophrenia have creative hobbies and vocations is not new, with a number of studies reporting this (e.g. Karlsson, 1970). Heston (1966) found that when he studied the creativity of children whose mothers had schizophrenia they possessed more “artistic and imaginative talents” than

the rest of his control group in a sample of children being raised in foster care (cited in Nettle, 2001, p. 391). McNeil (1971, cited in Kyaga et al., 2011) studied the psychiatric profiles and creative achievement rates in adopted Danish participants. The sample was split into 'high', 'medium', and 'low' categories of creative achievement and the results showed not only that rates of mental illness to be highest in the *high creativity* group, but also that the biological parents of these individuals reported disproportionately high incidences of mental illness too. Karlsson (1984) later conducted a large study which concluded that the first-degree relatives of patients with schizophrenia showed heightened 'creative intelligence'. He found that the relatives of psychotic patients were thirty percent more likely than general the population to be listed in Icelandic Who's Who?, and were fifty percent more likely to have authored and published a book. More than double the expected number were involved in professions relating to the arts or scholarship.

Andreasen (1987) studied 30 creative writers and their first-degree relatives. The writers had increased rates of mental illness, and she too found evidence of increased creativity and prevalence of affective disorder in the relatives of these writers compared to the control group. Jamison (1993) found an increase in the self-reported prevalence of affective disorders, suicide, and institutionalisation in poets and their first degree relatives. Ludwig (1995) conducted an investigation into female writers and their families and found that personal and maternal psychopathology significantly predicted

creative performance and demonstrated that a disproportionate amount of psychopathology and creativity could be found in the family trees of these individuals. Post (1994) studied 294 recognised people of notable creativity and of the novelists and playwrights in the sample a significant proportion had a history of familial psychopathology. Similarly, Nettle (2001) and others have suggested that both psychiatric disorder and creative thinking styles run in families. For example, Fanous, Gardner, Walsh, and Kendler (2001) found that it was possible to use positive and negative symptoms of schizophrenic patients to predict schizotypal symptoms in the relatives of these patients. These findings lend support to the proposition that it is not simply the thought or affective disorder itself that is beneficial to creativity but rather the phenomenology of these spectrum disorders. Kinney et al., (2000-2001) found that children who had been adopted who also had parents with schizophrenia were rated as significantly more creative than controls (as adults) by independent-researchers blind to the aims. Those exhibiting schizotypal symptoms and personalities were rated even higher for creativity. These individuals are free from diagnosis and were therefore theoretically more psychologically healthy, yet what is suggested is that they share similar modes of thinking with their psychiatrically unhealthy relatives, i.e. the tendency for unconventional and idiosyncratic thought, unusual experiences in imagery and perception. As a result of this they exhibit more unusual and unique behaviours, thoughts, conclusions, abstractions, and so on (Green & Williams, 1999; Batey & Furnham, 2008). Richards' (2000-2001) study found that bipolar disorder patients scored slightly higher on measures of creativity, but also found that their unaffected relatives

scored higher still. It was suggested that these relatives may reap the compensatory benefits of this inherited disposition ('psychosis proneness') when engaging in creative tasks, possibly due to the lack of debilitating symptoms they experience.

In their nested case-control study of more than 300,000 Swedish individuals, Kyaga, Lichtenstein, Boman, Hultman, and Langstrom (2011) used a substantial collection of National registers and censuses to look at relationships between creativity and mental disorder. Scrutinised were creative and non-creative occupations, which were further subdivided into visual and non-visual artistic groups, and familial patterns of both psychiatric diagnosis and creative achievement. The distinction between visual and non-visual artists was to allow for investigation of domain-specific differences in creativity, while the inclusion of maternal and paternal half-siblings meant that environmental factors which theoretically determine creativity could also be investigated. For the 'schizophrenia subgroup' in their study, it was found to be more likely that these individuals held artistic occupations, particularly visual artistic occupations. This latter observation hints towards the interrelationships between creativity, schizoaffective thought and visual imagery. This study also found that it was significantly more likely for the parents and siblings of people with schizophrenia to work in creative jobs across all domains. The children of parents with schizophrenia were also more likely to work in visual artistic domains. Though the present thesis focuses on schizotypal thought and behaviour, the vast literature implicating an increase of bipolar disorder in creative

groups, as well as the overlapping phenomenology of schizotypy and some affective disorders means that consideration of bipolar subgroups is relevant and cannot be overlooked. As may be expected given this abundance of literature, bipolar individuals in Kyaga et al.'s study were significantly overrepresented in professions independently considered to be creative, with an increased likelihood being found for visual artistic occupations, as was found for the schizophrenia subgroup, however, there was also an elevated chance of these latter individuals working in non-visually artistic professions. This last observation is interesting as it again points to a differential style between creative individuals both in terms of their psychological and cognitive 'make-up' and the creative professions that may distinguish them. Evidence has already been cited which suggests that enhanced visual imagery abilities are useful when creating (Chapter 1), yet here it can be seen that it is the schizophrenia subgroup who exhibited an increased likelihood of creativity in only one domain, that is, visually artistic occupations, and it is precisely this distinction that the current thesis is getting at. The experiences of those with schizophrenia, as has been outlined, often include perceptions that are aberrant, unusual, and even at odds with reality. It is possible that the processes underlying these disorders are what are important for novel creation, a frequently stated notion which is receiving increasing support, and this would go some way towards explaining the frequent reports of increased creativity in schizotypal individuals and the 'well' relatives of those with schizophrenia and bipolar disorder. This is further buttressed by the interesting finding reported by Kyaga et al. (2011) which showed that "the likelihood of

creative occupations... decreased with increasing familial distance to these individuals” (p. 377).

Studies have recently been published which report associations linking genetic polymorphisms and creativity (Kéri, 2009). The polymorphisms which were found to impact on creativity are also related to psychosis risk and altered cognitive functioning (Keri, Kiss, & Kelemen, 2009; McIntosh et al., 2008), and these studies provide further support towards an advantage of certain psychotic-type thought processes, otherwise known as the *balancing selection hypothesis*, which advocates a view of an adaptive advantage of the susceptibility to mental disorder.

This section has presented evidence that cognitive processes underlying psychiatric disorders may explain the frequently reported associations between creativity and psychopathology. Research that implicates aspects of the nonpathological, multidimensional construct of schizotypy in creativity has been published, a review of which is presented next.

2.4 Schizotypal traits and their relationship to creativity

Schizotypy, the collection of subclinical personality traits that bear a resemblance to schizophrenia, but which are not full-blown instances of the disorder, has been linked to

creativity in numerous studies (Burch et al., 2006a; Karimi, Windmann, Gunturkun, & Abraham, 2006; and, O'Reilly, Dunbar, & Bentall, 2001).

Traits resembling schizophrenia and bipolar disorder are said to appear towards the lesser extremes of their respective continua, are known as schizotypy and thymotypy, and these characteristics are present amongst the general population in the absence of clinical psychopathology (Claridge & Beech, 1997). As was noted by Nettle (2001), “This view of the benign functions of schizotypy has a long history, espoused by the influential Victorian psychiatrist Henry Maudsley in 1871” (p. 135). Broken down further, schizotypy consists of subclinical personality traits which themselves appear along separate continua. Schizotypy may enhance human imagination, verbal skills, creativity, especially when combined with high intelligence (Carson, Peterson, & Higgins, 2003). However, excessive and pathological development of such cognitive processes may lead to extreme distractability, overinclusive perception, overestimation of the meaningfulness of naturally-occurring coincidences, delusional ideation, and highly-disordered thought and language, all of which represent core symptoms of schizophrenia (Leonhard & Brugger, 1998; Mohr & Leonards, 2005; Mohr, Graves, Gianotti, Pizzagalli, & Brugger, 2001; Mason et al., 1995). When considering the discussion in the following section, that of ‘schizotypal creatives’, it would be interesting to think about what sets these individuals apart. Perhaps they did not possess these excesses or could control them in some way. It has in fact been found that, despite these impairments, those with

schizophrenia out-perform normal controls on a selection of tasks involving use of context information (Mellet et al., 2006) and syllogistic reasoning (Owen et al., 2006), indicating that the cognitive profiles of schizoaffective disorders include both strengths and deficits. The continuum of positive schizotypy represents a susceptibility to divergent thought and odd experience, and Mason et al. (1995) suggest it may be useful not to filter these stimuli out too effectively as these associative leaps can facilitate creative insight or help to find non-obvious solutions when solving problems. Theoretically the problem is one relating to balance: too much divergent thought leads to cognitive disorganisation, eccentric behaviour, delusion and hallucination, however a little may prove advantageous when engaging in creative pursuits.

Like many of the constructs described thus far in this thesis, there are a number of models to describe the construct of schizotypy. The *quasi-dimensional model* sees schizotypy as simply a milder form of schizophrenia (Meehl, 1962; Rado, 1953, cited in Goulding, 2004) and says that someone who is high on one or more schizotypy factors will probably show signs of psychological ill-health. The quasi-dimensional model is a disease model whereby schizotypy is related to psychological ill-health (Goulding, 2004). The quasi-dimensional model has been challenged by McCreery and Claridge (2002) who showed that high scores on the aberrant perceptions and beliefs factor of schizotypy can be seen as something positive, and not obviously associated with ill-health, as has been shown in the abundance of literature presented. There is also the personality model proposed by

Eysenck (1960) which supposes that psychotic people populate the extreme upper end of what he calls a *normality-psychosis* continuum. The *fully-dimensional model* has received the most empirical support and is seen as an extension of the previous two models. This model represents schizotypy as a collection of continuously distributed traits; the sources of healthy variation and also the predisposition to psychosis. It incorporates the quasi-dimensional model because an additional continuum on a different level from the personality traits exists. The disease continuum, which is found in the quasi-dimensional model, is included in this second continuum, and covers a spectrum of schizophreniform disorders (Goulding, 2004). These range from ‘schizotypal personality disorder’ (Raine, 1991) at the one end of the scale, to schizophrenic psychosis at the other. This model enables researchers to view schizotypy as sometimes associated with health and sometimes with ill-health as it is entirely possible that people with high scores on one or more schizotypy factors are as healthy as people with low schizotypy scores. The fully-dimensional model is fundamentally neutral in that it is not concerned with psychological ill health in any particular realm.

Factor analyses of schizotypy measures have revealed three or four factors (Neuvo et al., 2012; McCreery & Claridge, 2002). The first relates to aberrant perceptions and beliefs, and paranormal experiences and beliefs, and this factor resembles the positive symptoms of schizophrenia such as hallucinations and delusions. Second are the subclinical forms of cognitive failures such as attentional difficulties and increased social anxiety. Next is

introvertive anhedonia, describing subclinical forms of the negative symptoms found in psychosis such as social withdrawal and ‘flat-affect’, which is an inability to experience pleasure. A fourth debated factor has also been found which relates to asocial behaviour (McCreery & Claridge, 2002). What is debated is whether it can be said to be a ‘true’ schizotypy factor or not because it is not relevant to schizophrenia, *per se* (Day & Peters, 1999). The most common tool for measuring schizotypy is the Oxford-Liverpool Inventory of Feelings and Experiences (O-LIFE, Mason, Claridge, & Jackson, 1995). The four schizotypy subscales are *unusual experiences*, relating to magical ideations, overinclusive and bizarre thought processes (positive schizotypy); *cognitive disorganisation* (disorganised schizotypy), exhibited as attention and concentration difficulties, mood swings and social anxiety; *impulsive nonconformity*, showing disinhibited and reckless personality traits, and odd behaviours and speech and *introvertive anhedonia*, being a lack of social enjoyment, an aversion to intimacy and an emphasis on solitude (negative schizotypy).

Researchers have uncovered shared variance between schizotypy scales and the Big Five personality traits. The associations between personality and schizotypy appear to depend on the measure used to measure schizotypy (Boyle, Matthews, & Zaklofske, 2008). Openness to experience is one factor that appears to share variance with dimensions of schizotypy. Boyle et al. (2008) claim that the positive associations that have been found between schizotypy and openness are often revealed when university undergraduate

students are sampled, while negative associations between schizotypy and openness have been reported to exist in clinical populations (Ross, Lutz, & Bailey, 2002).

Miller and Tal (2007) administered the NEO-FFI (Costa & McCrae, 1992) and the Schizotypal Personality Questionnaire (SPQ, Raine, 1991) and their results revealed significant correlations between positive schizotypy (magical ideation, ideas of reference, odd speech, and odd behaviour) and openness ($r = .29$), conscientiousness ($r = -.26$), agreeableness ($r = -.30$) and neuroticism ($r = .31$). Negative schizotypy (flat affect, few close friends, social anxiety, and paranoid ideation) was associated with conscientiousness ($r = -.25$), extraversion ($r = .50$), agreeableness ($r = .38$), and neuroticism ($r = .51$).

Nelson and Rawlings (2008) found that unusual experiences significantly correlated with agreeableness ($r = -.23$), conscientiousness ($r = -.24$) and neuroticism ($r = .25$).

Kwapil et al., (2008) found that positive schizotypy was associated with increased neuroticism and decreased scores on both agreeableness and conscientiousness, while negative schizotypy was related to introversion (low extraversion) and decreased agreeableness. A linear regression indicated that positive schizotypy was associated with openness to experience ($\beta = .33$, $\Delta r^2 = .11$), while the negative symptom dimension was negatively associated with openness ($\beta = -.40$, $\Delta r^2 = .15$), with each schizotypy

dimension independently accounting for more than 10% of the variance in this subscale. The researchers used the Perceptual Aberration, Magical Ideation, Revised Social Anhedonia, and Physical Anhedonia scales in their study, that is, they did not include measures of cognitive disorganisation or impulsive nonconformity.

In a recent study with 355 participants, LeBoutillier (2015) found that the unusual experiences subscale shared 7% of variance with neuroticism, and 2% with openness to experience. Cognitive disorganisation shared 8% with extraversion, 4% with conscientiousness, and 18% with neuroticism. The introvertive anhedonia subscale shared variance with will of the Big Five personality dimensions: extraversion 9%; agreeableness 4%, conscientiousness 3%, openness to experience 4%, and neuroticism 1%. Impulsive nonconformity shared 2% of variance with conscientiousness and 7% with neuroticism.

Swami, Pietschnig, Steiger, and Voracek (2011) found that unusual experiences was significantly correlated with the Big 5 subscales as follows: neuroticism ($r = .3$), extraversion ($r = -.1$), openness to experience ($r = .2$), agreeableness ($r = .2$) and conscientiousness ($r = .2$); introvertive anhedonia was significantly correlated with the Big 5 subscales as follows: neuroticism ($r = .2$), extraversion ($r = -.6$), openness to experience ($r = -.2$), agreeableness ($r = -.4$), conscientiousness ($r = -.2$); impulsive nonconformity was significantly correlated with the Big 5 subscales as follows: neuroticism ($r = .2$), agreeableness ($r = -.4$), conscientiousness ($r = -.5$), and cognitive

disorganisation was significantly correlated with the Big 5 subscales as follows: neuroticism ($r = .7$), extraversion ($r = -.4$), agreeableness ($r = -.3$), and conscientiousness ($r = -.4$).

In early work into schizotypy subscales, positive schizotypy (unusual experiences) and impulsive nonconformity were both found to load on the same factor as extraversion, while negative schizotypy (introvertive anhedonia) and cognitive disorganisation loaded alongside introversion (Claridge *et al.*, 1996).

These results suggest some shared variance between dimensions of personality and schizotypy, though relationships appear to vary depending on sample and measures administered. Additionally, the dimensions measured by the schizotypy subscales are not orthogonal, as reported Mason and Claridge (2006). A UK sample of 1926 participants revealed significant weak to moderate interrelationships between all four subscales (range of $r = .07$ to $.48$).

Oldham and Morris (1995) state that both those with a diagnosis of schizophrenia as well as schizotypal persons display an 'idiosyncratic style' when it comes to their thinking and behaviour which influences creativity. It was outlined in section 2.2.2 that personality traits such as openness to experience and agreeableness were found in disproportionate numbers of creative persons, and reduced latent inhibition is another factor often linking

schizophrenia and schizotypy with creativity (Weinstein & Graves, 2002; Green & Williams, 1999). Reduced inhibition is a factor because those experiencing it are able to make use of their access to apparently irrelevant information in creative problem solving (Dorfman, Martindale, Gassimova, & Vartanian, 2008; Burch et al., 2006b). Recent evidence has also suggested that persons diagnosed with schizophrenia and people high on scales of schizotypy both demonstrate certain right-hemisphere biases in their cognitive processing (Barrantes-Vidal, 2004; Glazer, 2009). Studying these relationships is complicated further by the multidimensional nature of the construct of schizotypy; indeed similar problems exist with investigating the somewhat subjective construct of creativity, and also the varied ways of measuring it.

Positive schizotypy in particular has been implicated as a trait commonly shared by creative individuals (Schuldberg, 2000-2001; Dinn, Harris, Aycicegi, Greene, & Andover, 2002; Burch et al., 2006a). O'Reilly, Dunbar and Bentall (2001) found that creative art students scored higher than humanities students on the unusual experiences subscale of the O-LIFE. This suggests that thinking styles such as 'overinclusive' thought, which is the tendency to make remote associations and to link ideas in new and unusual ways (Mednick, 1962), and magical ideation (Eckbald & Chapman, 1983) may be conducive to creative endeavours. Nettle (2005) also found poets' and visual artists' levels of unusual experiences that were especially high, and that these participants obtained similar creativity scores to a schizophrenic sample (Nettle, 2001). Schuldberg

(1990) found that unusual experiences were positively correlated with creativity scores in a sizeable sample of students, creativity being measured by divergent thinking tasks. O'Reilly, Dunbar and Bentall (2001) found that unusual experiences correlated with the Torrance (1974) measures of divergent thinking in humanities and creative art students, but not in controls. This study concluded, however, that creative pursuits, rather than creative production *per se* were accounted for by schizotypy, that is, these differences were accounted for by the subject the participants were studying rather than their schizotypy scores. Unusual experiences and magical thinking have also been linked to divergent thinking and creativity in students, professors, writers, and actors (Brod, 1997).

Further support for a relation between artistic creativity and positive schizotypy comes from Rawlings and Locarnini (2008) who found a tendency to make unusual word associations in participants high in these traits. They postulate that causal links may exist between schizotypy indices and those of creativity and divergent thinking. These may result from a wider attentional focus, reduced cognitive inhibition of normally-irrelevant stimuli via top-down processing, increased openness to experience, enhanced associative processing, and generation of more-distant and more-novel connections between thoughts and events in schizotypal individuals and those with schizophrenia (Rawlings & Locarnini, 2008).

Nettle (2005) looked at schizotypy and personal and familial mental health in groups of poets, visual artists, and mathematicians, and also assessed participants' psychopathological history and current diagnoses. His results were intriguing. He found increased cognitive disorganisation in artists who had described themselves as 'seriously involved' with visual arts and poetry, while 'professional' and 'non-artist' groups were progressively lower in this trait, although the trend was non-significant. The lack of cognitive disorganisation in the professional groups requires comment. Those high in this trait may experience difficulties when making decisions and following conversations, intrusive and chaotic thought, and increased distractibility. In addition they may experience social anxiety and a sense of purposelessness (Claridge, 1997). An absence of this may have allowed the professional group to progress further in their creative endeavours than their cognitively disorganised counterparts. The professional poets in Nettle's sample scored lower on cognitive disorganisation than both serious poets and those who said they engaged with and wrote poetry as a hobby. Again, the severity of the schizotypal symptoms appears to matter, with the most successful individuals perhaps experiencing, without wishing to sound irreverent, 'just the right amount' of schizotypy for their creations and creative achievements to be successful. Nettle went on to find significant differences between the poet and non-poet groups on unusual experiences, cognitive disorganisation, and impulsive nonconformity, however, no difference was found for introverted anhedonia. When looking at the visual artists, a pattern of results emerges which includes yet another unique set of differences. Unusual experiences were higher amongst visual artists, this positive schizotypal trait has now been implicated for

all creative groupings, and they differed from the non-visual artists on impulsive nonconformity and introverted anhedonia. The visual artists had similar 'schizotypal profiles' to the poets. Batey and Furnham (2008) found that both unusual experiences and impulsive nonconformity were positively related to self-reported creativity in undergraduates, with cognitive disorganisation being significantly negatively related. In a study involving 1108 college students it was revealed that positive symptoms of schizotypy were positively correlated with creativity and that negative symptoms were negatively correlated (Schulberg, 2000-2001). Collectively this suggests that a different pattern of results may emerge depending on how one approaches the problem. It is clear that it matters whether one focuses on 'artists' as a homogenous group of creative individuals or whether one studies creative samples by their respective genres, i.e. poets, visual artists, writers, scientists, and whether the individuals themselves achieve a certain level of success or creative professionalism. To say that if you have schizotypal experiences you will be more creative is overly simplistic in light of the literature presented. Additionally the constructs are multidimensional, that is, both creativity and schizotypy are measured on many differing dimensions. Furthermore, when one differentiates between creative professionals and other 'less serious' creative individuals, the various relationships with schizotypal thought often disappear (Simonton, 2014). In early studies looking at the schizotypy-creativity relationship the distinctions previously described regarding the possibility of domain-specificity of creativity and the nuanced nature of schizotypal thought were not always made. Subsequently conclusions were often generalised and oversimplified. Additionally studies in this area rarely consider the

severity and intrusiveness of the schizotypal experiences for the creative individual, though it may be that some interesting findings have been missed because of this. Different creative outputs may arise depending on whether someone frequently experiences distressing and intrusive schizotypal symptoms compared to someone for whom experiences such as these are rare or less distressing.

Such attributes as overinclusive thinking, magical ideation, and loose and remote associations typical of positive schizotypal thinking are purported to be of creative benefit (Andreasen, 1987). Andreasen and Powers (1974) found that thinking styles of this nature were present in both patients with schizophrenia and patients in the ‘manic’ phases of bipolar disorder. However, as has been highlighted, most instances of schizophrenia do not lend themselves to structured and organised productivity, the debilitating thought processes typifying this disorder instead giving rise to disordered and aberrant attentional biases and behaviours (Simonton, 2005). Therefore it may be that it is the underlying cognitive styles which are important in creative generation, so often facilitating unusual and apt creative connections.

Another theory relevant to the current discussion of the relationships between creativity and schizotypy is Finke’s (1996) concept of ‘chaotic thinking’ in creative cognition, a model of creative imagery which was outlined in Chapter 1 (section 1.3.1). This is exemplified by ‘imaginative divergence’, a view of the world as unpredictable and full of

intricate associations, and these characteristics are reminiscent of elements of schizotypal thought described above. The relationships may not be as straightforward as they at first seem however, as Boden (2004) has asserted. She states that it may actually be ‘relative randomness’ that facilitates creativity, as chaotic thinking alone may imply disconnections from the original problems, and it is the top-down constraints that are key here. Chaotic cognition is of particular interest in the present thesis, as it is found that the thoughts typically displayed in chaotic thinkers, such as impulsivity, playfulness in imagery and cognition, and unstructured thought, facilitate creativity that is “strikingly original” (Finke, 1996, p. 390), and these facets of the construct appear particularly relevant to schizotypy too.

Nettle (2001) and others (Richards et al., 1988; Kinney et al., 2000-2001) theorise that it may be creative thought itself that holds the answer as to why certain psychopathological traits remain in the human gene pool at all. Nettle’s (2001) claim, along with other appropriately named creativity-benefit theorists, is that creative thought has evolved, like any other trait, by virtue of clear evolutionary advantages, and that the cost of this benefit is the presence of mental disorder in all societies. These disorders persist along with creativity because they are “flip sides of the same coin” (Nettle, 2001, p. 11), and it is precisely *because* of the benefits to creative thought that these disorders pervade all cultures. That there appears to exist such a preponderance of creative persons presenting with schizoaffective diagnoses, that so many great ancient and contemporary thinkers

have taken note of this relationship, the links between schizotypal traits and creative behaviours in non-eminent creative individuals and their families, and finally the influence of perceptual and imaginal phenomena for these individuals all complicate the relationship, while at the same time providing interesting avenues of research to explore. Fisher et al. (2004) and McCreery and Claridge (2002) support the notion of a ‘healthy schizotypy’, which can be described as “the uncoupling of the concept of schizotypy from the concept of disease” (p. 144), which dovetails with the notion that the genes related to schizophrenia persist in the population despite schizophrenia’s frequently maladaptive nature.

Recent claims surrounding the dimensional view of schizotypy are particularly relevant to interpretation of the literature, such as the observation that some symptoms from the schizoid and bipolar spectrums are not mutually exclusive (Acar & Sen, 2013). For similar reasons, the relatively new intermediate diagnosis of ‘schizoaffective’ disorder may further complicate interpretation of research findings into the creativity-schizotypy debate (Barrantes-Vidal, 2004).

2.4.1 Schizotypal creatives

Prentky (2000-2001) states that the clinical literature appears to suggest that many famous creative individuals, examples including Franz Kafka (writer), Jean-Jacques Rousseau (philosopher), Samuel Coleridge (poet and philosopher), Samuel Johnson

(poet), John Stuart Mill (poet), Edgar Allan Poe (poet and author), Virginia Woolf (writer), and Hart Crane (poet), reputedly had some “affective disturbance” (p. 101). The literature also suggests that others may have had symptoms which were more likely to be associated with schizophrenia, for example, Alan Swift (poet), August Strindberg (writer), and Charles Baudelaire (poet). These are again post-hoc diagnoses, and Prentky notes that “there are no discrete nosological entities or even nosological categories that capture all psychiatrically disturbed, highly creative individuals” (p. 101, 2000-2001). The attention now turns specifically to *schizotypal* creative individuals; eminent creative people who some claim may have had schizotypal personalities. Examples of these include Albert Einstein (physicist), Isaac Newton (physicist), Salvador Dali (artist), and Franz Kafka (writer) (Glazer, 2009), Lord Byron (poet and playwright), Heinrich Heine (poet), Blaise Pascal (mathematician), and August Strindberg (novelist playwright, poet and painter) (Prentky, 2000-2001), and René Descartes (philosopher, mathematician, writer) (Sass, 2000-2001). Sass (2000-2001) suggested that those with increased scores on schizotypy measures were superior and innovative in their creation compared to those displaying affective disorders, and it is suggested that their particularly unusual or unique thinking styles coupled with their lack of psychosis could explain why they are able to produce such exceptionally creative works. To take Albert Einstein as an example: many think of a stereotypical scientist when they think of Einstein, and his reportedly eccentric and unpredictable characteristics and proneness to fantasy are emblematic of traits often typified by schizotypal individuals. Perhaps the impression that Einstein had schizotypal tendencies comes from the observation of an unusual personality, characterised by

atypical, overinclusive and idiosyncratic thought, characteristics which synonymous with some schizotypal behaviours as conceptualised by current researchers in the field. It is worth elaborating on an observation made earlier. Rothenberg had the notion that “Deviant behaviour, whether in the form of eccentricity or worse, is not only associated with persons of genius or high-level creativity, but it is frequently expected of them” (Rothenberg, 1990, p. 149). Again one is reminded of the ‘role expectation’ of creative people which was mentioned earlier. Have those eminent in their creative fields felt the need to conform somehow to society’s view of how ‘a creative’ should behave? Or could these behaviours be associated with the cognitive styles typifying schizotypal personalities? The classic notion that creativity arose via divine intervention meant that creative individuals were traditionally bestowed with a “mystical and superior quality” (Barrantes-Vidal, 2004, p. 63), so it may not be a tenuous suggestion that some embellishment of symptoms may have ensued. However, Barrantes-Vidal makes the important point that this ‘myth of genius’ does not account for the preponderance of psychopathological traits in non-eminent creative individuals. The same could be said about the disproportionately heightened schizotypy scores often related to creative performance and endeavour.

Naturally, the connection under review, that of a relationship between creativity and ‘madness’, has been observed by creative individuals themselves, Salvador Dali famously declaring that “the only difference between me and a madman is that I am not mad”

(Nelson & Rawlings, 2008, p. 1), a prescient statement one may think in light of latter claims that he may have been high in schizotypy, for this could even be considered as a colloquial explanation for schizotypy itself, that is, the characteristics of ‘madness’ without the psychiatric diagnosis. William Shakespeare alludes towards the tendency for people to view creativity as synonymous with mental disorder in ‘A Midsummer Night’s Dream’, demonstrated with the following quote:

“One sees more devils than vast hell can hold;
That is the madman...
... The poet’s eye, in a fine frenzy rolling,
Doth glance from heaven to earth, from earth to heaven;
And as imagination bodies forth
The form of things unknown, the poets’ pen
Turns them to shapes, and gives to airy nothing
A local habitation and a name.” (Shakespeare, 1590-1596, cited in Nettle, 2001, p. 2).

Having considered the empirical evidence surrounding the link between schizotypal thought and creativity, both eminent and non-eminent, it appears that there is something

about the quality of schizotypal thought which relates to unusual and novel creative productivity, or the tendency to engage in artistic pursuits. However, the evidence is mixed, and it appears that there are other factors which influence the relationships, for example, the nature of the tools and the type of creativity which is considered. The admittedly lengthy quote above reflects this and has been included for a number of reasons. Shakespeare's observation is pertinent as not only is he specifying a relationship between creativity and mental illness, but he is also alluding to the function of mental imagery in the creative process, a process whereby previously unanticipated forms are adapted and given meaning. The wording has a certain 'schizotypal' quality to it; creating meaningful entities from 'things unknown', from 'airy nothings'. This description brings to mind elements of positive schizotypy, such as the tendency to encounter shapes and forms despite there being no external stimuli present. One may again notice the somewhat stereotypical view of the 'madman' portrayed here too, characterised by bizarre behaviour and speech, and frenzied, rolling eyes. Yet here Shakespeare is describing not a madman, but a poet. Having unusual perceptual experiences, indicated by high scores on measures of positive schizotypy, so called because it resembles the 'positive' symptoms of schizophrenia such as hallucinations, magical ideation and other unusual cognitive experiences, is associated with increased creativity in a wide range of vocations (Nettle, 2005). For example, O'Reilly, Dumbar and Bentall (2001) found that art students scored higher than humanities students on items measuring unusual experiences, supporting the supposition that these cognitive characteristics may contribute to their artistic pursuits. The propensity to view things in

an unconventional light or to make bizarre connections is common among individuals high on positive schizotypy scales, as are pseudo hallucinations and anomalous perceptual experiences (Claridge et al., 1996).

There appear to be associations with creativity between both schizotypal thought and mental imagery, yet these associations are far from straightforward. Rather than focussing on the creativity-imagery debate on one hand, and the creativity-schizotypy debate on the other, and in light of the evidence presented thus far, it may be time to consider the interrelationships between the three constructs and the possibility that schizotypy and imagery are themselves related.

2.5 Drawing the Three Constructs Together

An example which may demonstrate the interconnectedness of the three constructs under consideration relates to the relational aspects of certain schizoaffective constructs, specifically schizotypy, with elements of mental imagery. It was suggested earlier that the focus of researchers on distinct creativity-imagery and creativity-schizotypy links may have left a potentially worthwhile area relatively unexplored, that of the imagery-schizotypy link. The word ‘relatively’ is used here because some studies have been conducted more recently which make associations in related areas. In their research with

hallucination-prone individuals from the normal population, Aleman, Nieuwenstein, Böcker, and De Haan (2000) demonstrated that the ‘high hallucination-prone’ individuals in their study reported higher imagery vividness than ‘low hallucination-prone’ comparisons, suggesting an underlying link between these experiences, which are perceptual in nature. In their paper which looked at whether the confusion of internal and external imaginal stimuli resulted in hallucinations, Böcker, Hijman, Kahn, and De Haan (2000) found no differences between hallucinating and non-hallucinating participants in perception, but again found that the former group reported having more vivid imagery. While hallucinations, and indeed pseudo-hallucinations, are not synonymous with imagery, these examples highlight a certain ‘imaginal’ aspect to the construct. This is also relevant because, as has been shown, pseudo-hallucinatory experiences are associated with positive schizotypy, which is related to creativity. Sack et al. (2005) outlined the similarities between imagery and hallucinations by stating that mental images also have perceptual qualities and can occur in the absence of appropriate stimuli. However, the important difference between hallucinations and mental images comes from whether one may control these perceptual experiences, for hallucinations typically occur beyond control and intention (Bentall, 1990). Mental images by contrast are intentionally and actively generated and can thus be more easily controlled. This last point requires one caveat, however, and that is that the ability to control mental imagery is not one enjoyed by all at equal levels. A related point comes from Barrett (1993, cited Sack et al., 2005) who found that people experiencing hallucinations had more vivid imagery but worse control of images in comparison to people who did not experience

hallucinations. Additionally, Barrett and Etheridge (1992, cited in Sack et al., 2005) claimed that hallucinations were often associated with hypnagogic and hypnopompic sleep, which has already been shown to be linked to creativity (Chapter 1, section 1.1.1).

Sack, van de Ven, Etschenberg, Schzta, and Linden (2005) suggest that enhanced imagery vividness may possibly indicate a trait marker of schizophrenia, which would therefore theoretically demonstrate some association with schizotypy. Especially relevant to the present discussion is that strong correlations between increased vividness of mental imagery and the presence of positive schizotypal traits have been reported (van de Ven & Merckelbach, 2003). Bell (2010) suggests that the link between imagery and schizotypy may only materialise when considering imagery in a range of sensory modalities such as visual, auditory, gustatory, and cutaneous. As was shown in Chapter 1, mental imagery has been related to creativity in a wide range of settings, and the examples just outlined demonstrate further overlaps in the constructs under investigation in this thesis. None of these studies looks at mental imagery control, however, and it may be that some interesting associations exist between this ability and schizotypal thought, and subsequent relationships to creativity.

In an investigation of conceptual expansion, creativity, mental imagery, and respective relationships with psychopathology, Abraham, Windmann, Daum, and Gunturkun (2005) found the high-psychoticism group in their sample to perform well on Ward's (1994)

animal drawing task which measures conceptual expansion. This was supposedly due to defocused top-down processing which allowed this group of participants' access to a wider conceptualisation of relevance and to ignore schemas of common earth creatures, therefore conceiving of more conceptually unique drawings, and it may be that performance on this task is additionally benefitted by enhanced imaging abilities. Barrantes-Vidal (2004) notes McConaghy's (1960) observation that such allusive thinking may be linked to predispositions to psychosis and to creative cognition, creative cognition, incidentally, also embodying mental imagery processes. She describes the often irrelevant associations typical of psychotic thought which arise due to impairments in attentional filtering, again due to defocused top-down processing, and notes an enhanced capacity for "making logical attributions" (p. 68) amongst overinclusive thoughts, that is, those which go beyond typical strategies and which may therefore lead to increased creative output. It is conceivable that the creative person may also demonstrate these abilities, and that mental imagery processes may be involved as well. Unorthodox thinking and behaviours are also characteristic of schizotypy. It has already been mentioned that Einstein, Coleridge, and Dali all engaged in elaborate mental imaging techniques to facilitate their creativity, and even more interesting is that they have all been said to exhibit schizotypal behaviours and traits (Glazer, 2009; Prentky, 2000-2001). It is acknowledged that there are problems with characterising and assigning traits to people who are dead, but the claim is still a compelling one and buttresses arguments to be presented throughout the thesis.

What I am proposing is that relationships between creativity and enhanced positive schizotypy may reflect elaborate and unconstrained imaginations, as well as uncontrollable and unusual imaginal experiences, the associations between creativity and imagery on the other hand reflecting the ability to control and reconceptualise visual images.

2.6 Summary and Conclusions

It is evident that a multifaceted approach should be adopted studying relationships between creativity, mental imagery and schizotypy. Despite significant developments in methodologies and models available to elucidate the complex connections inherent in the debates, conclusive findings are still far off. The previous chapter and this one have highlighted potential reasons for the lack of progress, the most significant seemingly being the problems with operationalisation of all three constructs and subsequent failure to acknowledge the multidimensional nature inherent in each. A new approach to these investigations is therefore proposed, which acknowledges the shortcomings previously described and addresses them accordingly. The final section of this chapter provides details of such an approach.

2.7 Theoretical Framework

A related collection of traits underlying creativity

The empirical evidence presented thus far suggests that there are links between visual imagery and creativity, and elements of schizotypy and creativity. To suppose that creativity will inevitably be demonstrated by those high in positive schizotypal traits is naive, yet the evidence suggests that a relationship nonetheless exists (Nettle, 2006; Burch et al., 2006a; Fisher, 2004; Acar & Sen, 2013). Could this be further explained by investigation of the imaginal abilities of these individuals?

Finke (1996) states that creative thought and mental imagery utilise both conscious control and spontaneity, both of which can be explored by the tools and protocols to be employed in the thesis. The conscious control of mental imagery will be measured using a tool explicitly designed for the purpose of assessing imagery control aptitudes, and the ability to conceive of and provide creative responses in divergent thinking tasks and activities which require mental imagery will allow a thorough exploration of these aspects of creative cognition.

Another reason for the chosen design, one which has already been alluded to, is the supposition that positive schizotypy, specifically, is associated with mental imagery. A number of the O-LIFE unusual experience items enquire about such things as seeing ‘shapes and forms’ in the dark, and whether participants’ daydreams seem ‘so true to life

that [they] sometimes think they are real' (Mason, Claridge, & Jackson, 1995). Another item asks '...have you seen a person's face in front of you when in fact no one was there?' It is argued that experiencing any of these things would necessarily entail mental imagery, and it may be that the imaginative and perceptual nature of some questions in the O-LIFE are alluding to a side of the argument which has been studied with relative paucity.

Morrison and Wallace (2001) posit that both combinational play during mental synthesis, that is, the combination, separation and recombination of shapes in mental imagery, and analogical reasoning may be relevant to the generation of creative ideas due to the increased likelihood of original, unique, and previously unanticipated ideas. It is possible that these cognitive abilities may be further facilitated by schizotypy due to loose-associations and idiosyncratic thinking styles. The potential interactions between performance on creative thinking tasks, schizotypal thought processes and experiences exhibited in both creative and non-creative persons, and objectively measured mental imagery control have not been comprehensively examined collectively. Previous investigations into the somewhat mysterious processes leading to creativity may have failed to recognise that, rather than exploring psychopathology on one hand, and strong imaging abilities on the other, a focus on how these elements are related may yield more substantial and fruitful cues to the nature of the relationships.

2.8 Research Aims

Bentall, Claridge and Slade (1989) and others (Dinn, Harris, Aycicegi, Greene, & Andover, 2002) claim that many mental disorders also have multidimensional structures (Hasenfus & Magaro, 1976; Glazer, 2009), another reason why unpicking relationships with creativity is so problematic. I have now introduced three multidimensional constructs with which to contend; creativity, mental imagery and schizotypy. This thesis aims to investigate whether the underlying cognitive processes which correspond to each are themselves related. Visual imagery has been linked to enhanced creativity, however, the nature of these imaginal experiences ranges from the use of controlled and deliberate manipulation of images, to sudden and uncontrolled images (see Chapter 1, section 1.1.1 and 1.2.2). The type of imagery experienced by those scoring highly on measures of positive schizotypy is often unexpected and occurs outside of that person's volition, yet these individuals also often score highly on measures of creativity. Visual imagery is implicated in both examples, and the thesis aims to uncover why this is.

The development of an objective response-based measure of mental imagery, which reflects the multidimensional nature of the construct, will allow one to compare abilities in mental imagery with performance on creativity tasks. Additionally it will enable more thorough investigation into which elements of imagery influence creative ability, into whether these elements are related to schizotypy, and into which types of creativity are benefitted by enhanced imaginal abilities. By employing a range of measures of imagery

and creativity, and by exploring the cognitions of creative professionals in terms of their mental imagery, schizotypy, and creative cognition, the aim is that some of these as yet unresolved discussions will be disentangled.

The research aims to investigate the nature and measurement of mental imagery control and to ascertain whether it is related to both creativity and schizotypal traits. Whether enhanced creative performance is related to heightened schizotypy scores will also be studied, as will whether there are more pronounced relationships when visual artists are studied.

2.9 Definitions

The forthcoming discussions relate to creative ‘products’, measured through creative visualisation tasks, creative imagery tasks, and to the often similar idiosyncratic thinking styles characteristic of those typically scoring highly in creative domains. Individuals who work in professions commonly seen to involve imagination such as visual artists, writers, and sculptors may be referred to as ‘creatives’.

Mental imagery control has been defined as the ability to easily bring pictures to mind, to be able to combine and manipulate these images, and the ability to easily make shifts from the utilisation of object to spatial imagery (Blajenkova, Kozhevnikov, & Motes,

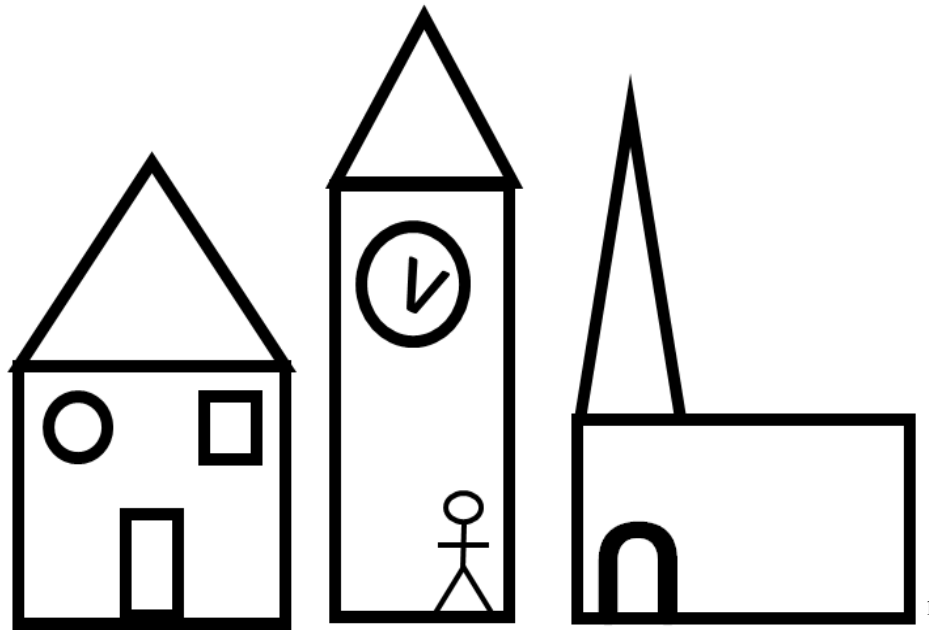
2006). Mental imagery, as defined by Kosslyn, Ganis, and Thompson, (2001), occurs when perceptual information from memory is accessed, in turn leading to the experience of “seeing with the mind’s eye” (Kosslyn, Ganis, & Thompson, 2001).

Schizotypy is defined as a multidimensional construct which encapsulates cognitive and behavioural traits and characteristics along four dimensions: *unusual experiences*, *cognitive disorganisation*, *introvertive anhedonia* and *impulsive nonconformity* (Mason, Claridge, & Jackson, 1995). This definition results from a large body of work by Mason and Claridge and their colleagues, who have found evidence for four schizotypy subscales. Other researchers may only encapsulate positive and negative elements, and may not consider cognitive disorganisation and impulsive nonconformity, which may both be relevant to other constructs under scrutiny in this thesis (imagery control and creativity). Another key aspect of Claridge’s definition is that it is not predicated on the more traditional view which considers the dimensionality of psychotic traits, and instead “regards psychotic characteristics as no different from other individual difference traits ... that potentially have either healthy or unhealthy outcomes” (Mason & Claridge, 2006, p. 205). I have adopted Mason et al.’s definition of schizotypy for a number of reasons related to this. The first relates to the multidimensionality of the schizotypy construct, as well as the literature suggests that differential relationships may emerge between schizotypy and other constructs which reflect this characteristic. Additionally, the O-LIFE is intended for use in this thesis, and this tool has not only been found to be an

acceptable measure in terms of reliability and validity, but it also taps four dimensions of schizotypy. Additionally, as has been seen, there are those who advocate a two-factor model of schizotypy, with factors which correspond to positive and negative symptoms characteristic of schizophrenia (Kelley & Coursey, 1992; Raine & Allbutt, 1989; Venables et al., 1990, cited in Ross, Luta, & Bailey, 2002), though less recent evidence for this exists. Brod (1997) defined schizotypy as “a set of behavioural, affective, and cognitive ‘eccentricities’” (p. 276), and felt that these factors (which include the four factors measured by the O-LIFE) may be the ‘foundation’ of psychotic illnesses. The factors unusual experiences (or “unreality”, “perceptual eccentricity”, or “positive schizotypy”), and individuals high on this factor are prone to magical thinking, aberrant perceptual experiences, hallucinations, suspiciousness, and paranoid ideation; social or physical anhedonia, characterised by withdrawn ‘schizoid’ traits and introversion; cognitive disorganisation, showing anxiety and social impairment, attention difficulties, and neuroticism, and finally impulsive nonconformity, which, according to Brod, overlaps with psychoticism, extraversion, and impulsiveness. Acar and Sen (2013) note the tendency of many researchers to generalise schizotypy to psychosis-proneness, and also state that measures of schizotypy typically resemble Meehl’s (1962) four schizotypy traits. These traits and symptoms include cognitive slippage, interpersonal aversiveness, anhedonia, and ambivalence. The Wisconsin Schizotypy Scales (Winterstein et al., 2011) also look at positive and negative schizotypal symptoms, such as perceptual aberrations, magical ideation and anhedonia, but do not assess other traits

such as cognitive disorder and impulsivity. These alternative definitions are briefly revisited in Chapter 5, section 5.3).

CHAPTER 3 A NEW PERFORMANCE-BASED MEASURE OF IMAGERY CONTROL



3.1 Introduction

As was described in Chapter 1, the phenomenology of mental imagery, along with problems relating to the psychometric properties of popular tools designed to measure it, make it an inherently difficult attribute to inspect. Whilst self-reported information about the vividness or control of mental imagery has yielded some interesting findings (Marks, 1973), a performance-based measure may offer new and more reliable insights to the

¹ Images taken from the Image Control and Recognition Task (ICRT). For illustration.

field. In addition to the ability to move away from the introspective and subjective tools of mental imagery which pervade the field, an objective mental imagery control tool will allow researchers to investigate associations between imagery control and other measures of spatial ability. Utilisation of an objective tool alongside more subjective tools of mental imagery may help to resolve some of the issues surrounding the reliability and validity of self-report measures, and around the interpretations drawn on the basis of scores derived from these tools (Lane, 1977; LeBoutillier & Marks, 2001-2002, 2003; McKelvie, 1995). These issues are outlined after an account of the neuropsychological evidence for the multidimensionality of imagery is presented.

3.1.1 Neural correlates of mental imagery: support for a collection of abilities

The similarities in the cognitive processes underlying visual percepts and visual images have been discussed extensively by Kosslyn and his colleagues (Kosslyn, 1980, 1994; Kosslyn, Thompson, Wraga, & Alpert, 2001; Kosslyn & Thompson, 2003). They propose that, like visual percepts, visual images involve analog working memory representations which include spatiotopic (world-centered) information. Loomis, Klatzky, Avraamides, Lippa, and Golledge put it nicely: “the model encompasses imagery mechanisms at multiple functional and cortical levels” (2007, p. 35), and evidence from neuropsychological research has consistently backed this claim up (Gansler et al., 2011). Findings from neuropsychological studies reveal similarities between deficits in visual imagery and visual perception (Farah et al., 1988) and

functional neuroimaging has revealed brain regions which activate during both visual imagery and perception (Ganis & Schendan, 2008; de Lange, Hagoort & Toni, 2005; Ganis, Thompson, Mast & Kosslyn, 2003; Kosslyn, Thompson, Wraga, & Alpert, 2001; Barnes et al., 2000). These overlapping areas are those which are implicated when engaging the visual buffer which organises visual input, such as delineating figure from ground. The visual buffer initially operates through two pathways, one processing object properties of visual input and another for processing spatial properties (Kosslyn, 2005).

In Baddeley and Hitch's (1974) 'classical' working memory model (see also Baddeley, 1986), the visuo-spatial sketch pad is conceived of as one uniform system which also has distinct visual and spatial components (Repovs & Baddeley, 2006). Studies by Klauer and Zhao (2004) and Logie and Marchetti (1991) support the claim that there are separate visual (object) and spatial subcomponents in the visual-spatial sketchpad of working memory. Dean and Morris use Baddeley's distinctions to assess spatial content and its influence on the phenomenological experience of images. They found that three separate classes of imagery processes influenced performance on 2D spatial tests, representing *pictorial resolution* (or quality), *formation*, and *spatial extent*, all essential processes when performing spatial imagery tasks (Dean & Morris, 2003). Purportedly the specificity of the stimulus, whether it is an image of an everyday scene or a line drawing, leads to the involvement of different cognitive sub-processes depending on its nature. Their findings revealed that self-report ratings of qualities of visual images appeared to

be at least moderately related to performance on the spatial tests participants were introspecting on, which is encouraging when considering the mixed reviews presented within this chapter.

Early claims that mental imagery involves analog spatial representations (Kosslyn, 1994; Shepard & Cooper, 1982) were supported by Zacks (2008) in his meta-analysis of the mental rotation literature. Areas of the brain responsible for motor planning and execution in the posterior frontal cortex were found to activate during mental rotation (Cohen & Bookheimer, 1994, cited in Zacks, 2008). De Lange, Hagoort, and Toni (2005) used fMRI to compare brain activity when participants were engaging in ‘right-left judgements’ about pictures of hands to activation during ‘right-left judgements’ relating to alphanumeric symbols. They uncovered two distinct sets of regions which activated during the trials and their findings suggest that participants were engaging in motor simulations. These findings lend further support to the claims that visual imagery is a multidimensional construct and therefore investigations into its nature should reflect this.

Evidence for the specificity of neural activity implicated during different visual imagery tasks, such as the finding that rotation of 2D and 3D stimuli utilise different brain areas (Voyer & Hou, 2006), coupled with multitudinous double-dissociations described in the literature suggest it may not simply be the experimental approaches and methodologies

employed which lead to the disparate findings in visual imagery research. Wraga, Shephard, Church, Inati, and Kosslyn (2005) employed functional magnetic resonance imaging (fMRI) while participants imagined rotating objects in two conditions, one involving an 'object-relative' reference frame, where participants imagined the object rotating in front of them, and a 'self rotation', which involved an egocentric reference frame, where participants imagined rotating themselves around a specified object. Their findings showed that distinct cortical regions activated according to the spatial-transformations being performed, as well as some common regions, yet more evidence that multiple spatial-transformation mechanisms are involved in the cognitive processing of mental imagery. Conclusions such as these have been delayed by a failure to adequately operationalise mental imagery also and with the observation that the majority of spatial tools concentrate on just one type of rotation task, either object or self-rotation, (Barnes et al., 2000; Kosslyn, DiGirolamo, Thompson, & Alpert, 1998). The dissociations described dovetail with the body of empirical evidence which indicates that spatial transformations conducted in imagery are subserved by multiple neural mechanisms (Kosslyn, Thompson, Wraga, & Alpert, 2001; Zacks et al., 1999).

Tomasino and Rumiati (2004) looked at hemispheric lateralisation and 'stimulus-dependent' strategies used during mental rotation in persons with lesions in either their left or right hemispheres and revealed double dissociations. It is claimed that these stimulus-dependent strategies engaging either motor or visual cognitive processes can be

consciously prompted or are triggered implicitly (Tomasino & Rumiati, 2004; Kosslyn, Ganis, & Thompson, 2001). Kosslyn, DiGirolamo, Thompson, & Alpert (1998) showed that the strategy applied can be manipulated by the experimenter's instructions, and suggest that methods of mental rotation may vary depending on whether somatomotor or visuo-spatial operations are being imagined, in this case imagining the rotation of limbs compared to strategies applied when rotating visual objects. Kosslyn, Thompson, Wraga, and Alpert (2001) provide evidence that shows that when one imagines using their own hands to mentally rotate an object, an endogenous force, cortical motor processes are implicated in mental rotation, while exogenous forces such as imagining external manipulation of object do not reveal activation in cortical motor areas. Kosslyn et al., (1998) found that rotating Shepard and Metzler's mental rotation stimuli increased parietal lobe activation bilaterally, while rotating hands induced activation only in the left parietal lobe and left motor and premotor areas. Different frames of reference may also result in the selection of different mechanisms for solving mental rotation tasks (Zacks et al., 2002). The supposition for the existence of dissociable neural systems is further supported by the finding that allocentric image transformations, where the object itself is the reference frame, and egocentric transformations in imagery, that is, those from the perspective of the viewer, entail "different chronometric patterns" (Tomasino & Rumiati, 2004, p. 878). Tomasino, Toraldo, and Rumiati (2003) found double dissociations in the performance of patients with left hemisphere lesions and patients with right hemisphere lesions depending on whether they were rotating mental images of body parts or images of objects, buttressing the previously outlined notion that operations underlying mental

rotation are distinguishable depending on the stimulus (Dean & Morris, 2003). Left hemisphere lesions lead to impaired performance when patients were rotating mental images of their hands but not when they were rotating mental images of external objects, and the opposite result was found for those with right hemisphere lesions. Double dissociations were also uncovered when comparing mental rotation operations in patients with left-hemisphere (LH) lesions compared to right-hemisphere (RH) impaired patients (Tomasino & Rumiati, 2004), with rotation of hands versus puppets, for example, showing activation in distinct neural areas for these brain-injured patients. It has also been found that brain areas associated with vision are activated during mental rotation, along with the parietal cortex, premotor regions, and the primary motor cortex (Tomasino et al., 2003). Evidence from experimental studies has shown object and spatial imagery to be distinct both functionally and neurologically (Kosslyn, Ganis, & Thompson, 2001; Milner & Goodale, 1995, cited in Blajenkova, Kozhevnikov, & Motes, 2006) with lesions in the temporal cortex affecting object imagery but not spatial imagery, the reverse resulting from lesions to the posterior parietal cortex (Levine, Warach, & Farah, 1985; Farah, Hammond, Levine, & Calvanio, 1988).

Barnes, Howard, Senior, Brammer, Bullmore, Simmons et al., (2000) found ‘overlapping’ brain activity in participants engaging in both perceptually-sourced and imagery-based spatial tasks requiring rotation and transformation of shapes and lines, suggesting functional similarities between imagery and perception. Barnes et al. also

found differences in cortical activity depending on whether participants were engaged in perceptual mental rotational, i.e. when they were actually rotating physical objects or the same tasks using imaginal processes, demonstrating once again that there lies a complex relationship between visual imagery and perception, with findings such as these pointing to multitudinous avenues of exploration for imagery researchers.

Complimentary conclusions regarding the multifaceted nature of mental imagery have been reached despite visual imagery researchers utilising uncomplimentary methodologies. Additionally, the notion that visual imagery and perception share neural correlates but do not draw on identical processes is one which substantial evidence supports, as has just been outlined. The very nature of imagery, the fact it engages so many cortical areas, is experienced in such diverse ways, comes in many ‘phenomenological flavours’, may be influenced by memory, and evokes emotions means that it would be conducive to study it in such a way that reflects these complexities.

The cognitive and neuroscience evidence *en bloc* suggest that to conceptualise and investigate visual imagery in the over-simplified manner with which it has been approached by some in the past, such as when vividness ratings are taken to demonstrate overall ‘imagery ability’, may have obscured the issues contributing to the imagery-creativity debate, rather than elucidating them. To treat ‘vividness’ as though it reflects all aspects of mental imagery is a flawed approach (Burton, 2003; Burton & Fogarty,

2003), and one should instead acknowledge that mental imagery is a collection of abilities. Where no relationship is found between mental imagery and creativity one needs to consider whether the tools used to measure each construct have obscured relationships that would have emerged had alternative measures been employed instead. For example, does the relationship reveal itself when figural as opposed to verbal creativity tasks are used, suggesting that visual imagery is more beneficial in visual creativity? Or could it be that some other element of mental imagery is related but had simply not been measured. The following discussion will specifically address the problems with existing measures of mental imagery and will go on to describe a new tool which has been designed in order to fulfil the need for a more effective, response-based measure of mental imagery control.

3.1.2 What is wrong with current mental imagery measures?

There are a great number of tools which offer the measurement of various aspects of mental imagery, for example, imagery vividness, imagery control, ability to rotate mental images, ranging from questionnaires to measures of accuracy and reaction time. These are described below, and throughout the forthcoming review the problems inherent in conducting research using some of these tools will be outlined in order to place the need for a new mental imagery tool in context.

A. Richardson's (1969) revised version of Gordon's Test of Visual Imagery Control (TVIC) is a commonly used questionnaire that requires participants to state whether they can visualise images about a car. Response categories of "Yes", "Unsure", or "No" may be selected, and the tool includes items such as 'Can you see a car standing in the road in front of a house?' and 'Can you now see the same car laying upside down?' This tool does not have a performance element, and therefore the actual ability of participants to manipulate the mental image is hard to ascertain. The psychometric properties of the TVIC have been investigated and have produced mixed results (Ashton & White, 1974; Kihlstrom, Glisky, Peterson, Harvey, & Rose, 1991; LeBoutillier & Marks, 2001-2002). LeBoutillier and Marks (2001-2002) found pervasive response leniency in this tool, and claim that it fails to satisfy univariate assumptions of psychometric testing. Nevertheless, the TVIC is shown to have acceptable test retest and split-half reliabilities, though there is disagreement as to the internal factorial structure (Campos, 2009-2010; LeBoutillier & Marks, 2000-2001). The TVIC authors purport that it measures a single ability, yet at least three latent variables may be tapped by this measure (Kihlstrom et al., 1991; LeBoutillier and Marks, 2001-2002). The Vividness of Visual Imagery Questionnaire (VVIQ; Marks, 1973) is a frequently used questionnaire in imagery research. A self-report tool, acceptable reliability and validity have been found for the VVIQ (McAvinue and Robertson, 2006-2007; Kihlstrom et al., 1991). A small number of the VVIQ items pertain to the control of mental imagery, though there is no precise way to determine whether participants are accurately depicting the intended images. There is evidently no way to discern whether an accurate internally image of, for example, 'the sky clear[ing]

and surround[ing] the sun with blueness' is visualised (Marks, 1973), as there is no objective element to the tool. This is an obvious but common problem with self-report imagery questionnaires.

Some theorists claim that imagery questionnaires do not measure mental imagery vividness and control at all, instead tapping abilities such as spatial memory, memory for experiences, or memory for visual stimuli (Ernest, 1977; Hiscock, 1978; Slee, 1988). When this is considered alongside purported problems such as social desirability, demand characteristics, and experimenter expectancy (Lequerica, Rapport, Axelrod, Telmet, & Whitman, 2002; Neisser, 1972; Sheehan & Neisser, 1969) it suggests that new methods should be developed. Many of the published performance-based measures for assessing spatial imagery abilities focus upon the visualisation and rotation of stimuli (McAvinue & Robertson, 2006-2007). In Shepard and Metzler's Mental Rotation Task (1971), in which participants to look at pairs of 2D or 3D images, one of which is rotated, and judge whether they are the same or mirror images, response times are usually found to have a linear relation to the angle or degree of rotation, known as the 'symbolic distance effect' (Moyer & Bayer, 1976). That is, that increased angles or rotations lead to inflated reaction times, demonstrating that participants form an image of the shape and mentally rotate it until it matches the orientation of the other, whereby a mental comparison takes place (Shepard & Cooper, 1982). Paivio (1971) stated that spatial tests based on findings from the mental rotation literature show that the linear relation between angle and

response time can indirectly serve to measure imagery ability. Paivio's (1978) Mental Clocks task assesses participants' ability to internally compare two images of clock faces, one of which is rotated, and this tool also demonstrates the symbolic distance effect, which is demonstrated by many rotation tasks and is the observation that the time taken to solve the tasks increases linearly with the degree of rotation required. Most mental rotation tasks have one thing in common: they present images of the final form alongside alternative incorrect options available for selection. The issue here in relation to measuring visual imagery ability is that these are perceptually-sourced tests, and though effective at assessing spatial-imagery abilities, they do not require visual imagery alone to solve. When asked to mentally manipulate an item, it may be easier to imagine it rotating and transforming when you can see the image in front of you, and when an example of what the item would look like upon completion of the task is also presented. There is no doubt that mental imagery is involved in these rotation processes, yet what is suggested in this thesis is that the requirement to engage in these processes without perceiving these stimuli would require a higher level of image control and maintenance. The mental clocks task and other spatial tasks such as the Flags Test, (Thurstone & Jeffrey, 1956, cited in McAvinue & Robertson, 2006-2007), the Space Relations Test, (Bennet, Seahore, & Wesman, 1974, in McAvinue & Robertson, 2006-2007), and the Paper Folding Test, (Kyllonen, Lohman, & Snow, 1984), are psychometrically acceptable measures of spatial ability, however, they do not reflect other facets of visual imagery which may be utilised by individuals, such as object imagery. Admittedly, there may not be much to be said about the detail involved in these task stimuli, usually consisting of

cubes grouped together in various ways, though the point remains that only measuring reaction times on this task may fail to give a true ‘flavour’ of other processes involved in mental imagery. Originally designed to measure spatial abilities, these tools undoubtedly require the controlled mental manipulation of visual images, and generally have good psychometric properties (Blajenkova, Kozhevnikov, & Motes, 2006). They lack a performance-based element, however, with no objective way to ascertain the efficacy of participants’ visual imagery control.

The Spatial Imagery Test from the Imagery Testing Battery (Version 1.0, Hollenberg, 1970, cited in Blajenkova, Kozhevnikov, & Motes, 2006) requires selection of the correct depiction of an image from a number of new perspectives (such as above or below) after being presented with a cube which has a thin line running along the surface. Participants must also mentally rotate and combine images of 3D shapes, and again select the resultant image from six options. Lastly, images of unfolded templates of patterned boxes are presented. After participants have folded the box in their mental imagery, they have to select the correct unfolded template. The self-report ratings were found to correlate with mental rotation performance and predicted performance on spatial imagery tests. A search of the academic databases PsychINFO and Ebscohost has indicated this to be a rarely used tool.

Carroll (1993) found several factors underlying spatial ability, including ‘visualisation’, pertaining to the manipulation of visual patterns, and ‘spatial relations’, which refers to the speed of manipulating visual patterns using rotation and transformation. These findings support claims that mental imagery is multidimensional (Kosslyn, 1983; Kosslyn et al., 2004). Blajenkova, Kozhevnikov, and Motes (2006), and others (Farah, Hammond, Levine, & Calvanio, 1998; Kosslyn, 1994; Kosslyn & Koenig, 1992) have found visual imagery to be comprised of at least two distinct subsystems involved in the encoding and processing of spatial imagery; object imagery, and spatial imagery. Object imagery alludes to the form, size, colour, shape and aspects of literal appearances of objects in imagery. Spatial imagery on the other hand alludes to the spatial relations between objects in an image (Blajenkova et al., 2006). Blajenkova and her colleagues (Blajenkova, Kozhevnikov, & Motes, 2006; Blazhenkova & Kozhevnikov, 2009) have developed two self-report tools to assess imagery abilities which do not treat ‘imagery’ as a single, undifferentiated construct. These evaluate the qualities, preferences and experiences of those engaged in object and spatial imagery, as well as verbal cognitive styles. The Object-Spatial Imagery Questionnaire (OSIQ, Blajenkova, Kozhevnikov, & Motes, 2006) and the Object-Spatial Imagery and Verbal Questionnaire (OSIVQ, Blazhenkova & Kozhevnikov, 2009) are derived from findings in cognitive psychology and neuroscience which have shown object and spatial imagery to be distinct subsystems in terms of the neurological processes underlying each of them (Blajenkova et al., 2006), yet in the past tools have been designed which fail to address this possibility, often asserting that a measurement of ‘imagery’ more generally would suffice. In the OSIQ,

preferences for pictorial or schematic representations are assessed on a Likert-type scale, as are qualitative characteristics and the ease of maintenance and transformation of images. It has been suggested that visual-object ability, the processing of shape, colour, and texture, should be treated as a new dimension of non-verbal intelligence as it features the same essential characteristics. In their words, these characteristics are “ecological validity, capacity to support abstract spatial processing in engineering and scientific fields, as well as unique qualitative and quantitative characteristics supported by cognitive research” (Blazhenkova & Kozhevnikov, 2010, p. 277). Also claimed is the suggestion that visual-object imagery is necessary for the processing of visual-spatial properties, another rate-limiting quality of imagery, and evidence has been cited that has shown both of these non-verbal constructs to be cortically distinct from verbal-spatial imagery (Blazhenkova & Kozhevnikov, 2010). Spatial ability tasks undoubtedly require the controlled mental manipulation of visual images, and generally have good psychometric properties (Blajenkova, Kozhevnikov, & Motes, 2006) making them invaluable for research into spatial imagery and also for assessing concurrent reliability of performance-based imagery questionnaires.

The Shapes Questionnaire (Dean & Morris, 2003) is a self-report tool which seeks to measure a wide range of properties of mental imagery including the ease of evocation, maintenance, and stability of image, ease of rotation, amount of detail and the changes to this detail. Dean and Morris (2003) purport that the tool is less open to influences of

egoistic responding, a form of social desirability often found in 'agency-related' contexts, where there is a tendency to respond in ways which reflect control, mastery, autonomy, and independence. This is a problem with a number of imagery tasks as has been described, however Dean and Morris suggest three ways to reduce such confounds in mental imagery research: requesting participants to respond honestly, to discard results from those showing socially desirable responding, and to 'partial out' these influences. The Shapes Questionnaire was developed to reflect Kosslyn's assertion that the multidimensional nature of imagery should be reflected in tools designed to measure it. In factor analyses of the Shapes Questionnaire, four factors were revealed; ease of forming an image, the pictorial stability of an image, the ease of rotating an image, and the relative size at which the stimulus is imagined. This provides support for the generation processes, rotation sub-process and maintenance processes operating on the visual buffer, identified in Kosslyn's model of imagery (1980, 1994), and resembles processes employed in creative cognition. Welling (2007) states that four mental operations are at work during creative cognition, namely application, analogy, combination, and abstraction. Welling discusses both the 'sudden-gradual' problem and the 'special-ordinary' paradox, and states that insight problem-solving is insufficient to study the range of creative operations. In a paper which provided encouraging results for the field of imagery research in terms of the application of self-report measures, Dean and Morris (2003) found that participants in their study were able to effectively introspect on several different properties of their images, and also found that the imagery ratings reflected the multidimensional nature of mental imagery in that they captured specific

imagery processes more effectively than did vividness. The self-reported ratings also predicted performance on tests of spatial ability, a development in light of previously reported findings.

The Degraded Pictures Test (Kozhevnikov, Kosslyn, & Shepard, 2005) comprises a series of perceptual closure problems. The recognition of images which are obscured by 'noisy' backgrounds is required and these tasks demand top-down processing to complete. The tool therefore taps object-imagery due to the reliance on mechanisms underlying this construct. Kozhevnikov, Kosslyn, & Shepard (2005) supported this with their finding that object imagers identified the degraded pictures more accurately than spatial imagers.

Scores on spatial ability tests are frequently found to be independent of subjective reports of mental imagery ability and it has been suggested that self-report questionnaires and spatial tasks actually measure entirely different abilities (Campos, 2009-2010; Burton, 2003; Campos, 1998; Blajenkova et al., 2006), yet they are treated as though they measure comparable ones, despite the lack of theoretical justification for this. It is suggested that the lack of relationship may result from the types of item which comprise many self-report imagery questionnaires (Blajenkova et al., 2006; Dean & Morris, 2003; Reisberg, Culver, Heuer, & Fischman, 1986). These primarily tap aspects of object-imagery, focussing on, for example, the brightness, vividness, and colourfulness of

mental images, and do not usually enquire about elements of spatial-imagery. Dean and Morris (2003) state that “the failure to find a relationship between self-reports of imagery and spatial tasks could be a result of existing imagery questionnaires failing to adequately capture the properties and processes of imagery that are relevant” (p. 248), often treating it as a unitary construct. However, most response-based tests of imagery ability measure the transformations and spatial relations between imagined forms. Dean and Morris’ (2003) Shapes Questionnaire was found to have a stronger relationship with objective spatial tasks than other self-report measures of imagery ability, such as the Vividness of Visual imagery Questionnaire (Marks, 1973). Dean and Morris state that vividness, for example, is just one way to examine imagery, yet claim that treating it as an exhaustive measure of imagery, as it often is, may be misjudged. They found that self-reported scores of vividness did not correlate with self-ratings of transformation and manipulation of geometric stimuli, but that mental rotation scores were related to these ratings. This view is echoed by Blajenkova et al., (2006) who state that it is the differences in the types of stimuli contained in the disparate tasks utilised to operationalise visual imagery that exacerbate the inconsistencies found in the literature. Dean and Morris observed that “The large differences in stimuli type raise the question of how valid it is to assume that the processes and quality or performance of imagining these different types of stimuli is functionally equivalent” (2003, p. 248). They purport that differential cognitive demands could result from different content in imagery and agreed with earlier theorists who suggested that an internal visuo-spatial mental representation exists and plays a central role in the solution of spatial problems (see Carpenter & Just, 1986; Kyllonen, 1996;

Poltrock & Agnoli, 1986, all cited in Dean & Morris, 2003). They purport three possible explanations for the lack of relationship between objective and self-report imagery measures, which often load on orthogonal factors, involving a lack of theory-driven questions regarding current imagery paradigms. Their first offering is unlikely, and states that “the phenomenological experience of a mental image either plays no functional role in spatial tasks or does not reflect the processes that do” (p. 246). Recent neurological studies showing aspects of mental imagery to involve distinct and overlapping brain regions and the double dissociations subsequently reported have shown this to be untrue (Wraga, Shephard, Church, Inati, & Kosslyn, 2005). These findings support the argument for multiple imagery and spatial abilities which should not be investigated using tools that confound these constructs. The next reason for the lack of relationship concerns problems with introspective (self-report) means of gauging imagery ability which, as has already been outlined, may be susceptible to demand characteristics and egoistic response biases from participants (LeBoutillier & Marks, 2000-2001; McAvinue & Robinson, 2006-2007). Lastly, there is an assumption that vivid visual imagery is ‘better imagery’ which is implied through the terminology of items (Morris & Hampson, 1983), and people tend to report having highly controlled or vivid imagery whether their experience reflects that or not. This is known as ‘acquiescent responding’ and is a tendency to provide affirmative answers to questionnaire items (Hinz, Michalski, Schwartz, & Herzberg, 2007). Tools that conceptualise ‘imagery’ as a single ability are especially problematic (Paivio, 1989) especially when considering the evidence that imagery is in fact better thought of as a collection of abilities (Kosslyn, 1980, 1994;

Farah, 1984). Dean and Morris (2003) suggest that it may be more beneficial to conceive of imagery vividness as a “reflection of the combination of the properties and processes involved in imagery” (p. 247), and not an indication of the multiple abilities involved in spatial imagery tasks. I will later suggest that it may also be beneficial to conceive of imagery control in that way too.

Burton (2003) has investigated both performance-based and self-report methodologies thoroughly in relation to each other and the two main factors of spatial imagery, namely visualisation (VZ - derived from American spelling; vizualisation) and speeded rotation (SR), (Carroll, 1993). Little relationship was found between these factors, purportedly due to the different to-be-imagined stimuli of scenes and objects compared to geometric shapes and capital letters. A more recent contribution to the study of mental imagery is Campos’ Measure of the Ability to Form Spatial Mental Imagery, or MASMI (Campos, 2009-2010), which is an objective tool which requires participants to answer questions about an unfolded cube decorated with geometric shapes. The picture of the cube is visible throughout, as is the case with a number of spatial ability tasks, meaning that it is not purely a mental imagery task but rather a perceptually-sourced one. It could be argued that being able to see this image could enhance a participant’s capacity to correctly generate and answer questions about a mentally rotated version of it.

It is claimed by Burton (2003) that the stimuli involved in imagery tasks influences the relationships uncovered in imagery research. Self-report ratings of images of shapes are supposedly more likely to relate to conventional spatial tasks, such as mental rotation or mental comparison tasks, than are self-report ratings of images retrieved from long term memory. Indeed, it has been found that if the stimuli are similar in type, for example, when geometric or alphanumeric shapes are imaged, the relationship between self-report imagery tasks and spatial tasks is stronger than when the stimuli to be brought to mind are of scenes or relatives (McAvinue & Robertson, 2006-2007). Notwithstanding these inconsistencies, tests of spatial performance have traditionally been accepted as ‘objective’ measures of imagery control due to the requirement to manipulate internal images in order to complete the task (Burton, 2003).

An alternative imagery protocol, the *image generation approach*, has emerged from the cognitive literature. The image generation approach looks primarily at the emergence of creativity through visualisation and mental synthesis of imagined forms (Finke, 1996; Finke, Ward & Slayton, 1992; Finke & Slayton, 1988). The tasks utilised in this paradigm tap into processes of controlled mental imagery and mental rotation that are of particular relevance to an understanding of individual differences in mental imagery. Finke, Pinker and Farah’s (1989) Guided Image Manipulation Task, though not explicitly designed to measure imagery control, seeks to understand whether participants can assign new meanings to imagined combinations of shapes and letters, and asks them to detect

any number of ‘emergent forms’ (new shapes or objects) from their internal representation. It is likely that success on this task would not be possible without controlled mental imagery, and it is interesting to note Burton and Fogarty’s (2003) finding that convergent and divergent problem solving tasks were located next to objective tests of imagery on their *continuum of self-report imagery and objective spatial tasks*, representing their inherent similarities. They scrutinised six studies which looked at mental imagery in their investigation of the factor structure of visual and spatial imagery and provided the following model (Figure 3.1) depicting their continuum representing the tools utilised, from self-report questionnaires at the left to more objective spatial ability tasks towards the right.

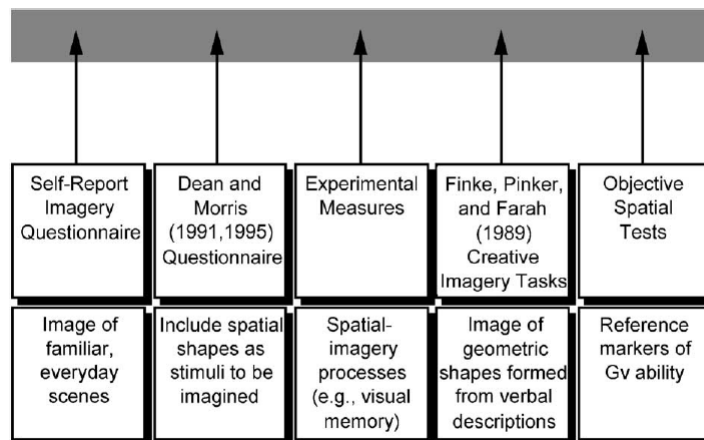


Figure 3.1

Continuum of self-report imagery and spatial tasks. From Burton and Fogarty (2003)

The measures described thus far are sufficient in terms of their individual application, whether measuring spatial ability, mental rotation capacity, or imagery vividness, however a performance-based indicator of imagery control may offer new insights into the field of mental imagery research, as common tools may not accurately reveal individual differences in this attribute. It is clear that controlled mental imagery is imperative for success in these imagery tasks, as some degree of manipulation or mental comparison is required in all of them, however, a true and accurate account of imagery control skill fails to be uncovered through these methodologies. Additionally, mental imagery control is likely to be required for some creativity tasks and tools utilised in the image generation approach.

The focus of Studies 1 and 2 is to develop an easy-to-administer measure of mental imagery control, which adopts an objective investigation into individual imaging abilities. The Image Control and Recognition Task (ICRT) was developed to assess individual differences in imagery control and involve increasing numbers of imagery transformations combining to form familiar objects or ambiguous shapes. The tool will allow objective investigation of levels of ability and will demonstrate that, for some, mental images can be easily manipulated when in possession of controlled mental imagery, even those with a relatively high degree of complexity. The ICRT could not only have applications in investigations into imagery research in general, but could also be used in examinations of creativity, visuo-spatial ability, and the aforementioned and

seemingly paradoxical finding that self-report imagery control measures do not tend to correlate with objective measures of spatial ability (Burton, 2003; LeBoutillier & Marks, 2001-2002; Ashton & White, 1980; Richardson, 1995). The design process of the ICRT is described in the next section.

3.2 The Image Control and Recognition Task (ICRT) – designing the tool

3.2.1 Initial design stage

The Image Control and Recognition Task (ICRT) is based on Finke, Pinker and Farah's (1989) image task, originally designed to investigate whether new 'patterns' can emerge from manipulated mental images. The ability to see these new forms is claimed to be beneficial in creative endeavours, and the ability to manipulate these images undoubtedly requires mental imagery control. Finke and his colleagues designed a series of three and four 'stage' tasks which required participants to mentally join and rotate shapes to form familiar objects, such as a TV or a stickman. Their protocol involved a series of three and four-stage tasks which required participants to mentally join and rotate shapes to form familiar objects. The ICRT differs from Finke et al.'s tool in that theoretically a higher level of image control is required during the image manipulations; there are more steps involved than were provided in their tool, thereby creating levels of difficulty in the task. The ICRT is also comprised of a larger number of problems it is hoped should yield a normally distributed range of scores. This can then be employed as an individual differences measure of mental imagery control which has applications in many settings.

A series of image tasks was designed involving increasing numbers of transformations, the longer of which should theoretically present more of a challenge to those lacking strong mental imagery control. These tasks require the manipulation of images in various ways, and controlled mental imagery should aid these processes.

It would aid comprehension of the following material if a series of definitions for common terms related to the ICRT were first provided. These definitions refer to those used in this chapter and all others to follow in the thesis.

Definitions relating to the terminology of the ICRT:

Table 3.1 presents a description and outline of terms used in the Image Control and Recognition Task. This aims to provide clearer understanding of the tasks in subsequent discussions and chapters.

Table 3.1

Terminology and definitions in the Image Control and Recognition Task

Term	Definition
Image Control and Recognition Task (ICRT)	The complete set of imagery control tasks
Imagery control	The combination of the ability to generate, maintain, rotate, manipulate, and recognise forms in mental imagery
Imagery task/Recognition task	These terms refer to an individual Image Control and Recognition Task in its entirety. The terms refer to the instruction items that make up that task, the internal depictions which are internally generated and manipulated as a result of hearing these items, and the final image itself. These terms are used interchangeably
ICRT item/ICRT instruction	Items in the ICRT are the instructions which make up each imagery task and which are read out to participants during the image generation and recognition phase of the task. These contain the directions for the image transformations
Intended Image	The mental image participants should see in imagery having correctly followed the items making up each imagery task. The shapes and letters each form to make a recognisable or nameable image which participants have to try and name from their mental imagery before drawing it
Stages/Number of stages	When the ‘number of stages’ is referred to it corresponds to the total number of instruction items within an imagery task. Imagery tasks are each comprised of discrete stages of instruction (the items), so imagery tasks which require the correct manipulation of three instruction items in order to generate the intended image are referred to as ‘three-stage tasks’, those with four items are ‘four-stage tasks’ and those requiring the correct manipulation of five and six instructions are five-stage and six-stage tasks, up to nine-stages.

3.3 Study 1 – Piloting the Image Control and Recognition Task

The aim of Study 1 was to administer the pilot set of Image Control and Recognition Task to participants in order to assess the efficacy of the protocol for measuring mental imagery control.

3.4 Method

3.4.1 Participants

Twenty-nine students participated as part of their undergraduate psychology course requirements and received course credit. Participants provided informed consent and demographic details were not recorded.

3.4.2 Materials

A series of twenty two imagery tasks were presented to participants in Study 1 which served as a pilot study. The imagery tasks were intended to have varied levels of difficulty with between three-stages and nine-stages required to solve each of them. Participants were provided with a pencil and sheets of plain paper on which to draw their responses.

Tasks consisting of three to nine image manipulations, or ‘stages’, were designed, resulting in a series of 22 imagery tasks. The ICRT requires participants to combine, manipulate and transform a series of geometric shapes and/or letters as instructed, step by step and without sketching, and then to draw the resultant mental images. Upon correct completion of the task, either a familiar object or a nondescript shape should present itself. The inclusion of random shapes was in order to dissuade participants from attempting to guess the final image. Examples of four- and five-stage tasks are provided in Table 3.2 with the associated images depicted in Figure 3.2.

Table 3.2

Examples of three, four and five-stage image tasks from the ICRT

a) Three-stage imagery task

1. Imagine a triangle pointing upwards
2. Imagine another downward pointing triangle so that it is directly underneath the first one and the horizontal lines overlap
3. Remove the horizontal line

b) Four-stage imagery task

1. Imagine a tall, thin rectangle so it is standing vertically
2. Add a very short vertical line to the bottom of it so it looks like it’s sticking out
3. Rotate the entire shape configuration 180°
4. Attach a teardrop to the top of the shape so that it is touching the line

c) Five-stage imagery task

1. Imagine a capital letter ‘D’
 2. To the left of it, imagine a triangle pointing left with the vertical edge nearly touching the side of the letter ‘D’, but not touching it
 3. Join the two shapes with a short horizontal line
-

-
4. At the right of the 'D', outside it, imagine a vertical wavy line touching the curve
 5. Rotate the entire shape 90° to the right (clockwise)
-

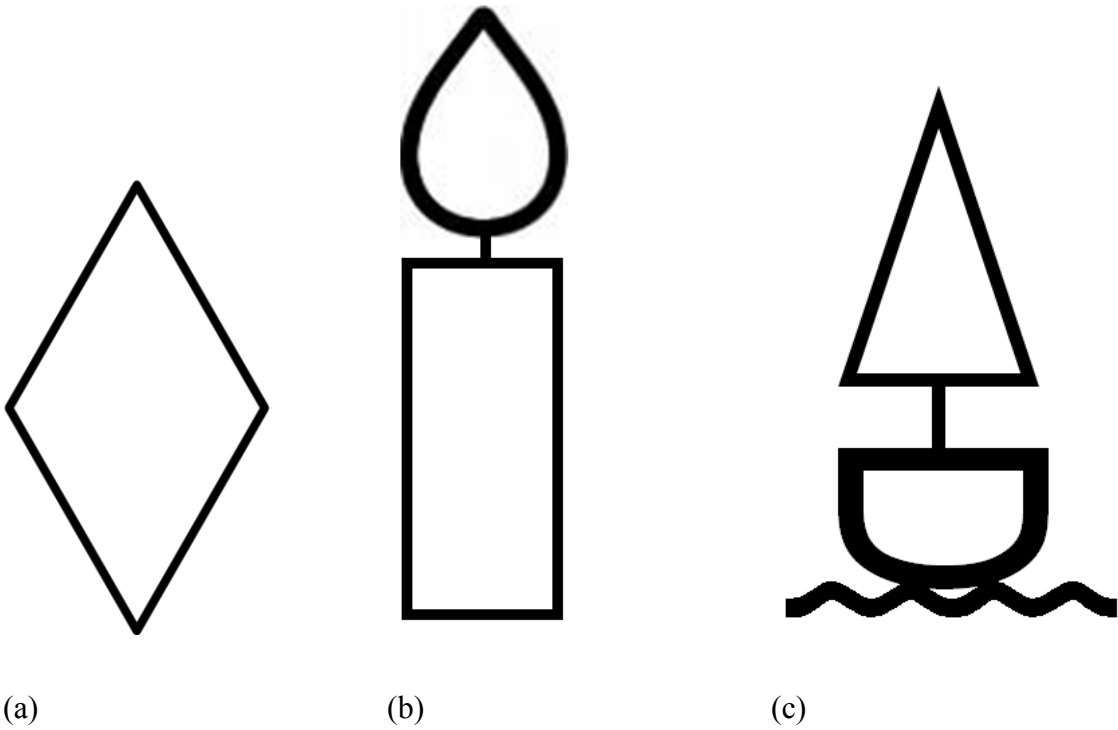


Figure 3.2

Example answers to the imagery tasks in Table 3.2

The longer of these imagery tasks should present more of a challenge to those lacking strong mental imagery control as greater image manipulation is required.

Scoring: Participants received 1 for correctly depicting the shape and 0 for drawing anything else.

The wording of the instructions was such that they aimed to eliminate overt reliance on memory beyond that which is required to maintain the image. For example, when moving through stages, the instruction often included a repeat of the initial stimulus shape (see example (c) in Table 3.2 above). However, specific instructions regarding orientation, rotation, and addition or subtraction of elements of the image were not repeated in this way as these are the elements of mental imagery which it was aimed would be evaluated.

3.4.3 Procedure

Participants read an information sheet and provided informed consent prior to commencement of the imagery tasks. They completed the ICRT in individual sessions in research cubicles and sat at a table away from the experimenter. They were advised not to attempt to memorise the instructions while the task progressed, but rather to create a clear mental image as they heard each instruction. No notes or sketches were allowed, participants could close their eyes if they wished to, and they were instructed to indicate when they were satisfied with their mental image after each instruction being provided. Completion of the tasks had no time limit, and repetition of the current instruction was allowed. However previous instructions were not repeated once the participant had

moved on to the next stage. After the last instruction of each task was presented, they were requested to draw whatever final image they ‘saw’ in mental imagery. Upon completion of all imagery tasks the participants were told their score, if they wanted it, were debriefed as to the aims of the study and any questions about the session were answered. The information sheet, consent form, and debrief sheet are all presented at Appendices A – C.

3.5 Results

The Image Control and Recognition Task (ICRT) was piloted in this study. Face validity was of interest, but more important was investigation of whether the tasks got more difficult as the number of instruction stages increased. A number of steps were taken to investigate this, and each stage of the analysis is outlined below.

Item Analysis

Initial analyses were qualitative, with investigation into wording and face validity of the tool informed by observations made by myself, and retrospective reports collected from participants. These highlighted a number of problematic items, which are described below:

Lack of clarity. Two of the items lacked clarity, with participants asking questions concerning the manipulations on every occasion. These instructions were not written in clear, unambiguous language.

Additional stages required. Three items were removed where suitable additions would have increased the length of the task.

Inconsistent task requirements. An item was removed as it was the only ICRT which required participants to think of and manipulate two separate images simultaneously, and then to combine them.

The data relating to these six items were omitted from further analyses, revealing 16 items that were suitable.

Descriptive statistics

The distribution of the correct ICRT scores was normal with a mean score (5.86) slightly lower than a to-be-expected middle score with a 0-16 potential range of scores. Non-significant z-score transformation values were calculated for both skew ($z(29) = 1.01, p > 0.05$) and kurtosis ($z(29) = -1.44, p > 0.05$). Descriptive statistics for the 29 participants on total number of imagery tasks solved revealed a mean score of 5.86 (SD = 4.31), with a minimum of 0 and a maximum of 16.

Inferential statistics

In order to investigate whether the items increased in difficulty as the number of stages increased solvability percentages were generated for the 16 imagery tasks and these are presented in Table 3.3.

A significant negative correlation was revealed ($r(27) = -.65, p = .003$) between number of steps and difficulty, that is, as the number of stages increased the percentage of people who solved them decreased. It is argued that only those with a high degree of mental imagery control can successfully complete the longer items from the ICRT, so one would expect to find a negative correlation here because fewer steps should results in an ‘easier’ task.

Table 3.3

Solvability Percentages for items in the Image Control and Recognition Task

Number of stages	Name of task	Percentage solved *
3	Shape 1	59%
3	Shape 2	59%
4	TV	52%
4	Heart	48%
5	Clock Tower	48%
4	Walkie Talkie	34%
4	Candle	34%
7	Stickman	34%

5	Cottage	31%
5	Sailing Boat	31%
9	Star	31%
8	Face	28%
8	Shape 3	28%
6	Cat	24%
6	Christmas Tree	21%
6	Snowman	21%

Note. N=29. * Listed by order of magnitude.

Table 3.3 shows the solvability figures for Study 1. It is possible to group some of these figures together representing number of stages, suggesting that the number of stages does have a direct relationship with how easy the imagery task is to complete. However, the seven- and nine-stage imagery tasks seem to be too easy, with solvability percentages above all six-stage imagery tasks in the table, and above two eight-stage ones (demonstrating the ease with which they were solved). This highlighted that imagery tasks constituting each ‘set’, i.e. those with the same number of instruction stages, were not appropriately difficult, with the six-stage imagery tasks being solved by the fewest participants, while some actually solved seven-, eight-, and nine-stage imagery tasks despite failing to solve any six-stage ones. This needs to be addressed as these six-stage imagery tasks should not be so easy to solve. There should be clear separation between the stages, and a rate-limiting effect will ideally emerge, that is, it should not be possible to solve six-, seven-, and eight-stage imagery tasks if one has failed to solve three-, four- and five-stage ones.

To test whether the number of instruction stages correctly solved was linearly related to scores, a trend analysis was conducted on the pilot study data. Analysis of variance (ANOVA) indicated that the number of stages significantly affected the percentage of imagery tasks solved by participants, ($F(3, 115) = 4.83$, $MSe = 1400.25$, $p = .03$, $\eta^2 = .11$). Bonferroni tests indicated that imagery tasks with fewer stages were associated with significantly higher solvability percentages than those requiring more steps to solve them, as shown in 3.4 below. The trend analysis indicated that the data fit well to a linear model with the linear component accounting for a substantial proportion (11%) of the variance in solvability.

Table 3.4

Study 1 ICRT Item Solvability Percentages as a Function of Number of Stages

Number of Stages	Mean (%)	Std. Deviation (%)
3	59 ^A	44
4	42 ^{AB}	35
5	37 ^{AB}	40
6	22 ^B	30

Note. $N = 29$; Figures with the same letter in their superscripts do not differ significantly from one another according to a Bonferroni test with a .05 limit on familywise error rate.

The results of the pilot suggest that it is possible to use the ICRT as a performance-based measure of mental imagery control that goes some way to distinguish between different competencies in this attribute. The solvability percentage scores decreased according to how many stages were involved in each imagery task, suggesting that participants found the longer tasks harder to complete. Some participants reported that they attempted to memorise the instructions, rather than concurrently amending their mental images, so a forward digit span task will be introduced in Study 2 to establish whether verbal working memory skill was associated with the ability to solve ICRT tasks. Participants may have been able to guess the resultant images in two of the items, so these instructions were re-ordered to prevent the possibility of any guessing. Three-stage imagery tasks were also introduced as a practice trial. In summary, Study 1, which was designed to pilot and develop the ICRT, provided a sound rationale for Study 2, which aims to evaluate the reliability and validity of the tool.

3.6 Study 2 – Development of the Image Control and Recognition Task

This study was conducted in order to ascertain whether amendments to the ICRT had improved the ability to assess individual differences in visual imagery control.

3.7 Method

3.7.1 Participants

Thirty-one psychology English speaking students participated as a component of their undergraduate research methods course. Demographic details such as age and gender were not recorded.

3.7.2 Materials

IMAGE CONTROL AND RECOGNITION TASK

The problems with a number of ICRT items were addressed following the pilot study, so an amended version of the ICRT (16 items, Appendix D) was administered to participants.

Scoring: This was the same as for Study 1.

WECHSLER ADULT INTELLIGENCE SCALE (WAIS) FORWARD DIGIT-SPAN TASK

The WAIS Forward Digit-Span task (FDS; Wechsler, 1944) was employed in the present study. The FDS taps cognitive processes which are implicated in solving the ICRT, for example, the phonological loop and visuospatial sketchpad (Goldstein, 2011). Working memory is a multifaceted system, as is mental imagery, and so the FDS test was felt to be a good choice for these reasons. Administering the FDS allowed me to study the

relationship of verbal working memory to imagery control. Phonological working memory processes are almost certainly at work whilst completing ICRTs, yet the ability to apprehend and manipulate the mental objects in imagery without putting too much ‘cognitive strain’ on these processes is what supposedly makes one able to succeed in controlled manipulation and combination of imagery in this way. The FDS includes 14 number strings of increasing length (3 – 8 digits) which were read aloud to the participant who then repeated them in order. Reliability for Digit-Span tests range from .70-.90 (Conway et al., 2005).

Scoring: Scores were totalled out of 14 and discontinuation on this task was after failure on two consecutive number strings of the same length.

3.7.3 Procedure

The procedure for Study 2 was the same as Study 1 apart from the following modifications: Two three-stage imagery tasks were introduced as practice trials to ensure that there were no confounds owing to task confusion, and this time it was explained that some of the tasks may involve the 90° and 180° rotation of items in imagery. Additionally, having completed the ICRT in a response booklet (Appendix F) they answered the following question.

Please tick the strategy or strategies you feel you used most while solving the imagery control task:

Visual imagery

Memory

Both

Unsure

Other (*if other please specify*) _____

The forward digit-span task was presented in a counterbalanced presentation format with the ICRT. This was to control for order effects whereby success or failure on one task influenced performance on the other. Participants were given as much time as they needed to visualise each image transformation though were told at the outset that the aim was to move through the stages quickly. They indicated either verbally or by nodding when they were ready for the next instruction stage. At the end of the session they were debriefed and handed a sheet containing information about the study (Appendix G).

3.8 Results

Descriptive statistics

Table 3.5 presents descriptive statistics for Study 2. All of the participants managed to correctly transform and draw at least one imagery transformation task, suggesting that the changes to the wording and the inclusion of practice trials increased participants' understanding of the task as this time no participants failed to solve any of the tasks. This led to a more normal distribution of scores (Figure 3.3).

Table 3.5

Descriptive Statistics for Measures used in Study 2

Variable	Std.			
	Mean	Deviation	Minimum	Maximum
Total number of imagery tasks solved	7.42	3.78	1	14
Forward Digit-Span score	8.16	2.39	3	13

Note. $N = 31$.

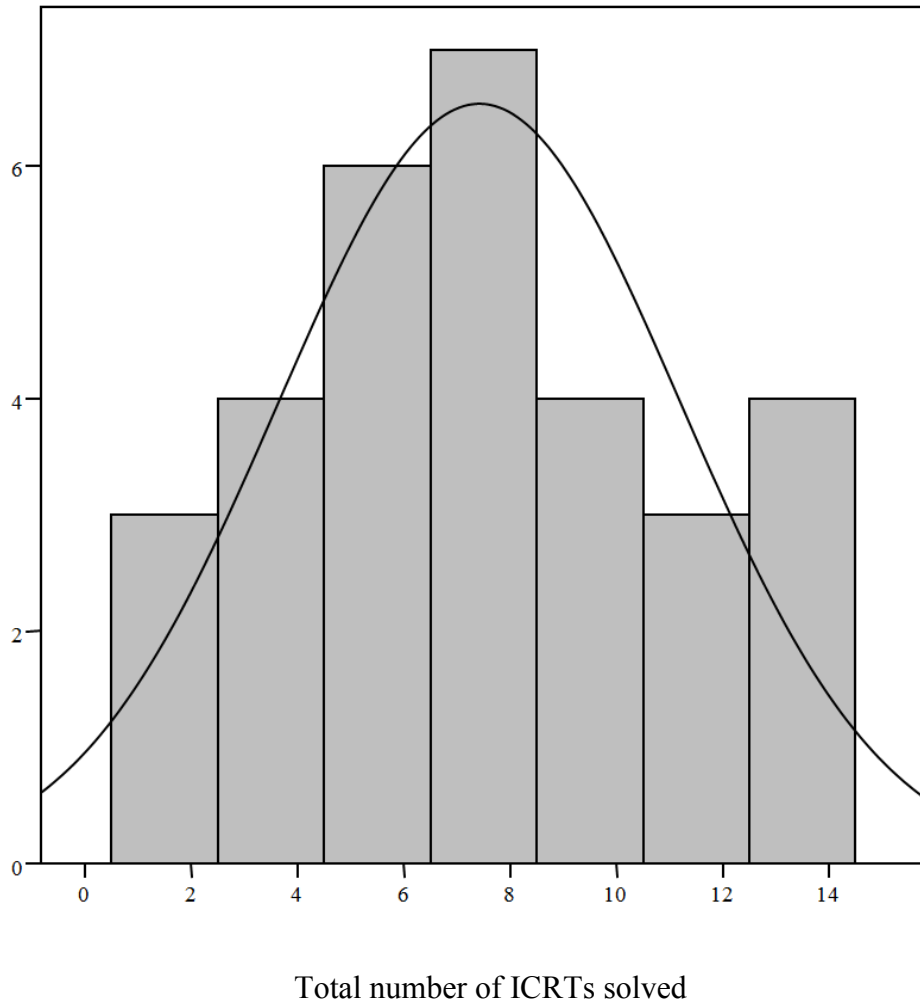


Figure 3.3

Distribution of Solvability Percentages for Study 2

As is shown in Figure 3.3 the distribution of correct ICRT scores was normal and revealed a mean score approximating the to-be-expected middle score (with a 0-16

potential range of scores). Non-significant z-score transformation values for both skew ($z = 0.29, p > 0.05$) and kurtosis ($z = -1.07, p > 0.05$) support the use of this measure in future psychometric studies into mental imagery control.

Inferential statistics

Forward digit-span scores were not significantly correlated with ICRT scores, $r(29) = 0.26, p = .08$, suggesting that verbal working memory ability had little relation to the ability to solve the image tasks.

Solvability figures were generated for each imagery task in Study 2, and these are presented in Table 3.6. The correlation between the number of stages and solvability was again calculated with low solvability percentages indicating more difficult tasks. A significant negative correlation ($r(29) = -.65, p = .01$) was found between number of stages and task difficulty, demonstrating that the more stages an imagery task has, the harder it is to complete. A Fisher's r to z transformation was conducted to check whether the results of the two studies differed significantly and indicated that the correlations from Studies 1 and 2 were not significantly different ($z = 0.19, p > 0.05$).

Table 3.6

Solvability Percentages for items in the Image Control and Recognition Task – Study 2

Number of stages	Name of task	Percentage solved*
3	Shape 1	87%
3	Shape 2	71%
5	Clock Tower	61%
4	TV	58%
4	Heart	58%
4	Candle	58%
9	Star	45%
7	Stickman	42%
5	Cottage	42%
5	Sailing Boat	39%
8	Bowtie	39%
4	Walkie Talkie	35%
6	Cat	32%
6	Christmas Tree	32%
8	Shape 3	23%
6	Snowman	19%

Note. $N = 31$. * Listed in order of magnitude.

As can be seen from Table 3.6 solvability improved for all imagery tasks except two ('shape 3' and 'snowman') which both got harder, as was intended because these tasks were previously too easy. The changes to instructions were therefore effective, with the experimenter observing that fewer participants asked for clarification during the tasks. It is noteworthy that one of the eight-stage imagery tasks was solved by over 38% of participants, while the other eight-stage imagery task was solved by only 22% of participants. This is a large discrepancy considering both imagery tasks should be equal in terms of their difficulty. The nine-stage task was solved by over 45% of participants, problematic as this meant it was easier than all six-, seven-, and eight-stage tasks, as well as a four-stage and a five-stage one. While the results were not identical to Study 1 sufficient percentage groupings emerged from the data for three-, four-, five, and six-stage ICRTs.

Solvability percentages that were close in size within each set of ICRT were selected and mean solvability figures for the pairs were calculated. These mean solvability percentages are graphed in Figure 3.4 and the figures are presented in Table 3.7 below.

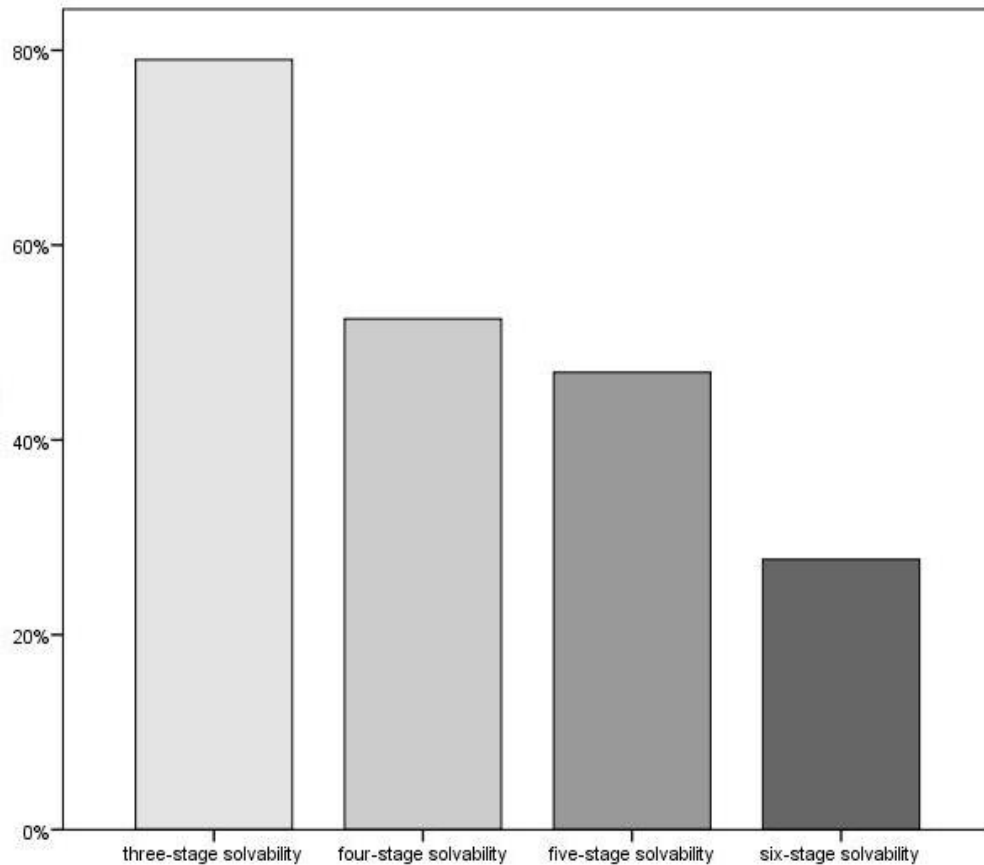


Figure 3.4

Mean solvability for three-stage to six-stage Image Control and Recognition Tasks

As can be seen from Figure 3.4, solvability decreased according to increasing numbers of stages, indicating that fewer participants succeeded at tasks requiring higher levels of imagery control. These results seem to suggest that it appears possible to distinguish between ‘exceptional’, ‘high’, ‘mid’ and ‘low’ range imagery controllers, highlighted in the clear pattern of responses by participants.

Table 3.7

Study 2 ICRT Solvability Percentages as a Function of Number of Stages

Number of stages	Mean (%)	Std. Deviation (%)
3	79 ^A	28
4	52 ^B	35
5	47 ^B	31
6	28 ^C	31

Note. $N = 31$; Means with the same letter in their superscripts do not differ significantly from one another according to a Bonferroni test with a .05 limit on familywise error rate.

To test the hypothesis that the number of ICRTs correctly solved was linearly related to the number of instruction stages required to complete them, a trend analysis was conducted. Analysis of variance (ANOVA) indicated that the number of stages significantly affected the percentage of ICRTs solved by participants, $F(3, 120) = 14.18$, $MSe = 979.29$, $p < .001$, $\eta^2 = .26$. As shown in Table 3.7, Bonferroni tests indicated that ICRTs with fewer stages were associated with significantly higher solvability percentages than were imagery tasks consisting of more stages. The data fit well to a linear model with the linear component accounting for a significant proportion (26%) of the variance

in solvability as indicated by the trend analysis, an increase of 15% in the proportion explained in Study 1. This is a more sensitive tool, though development is still needed, as is discussed in the final section of the chapter.

Regarding the self-reported strategies employed to complete the ICRT, 20 participants provided an answer to the question about method(s) used. Of these participants, 40% said they relied on their mental imagery when completing the tasks, while 35% said their memory was more important. 15% of the participants claimed to use both mental imagery control and memory, and 2 participants (10%) responded “don’t know” to the question.

3.9 Discussion

The aim of these studies was to design, refine and pilot a new measure of mental imagery control and the results suggested it was possible to objectively measure individual levels of mental imagery control. This is notable in light of the extensive literature pointing to problems with mental imagery tools and the conclusions drawn from studies using them. The ICRT revealed clear differences in ability and the task induced a good range of scores. It appears possible to distinguish between different levels of visual imagery control aptitude, for three to six-stage tasks at least. How much extra discrimination is uncovered from the longer ICRT problems however is unclear and will be scrutinised in

future studies. The trend analyses on the solvability figures of Studies 1 and 2 indicated that the imagery tasks increase in difficulty along with increasing numbers of stages, and therefore it would be fair to suggest that they require increasing mental imagery control to correctly solve. Some people simply do not have the ability to control their mental imagery, though at least one three-stage task was completed correctly by all participants in Study 2.

Forward digit span scores were not found to be related to ICRT solvability scores, though the small sample size means there is limited power. Verbal working memory processes are almost certainly utilised in order to keep the internally generated images ‘in mind’, and the correlation between scores on the forward digit-span and the ICRT, although not statistically significant, approached significance. It is theorised that verbal working memory is a fundamental aspect of what I conceptualise as ‘imagery control’, that is, working memory abilities, such as procedural and phonological working memory, are required for tasks of this nature.

The manipulation of geometric and alphanumeric shapes is related to spatial imagery, yet it is possible that elements of object imagery come into play upon successful completion of the Image Control and Recognition Task, with form, size, and shape of individual parts being appraised as a whole image. Also related to spatial imagery is of course mental rotation, and many of the imagery tasks entail some mental rotation in order to correctly

solve. In future it would be interesting to study the implications of this, that is, whether mental rotation serves as a rate-limiting factor of the ICRT. The ability to rotate images may be found to be a fundamental aspect of visual imagery control, as is suspected based on findings from recent literature (Blajenkova & Kozhevnikov, 2010).

The tools available to measure mental imagery and spatial ability would be complemented by this response-based measure, which entails elements of visualisation, mental rotation, manipulation, and spatial and object imagery aptitude, which theoretically are all components of mental imagery control. The to-be-imagined shapes in the ICRT are not perceptually-sourced, that is, there are no images in front of participants during experimentation. Rather participants hear the instructions and then imagine the forms without having seen them. If administered alongside self-report imagery measures, the ICRT could also provide researchers with more information regarding the finding that self-report imagery control scores do not correlate with measures of spatial ability (Burton, 2003). This measure does not rely on self-reporting and arguably taps a number of elements of imagery control, namely, object and spatial imagery, and rotation. There is therefore potential for further elucidation of the lack of relation between these types of tools and administration of a mental rotation task alongside the ICRT and self-report imagery tools would allow for this.

As an additional measure of individual differences of imagery ability, future studies could record response times. The way the ICRT had been designed meant that this was not possible. The instructions were read aloud and were in pen and paper format, and so time-keeping using a manual stopwatch would have been necessary. This would not have produced particularly accurate timings. It was noted during experimental sessions that, for high scorers especially, the processes required of them to accurately complete these imagery tasks appeared effortless, moving through the stages quickly, without asking for repetition or clarification. It was also observed from post-experimental conversations that those who reported using strategies other than imagery control alone when completing the tasks, for example, those who said they had relied more on their memory than their imagery, took longer to begin drawing after completion of all instructions. They appeared to take longer to complete each stage of the task. The few participants who were asked about this did not claim that they used memory alone, but rather that they used their memory *more than* their imagery when moving through the stages (though it is unclear why they did not select 'both' for their responses). Accurate records of these strategies and details of response times of both the transformation phase and the drawing phase would enable investigation of the efficacy of participants' attempts to memorise and 'go back' through previous stages.

The problems found in some imagery measures requiring introspection (e.g. response leniency, social desirability, and demand characteristics; LeBoutillier & Marks, 2000-

2001; Sheehan & Neisser, 1969; DiVesta, Ingersoll & Sunshine, 1971) are less likely to influence the ICRT due to the objective test-format the nature of the task. It would be hard, if not impossible to achieve high scores on the ICRT simply due to wishes to do well on the test, or to appear in a favourable light to the experimenter.

The findings of Studies 1 and 2 revealed previously unanticipated advantages with using this new tool in imagery research. There was no relation between the number of imagery tasks solved and working memory ability which may seem somewhat surprising considering the cognitive demands which may be placed on this system. As was noted however, those who were able to effectively solve a large number of the imagery tasks did not appear to have any problems with simultaneously processing the instructions and subsequently adapting their mental images, and they did so quickly. It certainly seemed as though the ability to perform well on these tasks was effortless and was carried out without having to especially to focus on any specific element or aspect of the task; not on following the instructions, not on manipulating the shapes, and not on drawing the images after all stages were presented. These participants efficiently carried out all parts to each task. The one element which many appeared to find quite difficult was the ability to recognise the intended image from their imagery before they draw it on paper, a process which theoretically requires object imagery due to the necessity to comprehend all aspects of the image as one and to look for clues in details of the image. Very few participants were able to name the picture from their mental imagery before they drew it.

The exact number of participants who were able to do this was not recorded because this aspect of the ICRT was not intended and was unanticipated (hence the meaningless, unnameable shapes). Despite being able to complete the stages to perfect accuracy, a sizeable number of these people apparently could not recognise the intended image until they had drawn it, much to their own surprise. Why could only a small number of people do this? The few who were able to recognise and name images before drawing them reported that they ‘popped out’ at them. Once they knew the instruction phase was over they were able mentally ‘stand back’ and inspect the image. While many were able to do this they could not name what they saw in their ‘mind’s eye’, and one possible reason could be the requirement to simultaneously employ the visuo-spatial sketchpad and the phonological loop systems of working memory (Baddeley, 1986), the necessary requirement to engage both systems at the same time in order to be able to effectively carry out this last step may simply result in cognitive overload for some, but controlled mental imagery for others. Future studies should seek to record the number of images people are able to recognise from imagery alone as detail regarding this would provide clues as to the processes underlying mental imagery control. It would also be interesting to look at whether the short imagery tasks are more easily recognised compared to the longer ones as this would also go some way towards understanding whether the increased cognitive demands required during these long tasks interfere with the ability to name the mental image. In order for this to be done there must be agreement on what the intended images depict, and so a study investigating the ‘nameability’ of the images would be beneficial. If there is agreement about what the images are, and if the images which

result from short tasks are as easy to recognise as the longer ones, then the failure to recognise these images would not be a result of the images themselves but some other aspect of the cognitive processing implicated in these tasks.

3.10.4 Limitations

I was not able to analyse and present the results of the counter-balancing because the order of presentation was not recorded, that is, which task the participant completed first was not detailed in the scoring sheet. This unfortunate oversight meant the while order effects were controlled, it was not possible to see whether there were differences between the participants who completed the ICRT first and the ones who started with the forward digit-span task. That being said the sample sizes in these studies were relatively small and so splitting the groups in order to carry out statistical comparisons may have been foolhardy.

3.10.5 Future research

The scoring of the ICRTs is stricter than Finke et al.'s (1989) method. Finke allowed 'partial' responses, which were drawings which did not exactly match the desired image. The conservative procedure employed in the present study was decided upon to because the view in the present thesis is that if participants had strong mental imagery control then they should have been be able to easily adapt any incorrectly positioned shapes

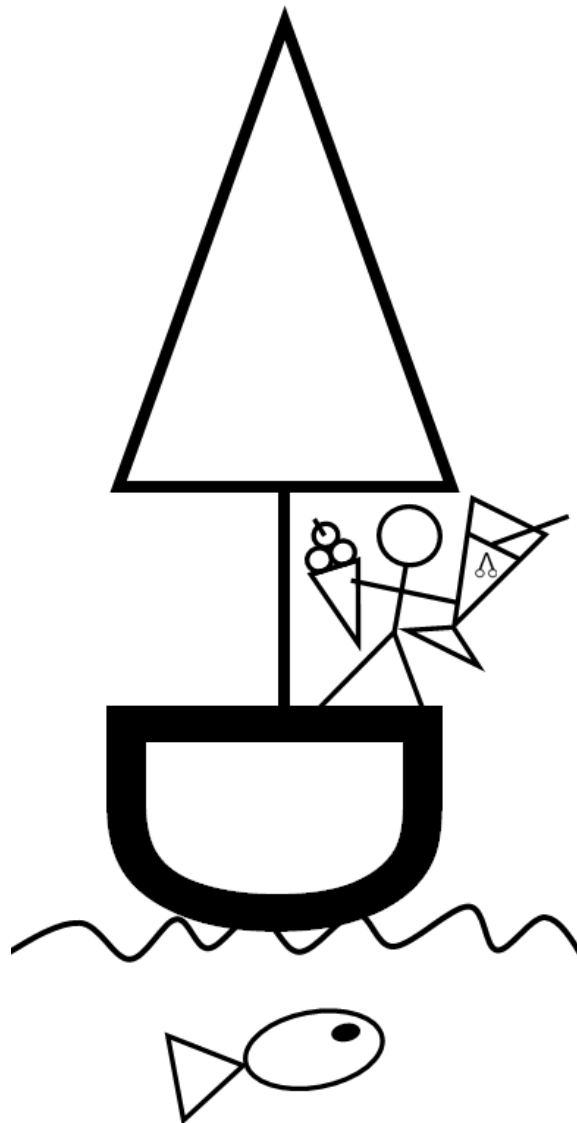
while both creative visualisation and mental imagery tasks (for example, after hearing the instruction *‘Imagine a triangle pointing left with the vertical edge nearly touching the side of the ‘D’, but not touching it’* in the example provided in Table 3.2, section 3.5), and if they were unable to do this then this would be reflected in a lower overall imagery control score. The scoring procedure could replicate Finke's however, and could include a ‘partial’ classification in addition to the existing ‘correct’ and ‘incorrect’ classifications. Any images which were not complete could be analysed as it would be fruitful to try to examine the point at which participants went wrong. Perhaps there were occasions on which participants narrowly missed out on points due to the strict scoring procedures, or because they confused ‘left’ with ‘right’. It is conceivable that those failing at longer transformation sequences were actually high scorers who made but one faulty transformation during the image manipulation phase, thus influencing any further, otherwise correct transformations. However, it can be argued in light of the evidence presented, that those with controlled mental imagery were able to do these image transformation tasks with ease due to being able to freely imagine and manipulate the images, and this was indeed observed on numerous occasions.

The results tentatively suggest the use of the ICRT as a ‘hybrid’ tool, so called because it encapsulates numerous elements of mental imagery control, namely, image evocation, rotation and manipulation, as well as tapping aspects of spatial and object imagery. In order to look more closely at the unanticipated nature of some aspects of the tool a series

of related studies was designed which looked in more detail at these distinct properties of the ICRT.

This chapter has introduced a new measure of the control and manipulation of mental imagery, the Image Control and Recognition Task (ICRT), which yielded a good range of scores, varying across individuals, and mapping a theorised relationship between number of stages and level of difficulty. This is what the study set out to do and it indeed appears possible to objectively measure spatial imagery aptitude, a characteristic offered by few measures, and additionally highlights individual differences for other facets of mental imagery control. The most encouraging finding is that the tool appears to tap a range of imaging abilities which encapsulate ‘mental imagery control’ and thus reflects the multidimensional nature of the imagery construct.

**CHAPTER 4 CONSTRUCT VALIDITY AND RELIABILITY OF THE IMAGE
CONTROL AND RECOGNITION TASK**



2

² Images taken from the Image Control and Recognition Task (ICRT). For illustration.

4.1 Introduction

Three investigations are reported in this chapter. Initially an investigation of the non-ambiguity of the intended images from the Image Control and Recognition Task (ICRT) is conducted. This relatively simple study asks whether it can be certain that the imagined images look the way there are supposed to look, so that future versions of the ICRT may confidently measure more than one aspect of participants' mental imagery abilities, that is, the ability to recognise and name an image from mental imagery alone as well as the ability to complete the imagery task and to draw it accurately, whether it is recognised from imagery or not. Following this, the relationship between performance on the ICRT and a mental rotation task is presented in order to investigate the previously outlined finding that scores on visual imagery tools and spatial ability tasks, such as those from the mental rotation paradigm, are largely unrelated. The final study provides an analysis of the ICRT in terms of its psychometric properties. The tool is deconstructed and elements relating to the individual responses to the items and processes underlying these are scrutinised. Riquelme (2002) suggested that discovery in visual imagery was a holistic process, involving rotation, inspection, and manipulation of various parts of a figure at the same time. The studies to be reported in this chapter directly investigate this possibility.

4.2 Rationale – ‘Nameability’ study

The aim of this small-scale study (Study 3a) is to ascertain whether the *intended images* in the Image Control and Recognition Task (ICRT) are accurate depictions of their intended form, or how nameable they are. These images are the resultant internal depictions one should get when correctly solving the imagery problems in the ICRT. This tool requires participants to combine and manipulate geometric shapes and/or letters as instructed, step-by-step and without sketching, and upon correct completion of the task, a familiar object shape should emerge in imagery. Participants are then required to try and name the mental image before they draw it. These tasks may be scored on two criteria; participants can be awarded one point for each image control task they correctly draw, but they can also be scored on the number of images they manage to correctly name from their mental imagery *before* drawing. This element of the ICRT means it can be treated as a hybrid tool, one that measures mental imagery control, which was the initial intention, but one that can also be used to measure the related constructs of spatial and object imagery (Blajenkova, 2005). It would therefore be constructive to be in a position where the final images are unambiguous in what they represent. The reasons for this are twofold: firstly, it would aid with scoring. It would be beneficial to have clarity and minimal ambiguity these images which will influence the selection process for the developed version of the tool. Secondly, future uses of the ICRT may constrain the tasks further by not requiring participants to draw their image at all, instead requiring them only to name the final image from imagery. Those scoring highly using this method

would certainly be demonstrating not only enhanced imagery control, but also an ability to apprehend their mental images with much clarity. It is important the images are unambiguously emblematic of their intended forms.

4.3 Method

4.3.1 Participants

Thirty five participants took part in this study. The sample consisted of undergraduate psychology students, academics from two London universities, and acquaintances of the researcher. Age and demographic details of these participants were not recorded. They took part for no monetary reward or course credits.

4.3.2 Materials

A booklet containing forty³ intended images from the ICRT, including all practice trials, printed large on separate sheets of paper was provided to participants. Each page also featured a space in which to assign a title for the shape. The intended images are depicted in Figure 4.1.

³ This booklet included intended-images for the entire collection of images tasks which had been designed, including original items, a number of newly created ones, and some which were not subsequently selected.



Figure 4.1

Intended images for all ICRT image tasks and practice trials

4.3.3 Procedure

Participants completed the booklets either on university property, in individual offices, a research cubicle or their lab classroom, and some took them home and returned them within a week. They read an information sheet explaining the nature of the research and informing them of the anonymity of their responses and signed a consent form (Appendices G and H). Participants were then asked to look at the booklet containing 40 images of everyday or recognisable items and to give each one a name or title. They were told not to try to be creative, and to simply write down what they thought the picture looked like. Upon completion a debrief form was provided (Appendix J) and participants were thanked for their time. If they had been unsure of any images and enquired about them, the intended title was revealed.

DATA REDUCTION

All names provided for the each of the ICRT images were entered into a spreadsheet for analysis. Spelling errors were corrected.

4.4 Results

Table 4.1 contains the nameability agreement percentage for each of the image tasks from the ICRT. This includes all data for the entire pool of imagery tasks and the practice trials.

Table 4.1

The amount of agreement obtained for the names of intended items in the ICRT in order of recognisability

Image name	Percentage agreement
Stick man	100%
Fish	100%
Drink	100%
Snowman	100%
Envelope	100%
Traffic lights	100%
Christmas tree	100%
Lamp (Practice)	100%
Cottage/House	97%
Boat	97%
Television	97%
Diamond	94%
Heart	94%
Clock tower	94%
Mouse (Practice)	94%
Umbrella	91%
Candle	91%
Ice cream	91%
Balloon (Practice)	91%
Sweet	86%

Mug	86%
Cat	86%
Hanging star	82%
Bow	80%
Pencil	80%
Mobile phone	77%
Present	77%
Church	77%
Hanger	77%
Pine tree	74%
Head and hat/Clown	72%
Cake	71%
Scales (Practice)	71%
Happy face	66%
Bag	66%
Rocket (or Pencil)	51%
Butterfly (Practice)	46%
Scissors (Practice)	43%
Cherries	23%
Teddy bear	17%

Table 4.1 shows that high agreement was found for the names of the majority of the images. The lowest percentages are associated with the cherries and teddy bear images, followed by two of the practice trial images (butterfly and scissors). This is unsurprising considering that three of these were newly designed tasks, that is, they were not part of the pilot or early studies and this demonstrates that these tasks did not benefit from the feedback and resultant modification that the initial tasks enjoyed. The finding that ‘cherries’ was an ambiguous image was not problematic because the practice trials are always explained to participants prior to commencement of the mental imagery control tasks proper. The evidence of low agreement suggests that some of the tasks should be removed from subsequent versions of the ICRT.

4.5 Discussion of Study 3a

The results of the study are encouraging, with considerable agreement being found between participants on the titles of the ICRT intended images for the vast majority of the depictions. The intended-images of the mental imagery tool do depict what they aim to depict, and this means that an 'image recognition' score for participants in future studies may be accurately obtained. The ability to accurately execute and follow the instruction in the image tasks is a related but separate skill to being able to 'view' and name the image from the mental image, and appears to require a shift in the type of imagery being used. When following the instructions within the ICRT, which involves manipulating and amending multiple shapes, one is utilising mental imagery control, spatial imagery, and mental rotation, however when the task is to envisage the separate shapes as a whole image, one must engage a more holistic approach, and this entails imagery vividness and the ability to see the details of mental images clearly.

Tasks which conclude in imagined-images which are more ambiguous (less than 85% agreement) will not be included in subsequent versions of the ICRT. This will allow further development of this performance-based imagery control tool.

4.6 Rationale - Mental rotation study

As has already been outlined in detail in Chapters 1 and 3, much of the research into mental imagery and its various attributes employs self-report measures to investigate them, despite a growing body of evidence to suggest that these tools are problematic for a number of reasons such as response leniency and social desirability (LeBoutillier & Marks, 2001-2002, see Chapter 3, section 3.1.1). Also described earlier in the thesis was the finding that scores on introspective self-report tests often bear no relation to more objective measures of mental imagery abilities, such as mental rotation (Burton, 2003, see Chapter 3, section 3.1.2). In order to try and elucidate these inconsistencies and to further investigate the properties of the ICRT, this study (Study 3b) administered three mental imagery tools in order to ascertain whether the self-report tool bears any relation to the more objective measures, as the literature often reports that they do not (Burton, 2003). It was expected that the self-report vividness of imagery tool would fail to correlate with both the imagery control task and the mental rotation task, and that mental rotation would be associated with high scores in visual imagery control.

4.7 Method

4.7.1 Participants

Thirty nine psychology students (32 females, 7 males) took part as a requirement of their research methods training and received course credit for their time. Their age was not recorded.

4.7.2 Materials

IMAGE CONTROL AND RECOGNITION TASK

The Image Control and Recognition Task (ICRT) required participants to follow verbal instructions and combine geometric shapes and letters. They were then required to name and draw the resultant image. This tool aims to measure mental imagery control and was the focus of Chapter 3 (Studies 1 and 2). The results and experience gained from the previous studies allowed a pool of ICRTs to be produced. Some replaced old tasks which resulted in meaningless images, as well as those which were deemed unsuitable for reasons discussed in the previous chapter. This resulted in a pool of 40 tasks and practice trials (Appendix E), and 8 of these were selected for use in the present study (see section 4.10 below)⁴.

⁴ Study 3b took place after the analyses reported in section 4.10.

Scoring: Each correctly depicted image was given 1 point while incorrect drawings receive 0. These points were summed (ICRT Total) and each image correctly identified from mental imagery received 1 point (ICRT Recognition).

MENTAL ROTATION TASK

Participants completed the Mental Rotation Task (MRT, Shepard & Metzler, 1971) which required them to view 48 pairs of 3D shapes and to mentally rotate one of them in order to decide whether the other was the same or a mirror image. The angles of rotation ranged from 0 - 330°. Studies investigating the reliabilities of mental rotation tasks have revealed them to have acceptable to good reliabilities (Hirschfeld, Thielsch & Zernikow, 2013). Two examples from the MRT are provided at Figure 4.2.

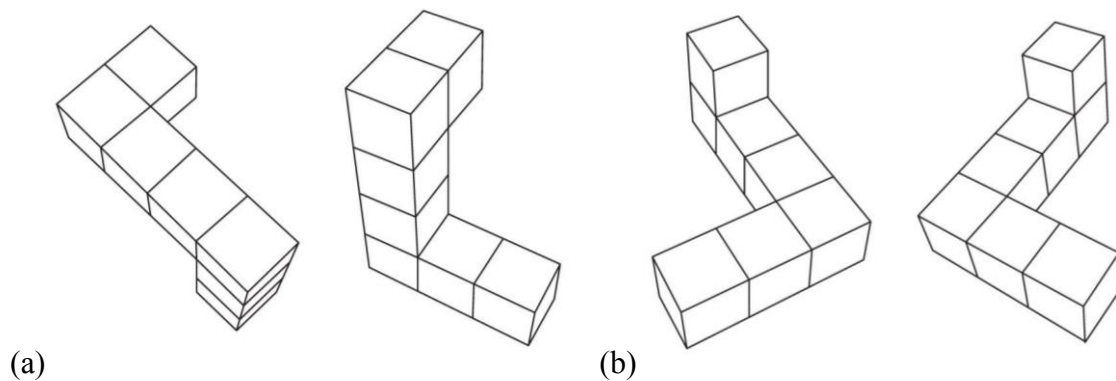


Figure 4.2

Examples of Mental Rotation task stimuli: Mental Rotation Task (Shepard, 1978) stimuli.

Participants are required to mentally rotate the shape on the right (of each example) and indicate whether it is a mirror image or the same as the shape on the left.

Scoring: The median response times for correctly identified shapes were also averaged for each participant (MRT-RT). The total number of images the participants correctly identified were also summed to give an MRT Total score (Kanoy, et al. 2012)⁵.

VIVIDNESS OF VISUAL IMAGERY QUESTIONNAIRE

Participants were also given the Vividness of Visual Imagery Questionnaire, (VVIQ, Marks, 1973, Appendix K). The VVIQ is a pen and paper questionnaire which they completed twice, once with their eyes open and also with their eyes closed. The VVIQ measures how vivid participants rate their mental images when introspecting on specific imagined scenes and scenarios and was described at length in Chapters 1 and 3. The tool contains 16 items which require the visualisation of people and scenes. Participants must rate how vivid their mental images appear on a 5 point Likert-type scale

⁵ It was not possible to calculate the slopes and intercepts due to the fact these data were not available for all participants. The MRT was administered on a website and therefore results were only temporarily available.

Scoring: A mean of participants' ratings was computed for each version of the VVIQ (eyes-open [VVIQ-O] and eyes-closed [VVIQ-C]).

4.7.3 Procedure

Participants were seen individually in research cubicles, provided informed consent (Appendices K and L) and completed the battery of tests in a randomised order. The MRT was completed on a PC in an internet browser. The relevant page was loaded before the participant arrived. Participants read a paragraph of text about mental rotation and then followed on-screen followed instructions using the keyboard which lead them to the MRT. The participants completed the VVIQs at a desk away from the computer. The ICRT required participants to complete a paper answer booklet in which they provide their responses to 16 image control tasks read aloud to them by the experimenter. After hearing all instruction items in each image task the participants provided a name for their internal imagery, if they could, and then drew the item underneath it. They were not permitted to change the image in any way once they had drawn it. However they were allowed to give it an alternative name. The three-, four-, five-, and six-stage ICRTs were randomised in their presentation. No time-limits were set for any of the tasks and the session lasted around 30 minutes. Upon completion of all tasks a debrief form was provided (Appendix N) and any questions were answered.

DATA REDUCTION

The VVIQ scores were reversed so that high scores reflected more vivid imagery and in order to anchor them in line with the other measures in the study.

4.8 Results

DESCRIPTIVE STATISTICS

Descriptive statistics for the variables in the study are presented in Table 4.2. The VVIQ and MRT results were not collected for some participants (VVIQ $n = 9$, MRT $n = 3$) so these participants were excluded pairwise from analyses.

Table 4.2

Descriptive statistics from the mental rotation study for all imagery tasks

	<i>n</i>	Minimum	Maximum	Mean	Std. Deviation
VVIQ eyes open	30	1.31	4.30	2.61	0.86
VVIQ eyes closed	30	1.60	5.00	2.97	0.88
MRT Total	36	19	48	29.53	8.13
MRT-RT	36	.36	3.44	1.66	0.73
ICRT Total Solved	39	.00	6.00	2.51	1.74
ICRT Recognition	39	.00	5.00	1.00	1.39

Note. VVIQ = Vividness of Visual Imagery Questionnaire; MRT-RT = Mental Rotation Task response time; ICRT = Image Control and Transformation Task.

Correlation coefficients were calculated between all variables and no significant relationships were found between MRT-RT and imagery scores. MRT Total scores were significantly positively correlated with ICRT total scores ($r(34) = .40, p = .02$) but not the number of ICRTs named from imagery ($r(34) = .09, p = .64$). The correlation between Total ICRT solved and ICRT Recognition was medium, positive and significant, $r(37) = .44, p = .005$. No relationships were found between the number of ICRT imagery items correctly completed and MRT-RT, or between the number named from mental imagery and MRT-RTs. A large, significant correlation was found between the eyes-open and eyes-closed versions of the VVIQ, $r(28) = .53, p = .002$. VVIQ-O scores were not correlated with either of the MRT indices, however, VVIQ-C was positively significantly correlated with MRT Total scores ($r(30) = .51, p = .01$).

INFERENCE STATISTICS

Given the small sample size, high and low scores were derived from a median split on the MRT median response times (for correctly answered tasks) and independent groups t tests between the ‘faster’ and ‘slower’ groups on the indices of imagery control revealed that the participants who were better mental rotators had significantly higher ICRT Total score and ICRT Recognition scores, with the group who could rotate their mental images faster scoring a mean of 3.13 ($SD = 1.67$) on ICRT Total, with slower rotators scoring a mean of 1.69 ($SD = 1.49$), $t(21) = 2.57, p = .015, d = .90$, and the faster mental rotation group also recognising significantly more ICRT images from imagery ($M = 1.69, SD =$

1.49) compared to the slower group ($M = .38$, $SD = .62$), $t(21) = 3.25$, $p = .003$, $d = 1.15$. This is relevant because it suggests that those who were able to quickly rotate and inspect mental images in their mind were not only able to follow image manipulation instructions accurately in their mental imagery, but were also better at correctly recognising and naming their mental image when compared to those for whom fast and accurate mental rotation was problematic. High and low scoring groups were derived from a median split on the total MRTs correctly answered and independent groups t tests between ‘high’ and ‘low’ groups on the indices of imagery control were conducted. These revealed no significant differences on any imagery index apart from VVIQ eyes-closed, with better rotators reporting significantly more vivid mental imagery, $t(21) = 2.15$, $p = .04$, $d = .94$.

4.9 Discussion of Mental Rotation Study

The correlations between the Mental Rotation Task (MRT) and the Image Control and Recognition Task (ICRT) indices were non-significant, however the median split between ‘fast’ and ‘slower’ participants on the MRT revealed that these participants differed significantly not only on their ability to solve ICRT problems but also on how many images they were able to name from their mental imagery alone before drawing them. This suggests that the two tasks are tapping the utilisation of the same psychological constructs, namely the ability to mentally manipulate and ‘inspect’ internal images, and to effectively recognise and describe properties of these images. The finding that the total number of correctly identified MRT tasks correlated with the ICRT Total

scores was expected. Mental rotation is required for success on the majority of ICRTs, and so this result may not be altogether surprising. This result does provide further construct validity for the ICRT, for the MRT is a well-validated measure of spatial ability. The lack of significant correlations between ICRT scores and MRT-RT, but the finding that significant differences emerged between strong and poor image rotators on imagery control (as measured by the ICRT) does merit comment as this may reflect a non-linear relationship between the two. It may be that the ability to rotate images is only useful for enhanced performance on the ICRT when the ability is exceptionally high, and this may be reflected in this result. The time taken to complete each ICRT could be recorded in future procedures, for it was not possible to ascertain an accurate relationship between rotation on each task due to the nature of how the ICRT instructions are delivered and the fact it is currently a pen and paper-based task. Only one of the VVIQ indices was correlated with MRT Total scores, namely the eyes-closed version, and high and low MRT Total groups were significantly different on this index. This finding was surprising. As has been outlined, there exist mixed relationships between self-report and performance-based measures of mental imagery ability, with a lack of relationship commonly being reported measures which purport to measure the same attribute. Another interesting element to this result is that the VVIQ indices each had different relationships with the MRT Total scores, while these imagery vividness indices were related to each other. This suggests that completing the VVIQ with eyes closed or open may actually engender different elements of mental imagery, and that when participants

complete this self-report tool with their eyes closed, they are able to more accurately report their mental experience of rotating and manipulating images.

Although the MRT measures response time and the ICRT require the accurate manipulation and recognition of internal images, both can be said to contribute to the overall construct of mental imagery control. As has been outlined (Chapter 1, section 1.1.1), empirical literature exists which points to a great number of creative individuals who cite the ability to rotate and manipulate internal images and who use this to their advantage in a wide range of ways. The fact that mental imagery control entails these facets, that is, that it encapsulates the ability to maintain and manipulate images at will, to rotate them and change their size and discover new combinations, means it is easy to see why these abilities might be important, and even conducive, for creative thought. Similarly, it is likely that being able to recognise when a new ‘pattern’ or idea emerges in mental imagery is equally as important for creativity and generation of novel output. All of the spatial and imagery measures investigated so far in the present thesis involve mental rotation and image manipulation, or what could be conceived of as ‘mental imagery control’.

Rock (1974, 1988) proposed an underlying mental rotation mechanism and stated that a limited amount of information may be rotated at any one time. Rock’s claim was that parts of mental images may fade when the requirements of the task go beyond these

capacity limitations. It is suggested that the ability to overcome limitations on this mechanism may be what sets an exceptional ‘imagery controller’ apart from those with more ordinary capabilities in this area. Some rotate increasingly complex forms and patterns in mental imagery with apparent ease and flexibility and appear to have a substantial aptitude for mental image rotation, as was seen in the pilot study (Study 1, Chapter 3, section 3.6). This included nine stage imagery tasks and though this was a small study in terms of sample size, it was nonetheless observed that for some participants, these tasks were just as easy as the three and four stages ones. In Mast and Kosslyn’s (2002) study into the reinterpretation of mental images they found evidence to suggest that mental rotation abilities and reinterpretation were intrinsically linked. The results of this analysis of mental rotation in relation to the ICRT support this claim. Those performing well on the ICRT are using enhanced imagery skills which not everyone possesses. Mast and Kosslyn's study showed that participants who could easily rotate images mentally were more likely to correctly reinterpret their rotated image and the present results support this finding. They concluded that “not everyone can perform this task. Rather, only people who are adept at relevant imagery processes can carry out key aspects of the task, allowing them to succeed” (p. 69), and this finding has been replicated here.

Reisberg and Chambers (1991) utilised an objective rotation task where participants were first shown a rotated image of an appropriate ‘recognisable’ outline, such as the US state

of Texas, were asked to memorise it, and were then told to rotate it mentally and to report any new ‘discoveries’ in their image, concluding that very few participants were able to correctly identify the ‘new’ image. However, research has been published which presents conflicting findings, revealing that in actual fact people are able to assign new meanings to imagined forms and rotated images (Mast & Kosslyn, 2002). Mast and Kosslyn challenged Reisberg and Chambers’ claim that mental images cannot be easily reinterpreted, a conclusion which had been reached after a small number of participants were unable to correctly complete the image reconstrual task. The issue of image reconstrual and whether participants are able to comprehend new patterns in imagery have implications for creative productivity, as it is necessary to be able to reinterpret and ‘play with’ forms in mental imagery when conceptualising ideas and theories. It was also found by Mast and Kosslyn (2002) that mental rotators were better at detecting novel images, which has relevance for forthcoming studies looking at the relationship between imagery and creativity. The problem as to whether people can reinterpret images may lie with the term ‘reinterpreted’. Does it ask whether participants *see the newly formed shape as it is intended to look*, which many clearly do, or does it ask *can they see what the image is supposed to represent?* This is pertinent to the discussion, and is one reason that the name of the imagery control tool developed for this thesis includes the term *recognition*. This represents something in addition to reinterpretation, and it acknowledges that another element of mental imagery is likely involved in the ability to actually understand the mental picture ‘as something’, as opposed to it appearing as a collection of shapes. By using the term *recognition*, it reframes the hypothetical question

to something more along the lines of *is it possible to take the ability to accurately control and combine mental images one step further and to see this image as something different to the parts it is composed of?* This is admittedly long-winded, though it makes the point that the ICRT enables the investigation of fundamental and useful questions regarding the multidimensional nature of mental imagery. This tool therefore has promising applications in research looking at individual differences in mental imaging abilities.

To conclude this section it seems fair to suggest that mental rotation abilities are crucial to the effective internal execution of the ICRT. Attention now turns to the properties of the individual imagery tasks which are included within the tool and looks at the specificity of what these measure.

4.10 Breakdown of the Image Control and Recognition Task

In order to further investigate the psychometric properties of the Image Control and Recognition Task (ICRT), analyses were conducted on individual instruction items included in it and are broken down in the sections that follow. It may be useful to present at the start of the section a reminder of the terminology related to the ICRT, so the following table (Table 4.3) is repeated from Chapter 3.

Table 4.3

Definitions relating to the ICRT

Term	Definition
Image control and recognition task (ICRT)	The complete set of imagery control tasks (including the practice trials)
Imagery control	The combination of the ability to generate, maintain, rotate, manipulate, and recognise forms in mental imagery
Imagery task/Recognition task	These terms refer to an individual item from the ICRT in its entirety. The terms refer to the instruction items that make up that task, the internal depictions which are internally generated and manipulated as a result of hearing these items, and the final image itself. These terms are used interchangeably
ICRT item/ICRT instruction	Items in the ICRT are the instructions which make up each imagery task and which are read out to participants during the image generation and recognition phase of the task. These contain the directions for the image transformations
Intended Image	The mental image participants should see in imagery having correctly followed the items making up each imagery task. The shapes and letters each form to make a recognisable or nameable image which participants have to try and name from their mental imagery before drawing it
Stages/Number of stages	When the ‘number of stages’ is referred to it corresponds to the total number of instruction items within an imagery task. Imagery tasks are each comprised of discrete stages of instruction (the items), so imagery tasks which require the correct manipulation of three instruction items in order to generate the intended image are referred to as ‘three-stage tasks’, those with four items are ‘four-stage tasks’ and those requiring the correct manipulation of five and six instructions are five-stage and six-stage tasks (respectively)

4.10.1 ICRT item analysis

The individual imagery tasks in the ICRT certainly require scrutiny in order to ascertain their reliability. However, it was not appropriate to conduct a reliability item analysis on the tool (Tabachnick & Fidell, 1989). The items making up each imagery task do not each assess the same ‘level’ or aptitude of mental imagery control, with some items requiring participants to simply imagine a geometric shape such as a square or circle, with others which require shapes to be altered in some way, such as turning a circle into an oval, and there are also items in which individual or conjoined shapes are rotated through 90 or 180 degrees. The tasks were not suitable for this process as the ICRT are not designed to assess equal levels of mental imagery control, on the contrary, they each intend to measure differing levels of mental imagery control. In addition, ‘items’ in this tool are conceived such that they consist of between three and six separate instructions, which could each themselves be considered as individual ‘items’. These too would be unsuitable for use in traditional reliability analyses. The differential imaginal elements which are tapped by the ICRT were therefore investigated. The data analyses were conducted on results from participants recruited for Study 4 (Chapter 5), but the results are reported here as they relate to the collection of studies reported in this chapter.

‘Complex’ and ‘Rotational’ imagery tasks

Three new dichotomous variables were computed. First, tasks which utilised ‘complex’ terms and which included potentially complicated instructions were separated from those

which did not include such terms. ‘Complex’ tasks were defined as those asking participants to add and manipulate ‘horizontal lines’ or ‘vertical lines’. It was recorded in concurrent notes taken during the sessions that a great number of participants, despite being reminded of the distinction in the practice trial, commonly confused the terms and some had to exert considerable effort in order to remember, and continue to remember, which was which. Secondly ICRT items were separated by those which involved mentally rotating elements to successfully complete the task, and those which did not require any mental rotation. Finally, ICRT items which contained both ‘complex’ and ‘rotational’ components were grouped as ‘complex rotation’ and those which only had complex or rotational components were classed ‘either/or’. Table 4.4 below presents these categories.

Table 4.4

Criteria for categorisation of ICRT

Categorisation	Criteria
Complex (C)	instructions include terms "horizontal line" or "vertical line" (may or may not include mental rotation)
Non-complex (NC)	instructions have no complex terms (may or may not include mental rotation)
Rotational (R)	task requires 1 or 2 rotations (may or may not include complex terms)
Non-rotational (NR)	task does not require any rotations (may or may not include complex terms)
Complex rotation (CR)	has both ‘complex’ and ‘rotational’ instructions
Either/Or (EO)	has either ‘complex’ <i>or</i> ‘rotational’ instructions (i.e., these are items

which were not selected as ‘CR’).

The groupings allowed in-depth analysis of the imaginal properties of the Image Control and Recognition Task. The groups were not mutually exclusive across type, that is to say, a task in the ICRT could be rated as ‘complex’, ‘rotational’, and ‘complex rotational’.

DESCRIPTIVE STATISTICS AND INFERENTIAL STATISTICS

Paired samples *t* tests were conducted between types of task to ascertain differences between these newly categorised ICRT groups. These were found to be significant when comparing ‘rotational’ ($M = 5.85, SD = 2.74$) to ‘non-rotational’ ($M = 3.29, SD = 1.62$) ICRT mean scores, $t(95) = 9.31, p < .001, d = 1.14$, and ‘complex’ ($M = 6.12, SD = 2.45$) with ‘non-complex’ ($M = 2.89, SD = 1.79$) ICRT mean scores, $t(95) = 12.80, p < .001, d = 1.50$. A significant difference was also found between ICRT with tasks containing with ‘complex and rotational’ ($M = 3.78, SD = 1.89$) instructions and those with just one of these components, that is, the ‘either/or’ tasks ($M = 5.36, SD = 2.02$), $t(95) = -8.41, p < .001, d = .81$). These results will be considered during item selection for the final version of the ICRT.

An investigation of the differences between items by number of stages was then conducted. Table 4.5 below provides this information.

Table 4.5

Rotations and complexity of ICRT by number of stages

Number of stages	Number of rotational tasks	Number of complex tasks	Number of complex rotations	Number of items containing either complex <i>or</i> rotational components	Explanation
3	3 rotation	5 complex	1 complex rotation	7 either/or	This group of imagery tasks contains the fewest complex rotations reflecting the relative simplicity of these items
4	7 rotation	5 complex	5 complex rotation	3 either/or	The four-stage tasks may focus too heavily on 'rotational' instruction, making these harder than the 5 stage tasks
5	4 rotation	6 complex	3 complex rotation	5 either/or	The five-stage tasks have few 'rotational' instructions, potentially making this set easier than the 4 stage tasks
6	7 rotation	6 complex	7 complex rotation	1 either/or	The six-stage tasks have the most rotational and complex instructions, reflecting the intention for these to be most difficult

Table 4.5 highlights differences between ICRT stage groups, with the four-stage tasks relying mainly on rotational instructions, while the five-stage tasks were possibly too easy due to only half involving rotational instructions and mainly containing complex ones. Table 4.6 below shows how many of each type of task is present in the ICRT. The results indicate that there were roughly the same number of ‘complex rotational’ imagery tasks as there were ones which included either rotational *or* complex terms. This bodes well because a range of imagery abilities theoretically require a range of tasks in order for accurate measurements to transpire.

Table 4.6

Total number of items in the ICRT broken down by type

Type of task	Total
‘Rotation’	21
‘Non-rotation’	10
‘Complex’	22
‘Non-complex’	9
‘Complex rotation’	15
‘Either/or’	16

Inspection of Table 4.7 below highlights the varying levels of imagery that each task entails. It can be surmised that success on these imagery tasks depends on a number of things. The ability to generate, maintain and rotate items is obviously essential in the majority of these tasks, but also critical is the ability to modify and then hold multiple shapes together while rotating them, and the capacity to rotate the shapes in the right direction. I am suggesting that these capabilities are essential elements of mental imagery control.

Table 4.7

Classification of Image Control and Recognition Tasks by Rotational Components and Complexity

No. Stages	Name	No. rotations	Rotational (r) /Non-rotational (nr)	Complex (c) /Non-complex (nc)	Degrees per rotation	Rotation and Complex (rc) Either/Or (e)	Actual use of complex term(s)	Horizontal	Vertical
3	Diamond	0	nr	c		e	“remove the horizontal line”	1	
3	Rocket	1	r	c	90°	rc	“imagine a horizontal rectangle” ¹	1	
3	Fish	0	nr	c		e	“imagine a horizontal oval” ¹	1	
3	Umbrella	1	r	nc	90°	e			
3	Cherries	1	r	nc	180°	e			
3	Sweet	0	nr	c		e	“imagine a horizontal oval” ¹	1	
3	Head and hat	0	nr	c		e	“remove the horizontal line”	1	
3	Teddy	0	nr	nc		e			
4	Heart	1	r	c	90°	rc	“remove the horizontal line”	1	
4	Mug	1	r	nc	90°	e			
4	Mobile phone	1	r	c	90°	rc	“add a horizontal line”	1	
4	Candle	1	r	c	180° ²	rc	“add a vertical line”		1
4	Stick man	1	r	c	180° ²	rc	“add a vertical line”		2
4	Hanging star	1	r	c	180° ²	rc	“add a vertical line”		1
4	Present	1	r	nc	90°	e			
4	Happy face	0	nr	nc		e			
5	Boat	1	r	c	90°	rc	“add a vertical wavy line”		2
5	Clock tower	0	nr	nc		e			
5	Cottage	0	nr	c		e	“add a vertical rectangle” ¹		1
5	Church	1	r	c	90°	rc		1	
5	Cake	0	nr	c		e	“imagine a trapezoid” and “add to the horizontal side” ³	1	
5	Pine tree	1	r	c	90°	rc	“add a vertical line”	1	1
5	Bag	2	r	nc	90°	e			
5	Drink	0	nr	c		e	“add a horizontal line/diagonal line” ⁴	1	
6	Cat	1	r	nc	90°	e	“add a question mark” ⁵		
6	Snowman	1	r	c	90°	rc	“add a vertical line”		2
6	Ice cream	1	r	c	90°	rc	“add a vertical line”		1
6	Envelope	1	r	c	90°	rc	“add vertical lines” and “add a horizontal line”	1	2
6	Bow	1	r	c	90°	rc	“add a horizontal line/vertical line/diagonal line”	1	
6	Pencil	2	r	c	90°	rc	“imagine a rectangle so that it is standing ‘vertically’” ¹		1
6	Traffic light	1	r	c	90°	rc	“imagine a rectangle so that it is lying horizontally” ¹	1	1

¹ Labelled as ‘complex’ because, though not particularly difficult imaginal requirements, some participants sought clarification of what was meant by these instructions.

² These instructions were accompanied with the instruction “that is, turn it upside down”.

³ Participants were required to think of a trapezoid which does not appear to be a shape that is commonly familiar. Just one horizontal edge of this shape was then specified in the instruction. This task was classed as ‘complex’ for these reasons.

³ A diagonal line was to be added so it was sticking out of the top of a triangle. Again, this appeared to be a complex instruction for many.

⁴ Many found it difficult to attach and rotate the question mark.

There are some caveats to this last point, such as the observation that rotating geometric and alphanumeric shapes appears to be easier than rotating more complex shapes such as question marks. It was noted that people write their question marks in different ways, in varying ‘personal fonts’ if you like. It is also advantageous to know left from right, to remember the difference between clockwise and anticlockwise rotations and to remember what horizontal and vertical lines look like, and so discussions clarifying confusions related to these should take place during the practice trial where necessary. Being sure that participants are able to accurately follow the instructions relating to horizontal and vertical lines, and ensuring they have practiced which is ‘left’ and which is ‘right’, would make it easier to isolate imagery control abilities. I shall repeat a point made earlier however, which is that proficiencies in the ability to manipulate images according to instructions about lines of certain orientations and the left or right sides of shapes are common amongst people who efficiently progress through the stages of the imagery tasks. Put differently, those who exhibit exceptional mental imagery control appear to have no problems following these types of instructions.

Trend Analysis on ICRT data

To test whether the number of ICRT correctly solved was linearly related to the number of instruction stages, a trend analysis was conducted with ‘number of stages’ as an independent variable and ‘percentage solved’ as the dependent variable. One way analysis of variance (ANOVA) indicated that the number of steps significantly affected

the percentage of ICRT solved by participants, $F(3,380) = 23.27$, $MSe = 902.104$, $p < .001$, $\eta^2 = .15$. Bonferroni-adjusted t tests indicated that ICRT with fewer stages were associated with significantly higher solvability percentages than ICRT requiring more steps to solve them (Table 4.9). The trend analysis indicated that the data fit well to a linear model with the linear component accounting for a substantial proportion (15%) of the variance in solvability. As shown in Table 4.8, significant differences were uncovered between three-stage ICRT set and the four, five and six-stage ones. The four-stage tasks were significantly different from all except the five-stage tasks, suggesting that the longer tasks which comprise of five stages are not statistically harder than the four-stage ones, as intended. The five-stage tasks were significantly harder than the three-stage ones, and significantly easier than the six-stage imagery tasks.

Table 4.8

ICRT Solvability Percentages as a Function of Number of Stages

Number of Stages	Mean (%)	Std. Deviation (%)
3	79 ^A	25
4	59 ^B	32
5	54 ^B	32
6	43 ^C	33

Note. $N = 96$. Means with the same letter in their superscripts do not differ significantly from one another according to a Bonferroni-adjusted t-test test with a .05 limit on familywise error rate.

This analysis indicates that overall the ICRT increases in difficulty as a function of the number of stages involved in the formation of the final intended-image. The aim was to develop a measure of mental imagery control which treats it as a continuous variable and measures individual levels of ability in controlling mental imagery and this has been achieved. The ICRT may be administered in order to assess differences in the ability to control mental imagery, although the non-significant difference between the four and five-stage tasks remains. These tasks will be refined further in response to this finding.

4.10.2 Number of ICRT named from imagery

As another index of the efficacy of the ICRT as a measure of mental imagery control, mean scores were calculated of the number of images correctly named from imagery *alone*, that is, the number of items which were named before the drawing phase of the task. The mean number of ICRT images named from imagery was 4.12 ($SD = 3.06$), with a minimum score of zero and a maximum score of 11.

No participant was able to name all ICRT images from their imagery alone, and the mean showed that on average four intended-images were recognised in mental imagery, which is just a third of those presented (16). It is noteworthy that the majority of participants however expressed surprise at how easily they were able to name the image once they had drawn it. This has implications for the study of mental imagery more generally, as many researchers assert that mental imagery is akin to perception in terms of overlapping cognitive and cortical structures underlying them (Borst & Kosslyn, 2008; Ganis & Schendan, 2008; Ganis, Thompson, & Kosslyn, 2004). However this finding suggests that many find it difficult to inspect the images produced in the ICRT effectively enough in order to recognise them. Even those who successfully solved sizeable numbers of imagery tasks and were able to draw accurate depictions of their mental images were usually unable to provide titles for these before drawing them. If the aforementioned tenet were true, they should have a clear enough mental image that naming it should be as easy as it clearly is when attempting to do so having drawn it. Therefore the ICRT offers more than one way to distinguish high mental imagery controllers from those less capable

in these areas. There is a sizeable literature on the topic of whether images may be reinterpreted in mental imagery (Finke, Pinker, & Farah, 1989; Reed, 1974; Reed & Johnsen, 1975; Brandimonte, Hitch, & Bishop, 1992; Brandimonte & Gerbino, 1993) and the results seem to vary dependent on the nature of the task stimuli, a recurrent theme that runs throughout this thesis. Chambers and Reisberg (1985) found that participants usually could not solve the 'duck/rabbit' problem when attempting this in mental imagery. This task presents participants with a figure which can be seen as both a duck and a rabbit (Figure 4.3). Participants, having previously identified the image and memorised the figure, are later instructed to recall it from memory and try to reverse this 'bistable configuration'.



Figure 4.3

The duck/rabbit figure. From Chambers and Reisberg (1985).

Reisberg and Chambers (1991) argued that mental images are meaningful depictions and that this may be one reason people find it difficult reinterpret them. They investigated when people can and cannot discover something ‘new’ in their mental imagery, and reported that few people were able to ‘see’ alternative images in mental imagery. In their words, “images, like percepts, include both information about stimulus geometry and also specification about how that geometry is understood” (p. 338). Slezak (1991) states that the geometrical shapes which are often used as stimuli in spatial imagery tasks lack semantic interpretations (to a degree) when compared to a duck or rabbit and states that this may reflect the differences in mental reinterpretation of these respective types of images. When one considers the image depicted above (Figure 4.3) it may be hard to imagine what types of semantic interpretations would result from viewing this especially simple image. It could be argued that it lacks sufficient detail to activate many semantic networks, it is unlikely to remind someone of other ducks they may have seen, for example. Admittedly, however, Slezak may have been referring to more traditional duck/rabbit images, such as that depicted in Figure 4.4, which are used when this task is physically presented for inspection, rather than being memorised and retrieved from memory (as was the case in Chambers and Reisberg’s study).

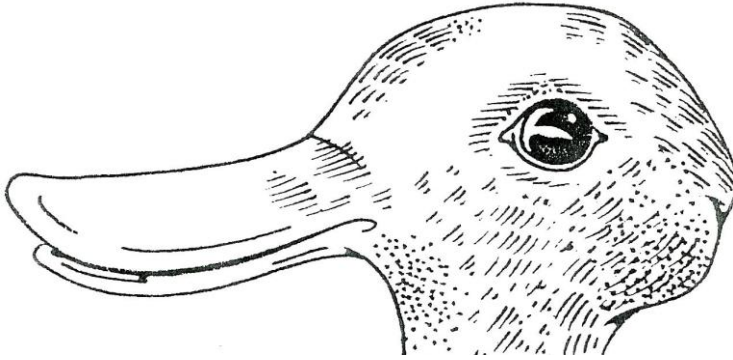


Figure 4.4

A traditional example of the duck/rabbit image. Image by Thompson, 2012

However, as mentioned, results in this area are mixed. Evidence has been found showing that parietal activation increases in direct relation to the computational demands which are required during the visuo-spatial processing required during mental rotation. Carpenter and Just (1979) suggested that the more complex a to-be-rotated figure was the more difficult it was to discriminate once it had been rotated. Just and Carpenter later suggested that this may be a result of the mental rotation of complex figures involving the rotation of “different parts of the figure in separate rotation episodes” (1985, p. 143). Just and Carpenter (2001) consider a ‘rotation workload hypothesis’ which asserts that more neural activity is observed in correspondence with the “number of successive rotation steps” (p. 495) representing increasing cognitively challenging tasks. Just and Carpenter's study revealed increasing cortical activity as participants were required to rotate more and more steps. They also obtained images of the inferior frontal gyrus (IFG) while participants were engaged in a task which required the simultaneous execution of

verbal instructions and mental rotations. They found increased activation in the IFG on the tasks of longer path length, that is, those which required more rotation steps. The reason offered for this result is that the verbal encoding of task instructions is processed in the IFG through encoding and rehearsal⁶, while the “cognitive coordinate system is generated for the required rotations” (p. 497). This relates to the discussions earlier regarding the multidimensional nature of mental imagery and the supposition that ‘cognitive overload’ may be experienced by some people during execution of the ICRT, while others may progress through the tasks quickly and easily, thus demonstrating their mental imagery control abilities. The findings appear to lend support to this and inspection of the incorrect drawings generated during the ICRT suggests that rotating multiple shapes together ‘as one’ is something that proved difficult for some.

Much research has been published presenting conflicting findings in the area of mental imagery and reinterpretation of visual images, revealing in fact that people are able to assign new meaning to imagined forms and rotated images (Mast & Kosslyn, 2002; Finke, Pinker, & Farah, 1989; Reed & Johnsen, 1975; Slee, 1980 Brindimonte & Gerbino, 1993). Pinker and Finke (1980) found that participants were able to discover new shapes that emerged after rotation of a three-dimensional configuration, and Shepard and Feng (1972) asked participants to rotate, for example, the letter “N” through 90

⁶ The type of rehearsal referred to here is different to that of the rehearsal strategies outlined and discussed earlier in relation to the ICRT. This rehearsal activity is a cognitive mechanism which is executed much faster than the decidedly deliberate mental operation of returning to the beginning of a task and repeating each stage once again.

degrees, and they were able to reconstrue the new image as “Z”. This latter task is however relatively simple, with only one rotation of one object required prior to being asked about the new image. The ICRT requires not only the reinterpretation of figures in mental imagery, but also depends on the participant's ability to complete the image manipulations in order to reach this penultimate stage of the process, that is, naming the final image before drawing it.

Ganis, Thompson, and Thompson (2004) raise an interesting point about visual imagery and the nature of tasks which require the inspection of mental representations. They state that “The mere requirement to extract certain information may cause that information to be included in the representation” (p.238). The example provided is that when someone is asked to visualise a cat and is then asked whether that cat has curved claws, most people report that they only add the claws when they are asked the question. This is relevant to the ICRT because even though the participants knew an image or picture would emerge at the end of the task, and even when they got the shape configuration correct in their imagery, they were not always able to contemplate it in its entirety and give it a name. It is clear from this that the internal image is not *always* perceptually equivalent, that is, not as clear as perceiving a drawing would be, for when participants actually drew the image the intended form immediately became apparent.

Whether participants are able to name ICRT images from their mental imagery alone can be taken as another index of mental imagery ability. High scores on this index show that such participants not only follow each instruction accurately, but then internally assimilate their mental image, inspect it, and then decide what it may portray. As has been discussed elsewhere in the thesis (in Chapter 1, section 1.2.2), mental imagery can be conceptualised as consisting of at least two distinct subsystems, including spatial imagery and object imagery (Blajenkova, 2006). Possessing high spatial imagery skills allows internal images to be manipulated and relations between mentally imagined objects to be assessed, and object imagery refers to the generation of highly ‘pictorial’ images, which are detailed and colourful. Blajenkova, Kozhevnikov, and Motes (2005) found that people in professions who utilised mental imagery in their work often had a preference for one or other of these types of mental imagery, and showed visual artists to prefer object imagery while providing results indicating that the scientists and engineers in the study had tended to be what Blajenkova and her colleagues called ‘spatial imagers’. It is conceivable however that to be described as someone with ‘controlled’ mental imagery one would need to be adept in both areas. The ability to utilise both spatial and object imagery may be indexed by the ICRT. The cognitive processes involved in both the generation of the intended image and the naming phase, where participants must inspect the manipulated mental image as a whole, and finally those responsible for the contemplation of what this new form may represent, seem to suggest that both imagery subsystems are utilised. Therefore, further analyses were conducted treating the number of ICRT images named from mental imagery as an additional

indication of imagery ability. These analyses look at the relation of this construct to other indices of mental imagery and appear in the sections which follow.

4.10.3 The Forward and Backward Digit-Span Tasks

The digit-span is a verbal working memory (WM) task which has two forms, forward and backward. The first involves participants repeating a series of digits in the order they were presented to them, known as the forward digit-span task, whereas the backward digit-span task requires recall and repetition of the numbers in the reverse order to the order in which they were presented. Different skills are required to do forward DS compared to backward. Essentially, the difference lies in the types of memory utilised when solving each one, the backward DS being thought to be more difficult due to the extra steps required to hold the digits in working memory for longer, and to manipulate these for repetition in the correct sequence. This was first suggested by Terman (1916) who claimed that the backward DS test, “as a test of intelligence ... is less mechanical and makes a much heavier demand on attention” (p. 208, cited in Ackerman, Beier, & Boyle, 2005). In their meta-analysis of the literature on WM and intelligence, Ackerman, Beire and Boyle (2005) found that when looking at g in relation to WM, a large correlation was revealed ($r = .89$). Another finding from this study which is particularly relevant to the present thesis is that the relationship between g and spatial ability was comparably high ($r = .86$). For this reason, though not explicitly measuring intelligence, any relationship between ICRT scores and backward DS scores would be

interesting to investigate. The backward DS scores will therefore be used as an indirect indication of executive control in models testing relationships and covariates.

A subset of participants ($n = 47^7$) completed both the backward and forward digit-span (DS) tasks and their scores were correlated with scores on the ICRT. This was in order to ascertain if verbal working memory or executive function related to mental imagery control skills, as it was expected that a relationship may be uncovered between backward digit-span and mental imagery control. Descriptive statistics and correlations between the variables are presented in Table 4.9.

⁷ This was a subset of the participants recruited for Study 4 who all had English as their first language.

Table 4.9

Descriptive Statistics for Forward and Backward Digit-Span (DS) task with Pearson's r correlation coefficients with ICRT total scores

	Mean	Std. Deviation	Minimum	Maximum	Correlation with ICRT (r)
Forward DS (verbal memory)	7.74	1.79	4.00	11.00	.15
Backward DS (executive function)	6.00	2.03	.00	10.00	.31*

Note. $n = 47$; * r is significant at 0.05.

Forward DS scores (verbal memory) were not related to ICRT scores. The forward DS can be taken as a measure of immediate verbal memory (Ackerman, Beier, & Boyle, 2005), so this is encouraging because should a relationship have been found, then it could indicate that verbal memory abilities were confounding the results and impacting the tool's ability to reveal individual differences in mental imagery control. However a significant moderate relationship was revealed between backward DS scores (executive function) and ICRT scores, revealing that high scores on the backward DS task were related to better performance on the ICRT. This was expected because the ICRT requires

participants to hold an image in one’s mental imagery at the same time as receiving subsequent instructions about how to manipulate it.

4.11 Selection of imagery tasks for final tool

The previous analyses found there to be a suitable pool of imagery tasks from which to select for the final version. The results into the complexity of each set of task instructions highlighted the items which were unsuitable for inclusion in the final tool. These items included instructions featuring complex shapes, tasks that were too easy and therefore participants were able to guess them before all instructions had been presented.

Table 4.10

ICRT final selection notes

Name of item *	Reason for rejection of item (where applicable) ⁸
Diamond	Too easy
Rocket	Too ambiguous
Fish	Too difficult (people confuse the location of the ‘eye’ – left or right)
Umbrella	
Cherries	Now a practice trial
Sweet	
Head and hat	
Teddy	Too easy
Heart	
Mug	
Mobile phone	Too ambiguous ⁹

⁸ Those with no comment in this column will retained for future versions of the tool.

Candle	
Stick man	
Hanging star	Too difficult – confusing instructions
Present	
Happy face	Too easy and guessable
Boat	
Clock tower	Too easy – no rotation or complex terms and guessable
Cottage	Too easy – no rotation and guessable
Church	
Cake	Guessable and includes an uncommon shape (trapezoid)
Pine tree	
Bag	Confusing instruction ("inverted 'U' or arch" and too ambiguous)
Drink	Too difficult (diagonal line sticking out at an angle)
Cat	Confusing due to use of a question mark
Snowman	
Ice cream	
Envelope	
Bow	Too easy
Pencil	Guessable
Traffic light	Guessable ¹⁰

Note. * Selected items in **bold**.

Table 4.11 contains the imagery tasks which are most suitable for inclusion in the final version of the tool. Selection of these has taken into account the previous analyses and the clustered solvability percentages presented in the table. The remaining imagery tasks will either be dropped or will be modified for testing in future versions of the tool (see Table 4.10 above).

⁹ Additionally, in the time since the design of this task the conception of what a mobile phone looks like has changed substantially. The depiction of the 'mobile phone' in the present version of the ICRT looks more like a walkie talkie.

¹⁰ This could be amended so that the addition of the telltale lights (three circles in a row) comes at the end reducing the likelihood of guessing.

Table 4.11

Selected items for final version of ICRT with percentage of items solved by participants in the digit-span and mental rotation studies

Name of imagery task	Number of stages	Overall percentage solved
Umbrella	3	78%
Sweet	3	78%
Heart	4	60%
Candle	4	58%
Boat	5	37%
Pine tree	5	42%
Snowman	6	38%
Envelope	6	37%

Note. Pooled result for the digit-span and the mental rotation study samples are presented here; $n = 82$.

‘High’ and ‘low’ imagery control groups were computed by conducting a quartile split on total percentage of ICRT solved. Using independent groups t tests these participants were compared on total number of correctly solved three-stage, four-stage, five-stage and six-stage imagery tasks. Additionally, an independent groups t -test was used to compare the groups on the number of images they were able to name from their mental imagery. The means were all significantly different and were in the expected direction, with highly controlled imagers scoring higher on all variables. These figures are presented in Table 4.12.

Table 4.12

Means, t tests and effect sizes between high and low imagery controllers on the four levels of difficulty and number of ICRT images named from imagery

Grouped stages	High control (n = 21)		Low control (n = 26)		t	p	d
	Mean	Std. Deviation	Mean	Std. Deviation			
Total three-stage tasks solved	3.86	0.36	2.15	1.01	7.37	< .001	2.25
Total four-stage tasks solved	3.33	0.73	1.11	1.07	8.09	< .001	2.42
Total five-stage tasks solved	3.57	0.60	1.04	0.96	10.55	< .001	3.16
Total six-stage tasks solved	3.00	0.89	0.46	0.65	11.48	< .001	3.26
Number of images named from imagery	4.71	3.15	3.08	2.98	3.75	< .001	.53

Note. All results were significant; $df = 45$; the significantly higher mean in each pair is highlighted in bold.

Having scrutinised the properties of the ICRT the observation is made that the tools should not be made ‘uniform’ because as they stand they accurately reflect the multidimensional nature of mental imagery and effectively operationalise the construct of imagery control. The fact that only some tasks require the rotation of imagined forms while others feature imaginal manipulations of other types is actually an asset to this tool because the result of this are accurate indices of a range of imaging abilities. In future investigations which use the ICRT it will be possible to deconstruct these additional imagery abilities. Indeed, the results even suggested that without elements of rotation in the imagery tasks a ceiling effect emerged as these tasks appeared to be quite easy. This tool will therefore assist in the contribution to the understanding of mental imagery in a

large number of areas, and will complement already existing tools in their joint exploration of the many characteristics underlying this construct.

Adaptations were made to the Image Control and Recognition Task, both in terms of the items themselves and the methodology utilised when implementing the tool.

4.12 Evolution of the Image Control and Recognition Task

The Image Control and Recognition Task (ICRT) has evolved over time. Though it was initially designed to measure imagery control, as development and investigation continued it was clear that this tool could be used to indicate abilities in more than just one type of mental imagery. The work by Blajenkova and colleagues (Blajenkova, Kozhevnikov, & Motes, 2006; Blajenkova & Kozhevnikov, 2010) and many others (Kosslyn & Koenig, 1992; Farah, Hammond, Levine, & Calvanio, 1998; Kosslyn, 1994; Levine, Warach, & Farah, 1985) has provided empirical support for at least two separate types of what could be conceived of as ‘imagery control’, namely spatial imagery and object imagery, and their findings are frequently buttressed with neuropsychological evidence indicating distinct cortical areas responsible for these separate but related imaginal abilities (Chapter 3). Also, the extensive body of research which employs mental rotation paradigms has further highlighted these distinct capabilities in mental imagery ability.

The findings from Studies 1 and 2 support the notion that the many previous attempts to operationalise mental imagery may have failed to adequately address its multidimensional structure, and have frequently treated their chosen measure, whether it be an indication of vividness, control, or rotation, as though it measured ‘imagery’ as a more general construct, when in fact these tools only measure one of aspect of imagery, and even that is a tenuous claim when considering the problems that exist with so many of the self-report tools. A serendipitous finding which came to light while the psychometric properties of the tool were being scrutinised was that the ICRT can actually be used to address these inconsistencies, that is, the nature of the processes required to solve them means that they tap all of the essential features of mental imagery control and treat it as a multidimensional construct.

The ICRT requires the engagement of a number of mental imagery processes in order to successfully solve them. The protocols for administration of the ICRT can be adapted depending on the nature of the investigation in question, so one can use the ICRT to look at ‘overall imagery control’, but also at the related index of ‘image recognition’. These two indices are themselves only moderately correlated, suggesting that the control of mental imagery and the ability to recognise mental images may require subtly different processes. Of course, in order to be able to recognise the mental image it would have had to be constructed correctly in mental imagery in the first place, so it seems that image

recognition is one part of mental imagery, along with maintenance, rotation and manipulation. It has already been shown that to achieve creative greatness requires greatness in a number of areas, and actually it may be precisely this amalgamation of superior abilities in so many realms of imagery that allows for this greatness. It appears that some people are able to use the strengths that they possess in these disparate areas to their advantage. As has been said, no real conscious effort appeared necessary for some participants to manipulate the shapes, sizes and locations of forms in imagery, nor when they were asked to visualise and recognise the image as a whole. Obviously conscious effort was required, for being able to transform a mental image requires the initial encoding of the spatial relations between the stimuli (Hyun & Luck, 2007), which, in the case of the ICRT, sometimes increase in number, as well as the rotation of the stimulus itself. However, it was observed that the participants who accurately completed the ICRT did not seem at all ‘pressured’ during these phases, instead thoroughly enjoying the challenge of the tasks and relishing in their successful recognition of the images.

4.13 Limitations and future research

It was not possible to statistically investigate the number of people who took longer to complete each imagery task due to nature of the ICRT’s design. The tool was not initially designed to be a reaction timed task and so these data are not available. Future research could seek to adapt the tool further so that investigation into the tendency to deliberately rehearse instructions may be undertaken. Having said that it has been found

that deliberate verbal encoding of visual images may in fact inhibit the ability to recognise alternative versions of these patterns. Brandimonte et al. (1992) investigated whether phonological recoding in STM was related to visual imagery, and provided further support to the claim that the visual STM is responsible for performance on image subtraction tasks whereby an image is memorised followed by instructions to remove some part of that image in order to reveal a new image. An elegant study conducted to investigate this found that articulatory suppression during the image encoding phase led to improved image subtraction for easy-to-name stimuli, but not for stimuli that were difficult to name, which were included to reduce the effect of phonological coding. This effect was “attributed to the influence of verbal recoding in STM on encoding in LTM” (1992, p. 163) and suggest that ICRT instruction rehearsal is unlikely to lead to inflated scores because this strategy actually decreased subsequent recognition due to diminished encoding of image properties. When pictures are recoded into a phonological form, performance on subsequent manipulation tasks is impaired, and this may also be true when manipulation of mental images is attempted according to repetition of phonological descriptions.

McAvinue and Robinson (2007) stated that treating “Psychological properties as measures of imagery ability... [was the] next step in the development of objective tests of visual imagery” (p.203), and the analyses reported in this chapter certainly go some way towards this. As has been noted, there exist at least four individual imagery abilities: the

ability to generate high-resolution images; the ability to compose images from separate parts; the ability to inspect imaged patterns, and the ability to rotate objects in images (Mast & Kosslyn, 2002). It can be concluded that the results indicate that the ICRT taps a number of of these imagery abilities. D’Ercole et al. (2010) also ascertain that objects can be named, and these names can evoke images (of objects). They state that “Mental representations have measurable characteristics” (Ercole et al., 2010, p. 3), and this certainly appears to be the case considering the overall results of this thesis *en bloc*. D’Ercole et al. also looked at abilities in turning verbal descriptions into mental images, and vice versa, and how easy this is. It may be that strengths here are related to visual art and many other domains, for example, literature, architecture, mathematics, and engineering, professions which often require the physical or written manifestation of internal, possibly verbal descriptions. Denis (2008) found that images constructed from verbal information could contain accurate metric information. His argument was that participants less adept in spatial ability (low imagers) had differing “amounts of computational resources available to them” (p. 209) which reflected their inability to mentally traverse and control their mental images. A tentative suggestion is that exceptional artists and professionals in creative roles take advantage of exceptional computational resources in such a way that those with less controlled imagery cannot. In their study into the reinterpretation of visual images, Mast and Kosslyn (2002) found that only participants who were adept at relevant imagery processes such as resolution, inspection, composition, rotation, and transformation, could recognise the new images. It

may be that this collection of imagery abilities are the same processes which relate to increased creativity.

The finding which was reported above regarding that observation that articulatory suppression improved the ability for participants to reinterpret visual image (Brandimonte et al., 1992) means that any strategies to memorise the ICRT instructions may actually have hindered the ability imagine and amend the shapes according to the instructions. This is encouraging because it can be taken as validation of the ability of the tool to accurately assess mental imagery control skills. Should participants attempt to rely on rehearsal strategies for success on the ICRT then rather than improve their score, which is the confound that was originally feared, this may have meant their scores suffered as a result, more so than if they were instructed to form an image and prevented from mentally articulating details about this image. Attempts to memorise the instructions and repeat them to themselves may have impaired the mental image due to the articulation of the instructions.

The ICRT originates from the Geneplore model of creative cognition and employs the same steps of *generate* and *explore*. Therefore it could reasonably be expected that the processes underlying successful completion of this tool are likely to be related to creativity in future studies.

CHAPTER 5 FURTHER EXAMINATION OF THE INTERRELATIONSHIPS BETWEEN CREATIVITY, SCHIZOTYPY AND MENTAL IMAGERY



11

5.1 Introduction

This chapter will begin by placing the subsequent study in context, introducing an overview of research demonstrating links between creative performance, mental imagery capabilities and psychopathology, with a specific focus on the construct of schizotypy. The present study seeks to examine possible links between the three constructs outlined in preceding chapters. Theoretical decisions for inclusion of all tools then follow, concluding with aims, expectations, and hypotheses for the present study.

¹¹ Image provided by a participant during the Creative Visualisation Task in the subsequent study. For illustration.

5.1.1 Creativity, Schizotypy and Mental Imagery: Further exploration and points clouding the debate

The evidence reviewed in Chapter 2 showed that increased levels of unusual ideas and remote associations has been associated with both creative thought and schizophrenia-spectrum disorders. However, as was put by Fisher, Heller, and Miller (2013), “this activation results in innovative output in one case and communication disturbances in the other” (p. 70). Nettle’s (2006) claim that there is an evolutionary explanation for the persistence of psychopathology in the human gene pool, namely that creativity may lie at the lesser extremes of the dimensions of schizotypy, is therefore all the more compelling. Schizotypy, which lies on a continuum between ‘normality’ and schizophrenia, is posited to be present in the general population (Claridge et al., 1990). The multidimensional construct of schizotypy, now regarded as a personality trait (Raine, Lencz, & Mednick, 1995), has been related to creativity in a number of studies. These have included studies of eminent creativity, shared trait research investigating similarities between creative groups, family studies involving the relatives of psychotic patients, and laboratory studies investigating the role of schizotypal thought in various creative tasks. Other studies have also been published, however, which suggest that there exists little or no relationship between schizotypy subscales and creativity (Batey & Furnham, 2008). Some evidence has also been found for a negative relationship between the constructs, with Fisher et al. (2004) finding that positive schizotypy was positively associated with creativity while negative schizotypy had a negative relationship in this study. Mixed findings have also

been found involving specific levels of schizotypy in artists (Burch, Pavelis, Hemsley, & Corr, 2006a). Many of these studies were outlined in Chapter 2, and Chapter 6 focuses on imagery and creativity in visual artists, however, further exploration of the most pertinent findings from this body of research which may be obscuring the debate is presented in this chapter.

Some suggest that the positive association between creativity and schizotypy is explained by the cognitive patterns and associations which are characteristic of psychiatric disorders which facilitate original thought. As was pointed out by van Os and Verdoux (2003), the dimensions of pathology which characterise these disorders are not exclusive to any one of them. These include previously discussed traits which have been shown to be related to creativity, such as delusions, overinclusive cognitive style, perceptual distortions and idiosyncratic thought and language. Claridge (1995) suggested that studying particular illnesses and how they each relate to creativity was a somewhat redundant practice considering this observation.

Stoneham and Coughtrey (2009) investigated whether levels of schizotypy were related to creativity. 'Low', 'medium' and 'high' schizotypy groups, as indicated by scores on the short version of the O-LIFE (Mason, Linney, & Claridge, 2005), attempted a group-problem solving task. As was predicted in the aims of their study, they found that the high schizotypy group employed significantly more strategies when attempting to solve

the task, which the authors had designed to appear initially impossible to solve. Additionally they found that low schizotypy groups were associated with convergent thinking strategies while those with higher scores in schizotypal traits were more likely to employ divergent strategies during problem solving, and this latter group implemented twice as many strategies as their lower scoring counterparts. The finding that low schizotypy was related to convergent thinking is similar to the finding that scientists and mathematicians are associated with reporting lower levels of schizotypal symptoms, and this is noted by Stoneham and Coughtrey. These professions arguably require higher levels of convergent thinking than other creative specialities such as visual art and poetry, which are, by their nature, far less constrained. The finding that differential relationships for members of different creative professions may be taken as further evidence that schizotypal traits are not always linearly related to creative performance or ability.

As has been noted, research that has shown negative associations to exist between creativity and schizotypal variables (e.g. Schuldberg, 1990; Claridge & Blakey, 2009). Batey and Furnham (2008) reported a negative relationship between cognitive disorganisation and creativity. However the impulsive nonconformity and unusual experiences scores were positively related to their 'aggregate' creativity score comprised of self-judged creativity, a score on the Creative Personality Scale (CPS; Gough, 1979), and the Biographical Inventory of Creative Behaviours (BICB: Batey, 2007, cited in Batey & Furnham, 2008). These types of creativity indices, which are all self-report

measures, are highly dissimilar as a method of indexing or measuring creativity as are, for example, divergent thinking (DT) tasks and tests of creative imagery, yet they have been shown to correlate with these measures. Other researchers have demonstrated that self-rated creativity is sometimes related to both DT and independently rated creativity (Batey & Furnham, 2006; Barron, 1955, cited in Batey & Furnham, 2008; Carson, Higgins, & Peterson, 2005). Batey and Furnham (2008) found negative relationships between introverted anhedonia and word fluency, DT fluency, and rated DT. A negative association was revealed between introverted anhedonia and 'total creativity', a composite score and self-rated creativity as measured by the CPS. A negative relationship was shown to exist between cognitive disorganisation and CPS. Dinn, et al., (2002) found evidence suggesting negative relationships between 'interpersonal difficulties', which is akin to introverted anhedonia, and DT. The finding that differential relationships emerge between creativity and schizotypy depending on which scales are used and which traits are measured has been supported by empirical research which has shown that some forms of schizotypy may be counterproductive for creativity while others may facilitate it (Acar & Sen, 2013).

In their meta-analysis into the creativity and psychopathology link, which focussed exclusively on psychoticism (a unidimensional trait), and not schizotypy, Acar and Runco (2012) found that the index of creativity explained a large amount of the variance in the relationship. Overall, mean effect sizes were small (lowest $r = .10$, highest $r = .20$), however the effect increased when the Eysenck Psychoticism Questionnaire (EPQ,

Eysenck, 1995) was taken as the indicator of psychopathology and when *uniqueness* scores were included as the index of creativity ($r = .50$). Acar and Runco conclude that the relationship between creativity and psychopathology is only likely to be observed occasionally and in very specific circumstances, rather than it being a “broad and general” (p. 37) relationship.

Much of the evidence that has been cited supporting a link between positive schizotypy and creative thought has tended to focus on the association between creativity and unusual cognitive style, bizarre thoughts, even magical ideation, and often does not consider the extent to which the unusual perceptual and imaginal experiences may be relevant to the relationship. Their relevance may, of course, be implied by a high positive schizotypy score, for questions measuring this construct include such items as *When in the dark do you often see shapes and forms even though there is nothing there?*, *Have you ever felt when you looked in the mirror that your face seemed different?*, and *On occasions, have you seen a person's face in front of you when in fact no one was there?* (questions from the O-LIFE unusual experiences subscale; Mason, Claridge, & Jackson, 1995). It is argued that mental imagery is involved in these unusual experiences, for in order to perceive something which is not there it is likely that cognitive processes implicated in mental imagery would necessarily be engaged. Though, unlike other types of imagery which has been implicated in enhanced creative performance, these perceptual occurrences may not be entirely controllable. As was outlined in Chapter 3 (section 3.1.3), the neural correlates of imagery and perception overlap to some degree (Ganis,

Thompson, & Kosslyn, 2004), and, notably, it is the cognitive control processes that are comparable in terms of neural machinery. The relevance of mental imagery to the schizotypy-creativity relationship appears to have been largely overlooked.

Positive schizotypy has been linked to creative performance in a number of studies (Claridge et al., 1996; Venables, 1995; Brod, 1997). Oldham and Morris (1995) describe positive schizotypy as possession of an idiosyncratic style and strange and eccentric behaviours. Mason, Claridge, and Jackson (1995) found that creative art students scored higher on the positive schizotypy scale of unusual experiences when compared with humanities students. Those scoring highly on scales of unusual experiences often experience anomalous perceptions of the world surrounding them and may have a propensity to fantasise. A recent study by Fisher, Heller and Miller (2013) indicated that high scores on a positive schizotypy measure named 'Odd Beliefs' was correlated with high scores on the Creative Experiences Questionnaire (Merckelbach, Horselenberg, & Muris, 2001). People who score high in this trait are characterised by making unusual or 'loose' associations between ideas and may find it hard to express these verbally. Perhaps their imagery enables them to communicate these ideas more easily if they do so visually, and perhaps this is what ultimately leads to increased creativity in this group. A disengagement from reality, thought and perception characterises positive schizotypy, and disengagement of this nature is purportedly conducive to creativity (Schuldberg, 2000-2001). The tendency or requirement to create something that is novel and

surprising may benefit from experiencing and thinking about the world in an unusual way. These studies seem to illustrate the contribution of this unusual and idiosyncratic thought within creative domains, especially among visual artists. A tentative argument is made that this propensity for visual artists to engage in this type of thought may be somehow influenced by unusual imaginal experiences.

Another trait linking schizotypy and creative thought which has been briefly described is that of overinclusive thinking (Chapter 2, section 2.2.2). This is characterised by the breaking of conceptual boundaries and incorporation of irrelevant ideas which may ordinarily be ignored. This may lead to the generation of more original ideas due to the tendency to link remote associations and to therefore exhibit a more unique and often abstract style of thought (Eysenck, 1992). Carson, Peterson, and Higgins' (2003) meta analyses suggested that those high in schizotypy appear to share the same overinclusive cognitive style as is often observed in highly creative individuals, and that this becomes apparent through reduced latent inhibition. Similarly, Abraham and Windmann (2008) suggest those with increased schizotypy scores exhibit poorer cognitive inhibitory control. It may be that the mental imagery associated with schizotypal thought, or, to coin a term, *schizotypal imagery*, is related to creativity, but perhaps it is not the control of mental imagery that counts here, but rather its nature and quality. The tendency to attend to usually inhibited, possibly irrelevant information, or even the inability to ignore that which is only distantly related, may lead to an increased likelihood of unusual

associations, ideas and conceptualisations. Eysenck's theory suggests that overinclusive thinking may result in a cognitive style characterised by an unusually wide conception of relevance (Abraham & Windmann, 2008). Are these creative ideas and novel conceptualisations facilitated by mental imagery? Perhaps the tendency to fantasise and to engage in such unusual, elaborate and creative thought is aided or even encouraged by imaginal processes and abilities.

Introvertive anhedonia refers to flat affect and an isolated, often negative attributional style (Claridge, 1997). Individuals scoring high on scales measuring this factor are often socially withdrawn and introverted. Researchers such as Abraham et al., (2007), Schulberg, (2000-2001), Dinn, Harris, Aycicegi, Greene, and Andover (2002), Nelson and Rawlings, (2010) have all found negative relationships between introvertive anhedonia and creativity, as measured by divergent thinking tasks and self-reports. This is reflected in Acar and Sen's (2013) meta-analysis which looked at 45 studies that directly analysed the relationship of introvertive anhedonia to creativity, as opposed to general 'psychoticism' or psychopathology. They found that introvertive anhedonia and creativity were generally negatively related, however the effect size was small ($r = -.09$). Tsakanikos and Claridge (2004) showed decreased verbal fluency in individuals who had introvertive anhedonia scores which were one standard deviation above the mean. Some research which was cited earlier by Cox and Leon (1999) found a positive relationship between divergent thinking (the Alternative Uses Task) and scores on introvertive

anhedonia scales. Again it can be seen here that the relationships between schizotypal thought and creative performance are convoluted and depend largely on how the respective constructs are measured, as was outlined in Chapter 2 (section 2.3.2).

Another observation related to overlapping traits concerns magical ideation, which is not only found in persons with high unusual experiences but also in those who report frequent cognitive disorganisation (Eckbald & Chapman, 1983). Cognitive disorganisation and introverted anhedonia also both load with introversion in factor analytic studies. Loaded alongside extroversion are unusual experiences and impulsive nonconformity (Acar & Sen, 2013). It is also claimed from these meta-analytic works that schizotypal traits that load alongside extroversion may be conducive to creativity, whereas those traits which load onto introversion may potentially be detrimental to the creative process (Acar & Sen, 2013). This is in contrast to Feist's (1998) finding that social isolation, an introverted trait, was important for creativity and was found to distinguish both artists and scientists from less creative groups. Findings such as these highlight once again the difficulties with research into creativity and schizotypy. This thesis does not concentrate on *The Big Five* factor of personality (Costa & McCrae, 1992). However this observation that introversion and extroversion have relationships with schizotypy, alongside indications that personality factors have their own relationships with creativity (Huges, Furnham, & Batey, 2013), which may differ according to creative profession and vary depending on how creativity is operationalised

(Batey, Furrman, & Safiullina, 2010), once again accentuates the complexities relevant to the debate. Naturally, the constructs which are related to creativity are not mutually exclusive of others. However what is interesting, but what perhaps makes this investigation so complicated, is that many of these constructs are associated with each other as well as having independent contributions to creative thought and production. This observation is important because it may highlight why so many inconsistencies and conflicting findings have been found in this area of research, but also it supports the view that differential psychological profiles may be found amongst disparate creative groups, such as the finding reported earlier that scientists and visual artists differ significantly in their psychopathological experiences and characteristics (Post, 1994, 1996; Ludwig, 1995; Storr, 2000; Feist, 1998).

An experience of social anxiety may be prevalent in individuals experiencing cognitive disorganisation, with attentional deficits and neuroticism also common symptoms. This may have negative associations with measures of creative thought production, as well as, arguably, mental imagery control, and negative associations between cognitive disorganisation and creativity have indeed been reported (Batey & Furnham, 2008). Brod (1997) reported that disorganised thought was associated with a type of open-ended creativity due to a flow of ideas which may be difficult to constrain and control, and related this to poetry, literature, dance and musical creative domains. An inability to 'take hold of' disordered thought, however, may impair the ability to generate plausible

responses in creativity tasks, and the ability to control chaotic thought may facilitate more success at creative tasks. Imagery control may be relevant for this. However, in a study by Burch et al. (2006a), cognitive disorganisation scores were shown to be significantly higher in visual artists than the non-artists. Nettle (2005) found no differences between non-artists, 'hobbyists', 'serious', and 'professional' visual artists in cognitive disorganisation, though the lowest scores on cognitive disorganisation, unusual experiences and impulsive nonconformity were observed in non-artists and non-poets, and were highest in the serious artist and poet groups. The professional visual artists and poets were slightly lower on all of these traits, suggesting once again that extremely pronounced schizotypy may actually be detrimental to exceptional creativity.

The impulsive nonconformity factor of schizotypy is characterised by extroverted and impulsive behaviours and a lack of adherence to social norms (Claridge & Beech, 1995). The inclination to generate responses which others may consider 'taboo' or inappropriate may be engendered by those high on the impulsive nonconformity scale, though these are rarely considered to be rated as 'creative' (Brod, 1997). According to Brod, the extravertive nature of impulsive nonconformist traits may be related to a heightened urge for creative expression, and it is noted that unusual experiences also 'loads' with extroversion in factor analyses. Those high in impulsive nonconformity may be more willing to express 'shocking' or 'rude' ideas which others may censor (Acar & Sen, 2013), and may in some cases lead to heightened creativity scores for persons high in this

trait. It is unclear what relationship, if any, may be revealed between impulsive nonconformity and mental imagery control. Perhaps a controlled imaginal ability could facilitate a more elaborate imagination or suggestive imagery.

This section has outlined complications and considerations which are relevant to the final two studies reported in this thesis. These relate to overlaps and similarities between the cognitions which are frequently associated with creativity and the next section aims to further illustrate how visual imaginal processes may be relevant to the generation of creative products.

5.1.2 Image Generation and Creative Cognition

The image generation approach to creativity often utilises a specific type of creative imagery task requiring respondents to mentally combine geometric and alphanumeric shapes and letters, during which time they may engage in ‘combinatory play’ in imagery (Smith, Ward, & Finke, 1999). This involves the mental manipulation of images internally, and in the generation of an image or mental picture, often according to a list of predetermined criteria. These criteria purportedly ‘map onto’ creativity as they both may be conceived of along originality/novelty and practicality/usefulness dimensions. *Creative cognition* occurs when original and useful products are conceived and formulated in imagery without perceiving any concurrent stimuli, relying solely on internal representations (Smith, Ward, & Finke, 1995). The Geneplore model supposes

that first, one engages in the *generative* phase, where mental images ('preinventive forms') are synthesised and combined in varying ways, which is subsequently followed by an *exploration* phase, where the mental image is restructured in order to discover some unanticipated form or invention (Finke & Slayton, 1988). Mental imagery is of course utilised during tasks such as these, and the ability to control mental imagery during both of these phases would surely be of benefit. It is suggested by Morrison and Wallace (2001) that the 'emergent patterns' resulting from these mental imaging techniques may be crucial to elucidation of the imagery-creativity due to the imaging abilities which are involved which seem pertinent for creative discovery. They gave participants the directed mental synthesis task (Finke, Pinker, & Farah, 1989) and addressed both spatial scores and skills in mental image naming. They found a positive correlation between the ability to name the image before drawing it and the accuracy of the imagined images ($r = .55, p < .005^{12}$).

When considering the evidence presented thus far it can be seen that the relationships to creativity of both schizotypy and mental imagery are unclear. The implication of certain types of mental imagery in the phenomenology of positive schizotypy cannot be disregarded. However, while it is possible that the imagery experienced by those scoring highly on measures of unusual experiences could be related to creative imagery and productivity, it may not be that this imagery is controlled, in fact, the descriptions suggest

¹² Exact p values were not published.

a lack of control over the characteristic perceptual and imaginal anomalies. Perhaps one could even describe this imagery as ‘uncontrolled’. It may not be that imagery control is directly related to schizotypy, but that different types of imagery, both controlled and uncontrolled, are differentially related to creativity. This may manifest in relationships between both unusual schizotypal experiences and creativity, and mental imagery and creativity. It may even be that controlled imagery is related to different creativity tasks when compared to the schizotypal (uncontrolled) imagery often reported by those scoring highly on measures of unusual experiences.

5.2 Rationale

As has been outlined above, a items measuring unusual experiences enquire about such things as seeing shapes and forms in the dark, and whether participants’ daydreams seem *so true to life that [they] sometimes think they are real*. Another item asks *...have you seen a person’s face in front of you when in fact no one was there?* (Mason, Claridge, & Jackson, 1995). It seems fair to suppose that a ‘yes’ response to these questions would necessarily involve elements of mental imagery, though a lack of control often appears to accompany these experiences. The possibility that the associations seen in the literature implicating positive schizotypy in creativity may indirectly reflect an association between unusual schizotypal imagery, as well as unusual ideation.

Administration of the measures selected for this study (outlined below) will allow the relationships between mental image ability and creative performance to be investigated, as well as the enabling the scrutiny of the imaginal characteristics of schizotypal thought. The association of schizotypal traits to both imagery control and creativity will be analysed. The thought processes typically associated with positive schizotypy may engender creativity because they allow abstract, unique and overinclusive thought, but the less controlled imaginal processes that are also characteristic for those high unusual experiences could also play a role in this association.

There are problems that emerge when evaluating previous research and this is due to the types of tests commonly used in these studies. As was reviewed in Chapter 2 (section 2.5), both schizotypy and creativity are multidimensional constructs, and this is reflected both in the multifarious ways of describing and measuring each, as well as the differential results often reported. There are a great number of tools which purport to measure schizotypal behaviours, tendencies and personality traits, and almost as many examples of divergent and creative thinking tasks, focusing on both visual and verbal creativity, and creative imagery and mental synthesis tasks (see Chapters 1, section 1.2.2 and Chapter 2, section 2.4.1). Somewhat unsurprisingly perhaps, given the previous discussions, the same can be said for tools measuring imagery ability, some focusing on vividness, some on manipulation or rotation, some self-report, others performance-based (see Chapter 1, section 1.2.3).

5.3 Justification for inclusion of all measures

The tools and tasks which have been selected have been chosen in an attempt to uncover whether a collection of traits, characteristics, and abilities are related to enhanced creative performance. The qualities of mental imagery control that are tapped by the ICRT, namely image manipulation, mental rotation and reinterpretation of mental images, are likely to account for much of the ability to score highly in tasks which employ image generation protocols, and the creative task has been chosen to reflect this as instructions also require participants to create something previously unanticipated in their mental imagery. The idiosyncratic ideation and cognitive connections often made by those high in positive schizotypy, along with the unusual perceptual and imagined experiences also characteristic of these individuals, may mean that more unusual, and potentially therefore more creative responses are given by these participants.

Image Control and Recognition Task

As well as administering the Image Control and Recognition Task (Irving, Barry, LeBoutillier, & Westley, 2011) to further investigate its psychometric properties, the influence of mental imagery control on creative performance is also of interest. Additionally, the question of whether mental imagery is related to any factor of schizotypy may also be investigated by the inclusion of this imagery task, as well as those listed below. Theoretically, positive schizotypal traits such as anomalous perceptions and

hallucinations may be associated with enhanced mental imagery, and cognitive disorganisation may be related to having less control over mental imagery. Any associations found here may be investigated further in relation to creativity.

Vividness of Visual Imagery Questionnaire and Test of Visual Imagery Control

The literature suggests that self-report mental imagery questionnaires and performance-based tools do not relate to one another, however, self-report tools are often associated (Burton, 2003). That the types of tools do not correlate strongly may be due to respective their psychometric properties, and could reflect that fact that the self-report tools may measure different aspects of mental imagery than do the objective measures of mental imagery and spatial ability.

Morrison and Wallace (2001) used Finke and Slayton's (1988) mental synthesis task as an indication of divergent thinking and this index was shown to be significantly related to the VVIQ-2 (an expanded version of the VVIQ) however these scores were unrelated to any measure of creativity (judged creativity of drawings and scores on the Creative Behaviour Inventory, CBI). Spatial abilities, as measured by the Surface Development Task (SDT, Ekstrom, French, Harman, & Dermen, 1976, cited in Morrison and Wallace, 2001) were mildly associated with DT production ($r = .21$). They were also significantly related to production of creative images, again suggesting an importance of image

controllability in creative productivity. These authors also looked at mental image naming ability and found that this was mildly related to VVIQ scores and was related to DT ($r = .46$). The Test of Visual Imagery Control (TVIC, Gordon, 1950) has also been found to correlate with ‘mental disorder’ (Costello, 1956, 1957) and also with creative self-perceptions (Khatena, 1975b), so it would be interesting to study any relationship this tool may have with both schizotypy and creative visualisation. These self-report imagery tools are included to shed further light on the relationships just described, and also to investigate the relationship(s) they each may have with creative performance and schizotypy (as mentioned above).

Creative Visualisation Task

By utilising an adapted version of Finke and Slayton’s Mental Synthesis Task (MST¹³, 1988), alongside the O-LIFE and a performance based measure of mental image control, it will be possible to see whether schizotypal traits, cognitions and behaviours are related to highly creative output. Additionally, it will be possible to investigate findings reported in the literature regarding the ability to control and manipulate mental imagery and the relationship that this has to creativity. The creativity task chosen for Study 4 requires participants to mentally combine shapes and make images and pictures from no specific category, as opposed to being provided with object categories, that is, types of object such as *tool*, or *toy*. Participants must mentally combine standard shapes into ‘interesting

¹³ herein referred to as the Creative Visualisation Task (CVT).

objects and scenes'. This task will assess whether highly creative responses are associated with high positive schizotypy, and whether mental imagery control has any association with the type of schizotypal thought often related to creative performance.

The Geneplore model of creative cognition describes two phases which are crucial in the creative process, the generation phase, where images are combined and 'played with' in imagery, followed by an exploration phase, which is typified by consideration of the mental image after which decisions are made about this creative 'product' (see above, section 5.1.2). The ICRT could be also be conceptualised as utilising combinatory and exploratory imagery, the former throughout the task while listening to the instructions, and the latter when attempting to recognise the mental image before drawing it. Although this combinatory phase is guided by the experimenter, there are still two discrete phases in these imagery tasks: those who successfully complete these imagery tasks have combined mental images and then, presumably, in order to recognise and name it they must explore that mental image in some way. Associations are expected to emerge between imagery control and creativity as a result of these similarities.

Oxford-Liverpool Inventory of Feelings and Experiences

Tools which measure schizotypy aim to either measure the whole schizotypal construct, such as the Oxford-Liverpool Inventory of Feelings and Experiences (O-LIFE, Mason & Claridge, 2005), the Schizotypy Traits Questionnaire (STA, Claridge & Broks, 1984), the

Schizotypal Personality Questionnaire (SPQ; Raine, 1991), or they may focus on specific schizotypal behaviours such as the Wisconsin Schizotypy Scales (Winterstein et al., 2011), which measure *Perceptual Aberration*, *Magical Ideation*, *Physical Anhedonia*, and *Social Anhedonia*. Some researchers treat schizotypy as a single unidimensional construct, rather than looking at individual dimensions of schizotypy, however, taking this approach would not be best suited to studying its relationship to creativity. As has been described in previous sections (Chapter 2, section 2.4), it appears that differential relationships exist between those with varying levels of schizotypal traits and creative performance. Important complexities related to the interconnectedness of these two multidimensional constructs may not have been unraveled had individual schizotypal factors (subscales) not been considered, and a multidimensional view of schizotypy will therefore be taken with the inclusion of the O-LIFE reflecting this.

5.4 Aims and expectations

The construct validity of the ICRT will be explored because the CVT utilises similar stimuli and may therefore require the utilisation of similar cognitive processes. In light of the evidence presented thus far, it is a reasonable assumption to make that it would not be possible to obtain high creativity scores in tasks employing image generation protocols *unless* one also had controlled mental imagery due to the requirements of these tasks to manipulate, recombine and reinterpret images in imagery (Finke, 1990, 1996; Finke & Slayton, 1988; Finke, Pinker, & Farah, 1989), and so the expectation is that scores on the

CVT will correlate with ICRT scores. The TVIC is expected to correlate with the other self-report measure of imagery, the VVIQ. The VVIQ measures imagery vividness, which is theoretically different to imagery 'control'. Again however, though not intending to measure imagery control itself, the VVIQ does require participants to manipulate and amend mental images, so some relation may emerge between these measures due to the spatial imagery processes which are required for each, though any association is not expected to be strong. This is not only due to the fact they aim to 'tap' subtly different constructs, but also because of the reported problems inherent in self-report imagery tools of this type (see Chapter 3, section 3.1.1). According to considerable anecdotal and empirical evidence, the utilisation of controlled mental imagery in creative endeavour is widespread amongst both eminent and non-eminent creative individuals (see Chapter 1, section 1.1.1). For this reason, it is expected that significant relationships will emerge between imagery control scores and those obtained on the creativity task.

Whether schizotypal thought and behaviour, as measured by the O-LIFE (Mason et al., 1995) has any association with mental imagery will be investigated. Some of the traits characteristic of positive schizotypy, such as the attribution of magical ideations, hallucinatory experiences and obscurities relating to everyday items and perceptions, may be related to mental imagery due to their inherent imaginal characteristics. Whether increased scores on cognitive disorganisation are associated with increased imagery

control or creativity scores will be also studied, as will associations between introverted anhedonia and creative output. Impulsive nonconformity may engender unusual output in the creativity task, and whether these products are rated as creative will be studied.

5.4.1 Research Aims

1. To investigate whether scores on the Image Control and Recognition Task are associated with scores on either the Vividness of Visual Imagery Questionnaire or the Test of Visual Imagery Control, and to ascertain the interrelationships between these objective and self-report mental imagery tools.
2. To establish whether there exist relationships between creative visualisation, mental imagery control, self-reported imagery abilities, and indices of schizotypy.
3. To understand whether positive schizotypal traits are associated with enhanced creative performance.
4. To investigate whether it is possible to predict creativity scores from imagery abilities and levels of schizotypy on the four subscales.
5. To study the possibility of both linear and non-linear relationships between creative performance, mental imagery, and schizotypy.

5.4.2 *Hypotheses*

1. Scores between objective and self-report measures of mental imagery will not be associated, while the two self-report tools will be associated with each other.
2. Those who have strong mental imagery control will out-perform those with less enhanced mental imagery control in the creative visualisation task.
3. Positive schizotypy (unusual experiences) is predicted to be associated with higher creativity scores.
4. Negative schizotypy (introvertive anhedonia) will show negative relationships with creative performance.
5. Cognitive disorganisation will be negatively related to mental imagery control with a tentative hypothesis that high cognitive disorganisation may be associated with lower creative visualisation abilities.
6. It will be possible to predict creativity scores from levels of mental imagery ability and positive schizotypal thought (unusual experiences).

5.5 Method

5.5.1 Participants

The participants were 96 undergraduate first year psychology students from a North London university (70 females, 26 males) with an average age of $M = 29.9$ years ($SD = 6.5$). Participants took part in the study in exchange for course credit for their Psychology Research Methods course. They responded to emails and notices posted around the psychology department, the only selection criterion being that English was their first language.

5.5.2 Materials

All tasks in the battery were presented in pen and paper format.

Image Control and Recognition Task

The *Image Control and Recognition Task (ICRT)* is a collection of 16 imagery tasks which together comprise an objective performance-based measure of mental imagery control, with participants manipulating common geometric and alphanumeric shapes according to verbal instructions (see Chapters 3 and 4). When a participant follows the instructions correctly for each of the 16 imagery tasks the shapes join to make a recognisable figure.

An example previously outlined (CHAPTER 3, section 3.4.2) is provided below, this time along with a depiction of the intended image (Figure 5.1).

1. Imagine a tall thin rectangle so it is standing vertically
2. Add a very short vertical line to the bottom of it so it looks like it's sticking out
3. Rotate the entire shape together 180°, i.e. turn it upside down
4. Attach a teardrop to the top of the shape so that it is touching it

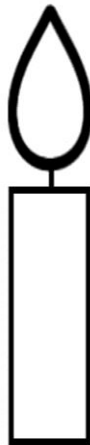


Figure 5.1

The four-stage 'candle' Image Control and Recognition Task

Scoring: Participants were awarded 1 point for correctly drawing the image and 0 for producing an incorrect drawing, high total scores therefore indicating controlled imagery

(*ICRT Total*). An additional index of imagery was provided by summing the number of images the participant was able to recognise and name from their imagery before drawing (*ICRT Recognition*).

Vividness of Visual Imagery Questionnaire

The *Vividness of Visual Imagery Questionnaire*, *VVIQ* (Marks, 1973, (Appendix K), fully described in CHAPTER 2 and CHAPTER 3) is a self-report tool which is said to have good internal consistency and moderate test-retest reliability (White et al., 1977). This tool requires participants to indicate on a 1-5 Likert-type scale how vivid visual images of certain scenarios generated from memory are, with 1 being *perfectly clear and vivid as normal vision*, and 5 being *no image at all, you only “know” that you are thinking of an object*. The 16-item tool contains items which require the visualisation of people and scenes and a mean of these ratings is calculated. The questionnaire is divided into four sections for which the participant must imagine and answer questions about a mental image of a relative or friend, followed by a rising sun, then a regularly-visited shop and finally a country scene. Example items from the *VVIQ* are as follows (with the subsection in brackets):

The exact contour of their face, head, shoulders and body (relative or friend)

The sky clears and surrounds the sun with blueness (rising sun)

A window display including colours, shapes and details of individual items for sale (familiar shop)

The contours of the landscape (country scene)

Participants completed the VVIQ twice, once with their eyes open and again with their eyes closed, and the ordering of this was randomised in presentation.

Scoring: Mean scores for each version of administration (eyes-open and eyes-closed) were calculated for each participant (*VVIQ-O* and *VVIQ-C*).

Test of Visual Imagery Control

An adapted version of the *Test of Visual Imagery Control*, (*TVIC*, Gordon, 1950, Appendix O) was administered to participants. The 13-item tool asks participants to rate how easy it is to control mental images involving a car. In the original version of the tool ‘yes’ or ‘no’ responses indicated whether participants found it possible to manipulate the images. However, in the present study a 5 point Likert-type scale was provided, with 1 indicating *no control* and 5 indicating *complete control*. The first three questions are as follows:

1. Visualise a car standing in the road in front of a house 1.....2.....3.....4.....5
2. Visualise it in colour 1.....2.....3.....4.....5

3. Visualise it in a different colour

1.....2.....3.....4.....5

The questions go on to describe changing environments and scenarios in which to imagine the car and to rate the ease of control of the image.

Scoring: A mean of the ratings provides the score for this tool, a high scoring indicating high self-reported imagery control (*TVIC Mean*).

Creative Visualisation Task

The *Creative Visualisation Task, CVT* (Finke & Slayton, 1988) requires participants to combine and manipulate geometric and alphanumeric figures into ‘images, objects or scenes’. The CVT is a measure of visual mental synthesis originally designed to investigate whether it was possible to make ‘creative discoveries’ in mental imagery, and a modified version was employed in the present study. Participants were given 10 sets of three stimulus shapes instead of generating multiple responses using the same three shapes. This was so that participants were presented with a larger assortment of stimuli and meant that if they were unsuccessful with one set of shapes they still had other chances to make something with subsequent new sets. Participants were shown 15 geometric and alphanumeric forms (see Figure 5.2) and were instructed to familiarise themselves with these basic shapes and the names which described them.

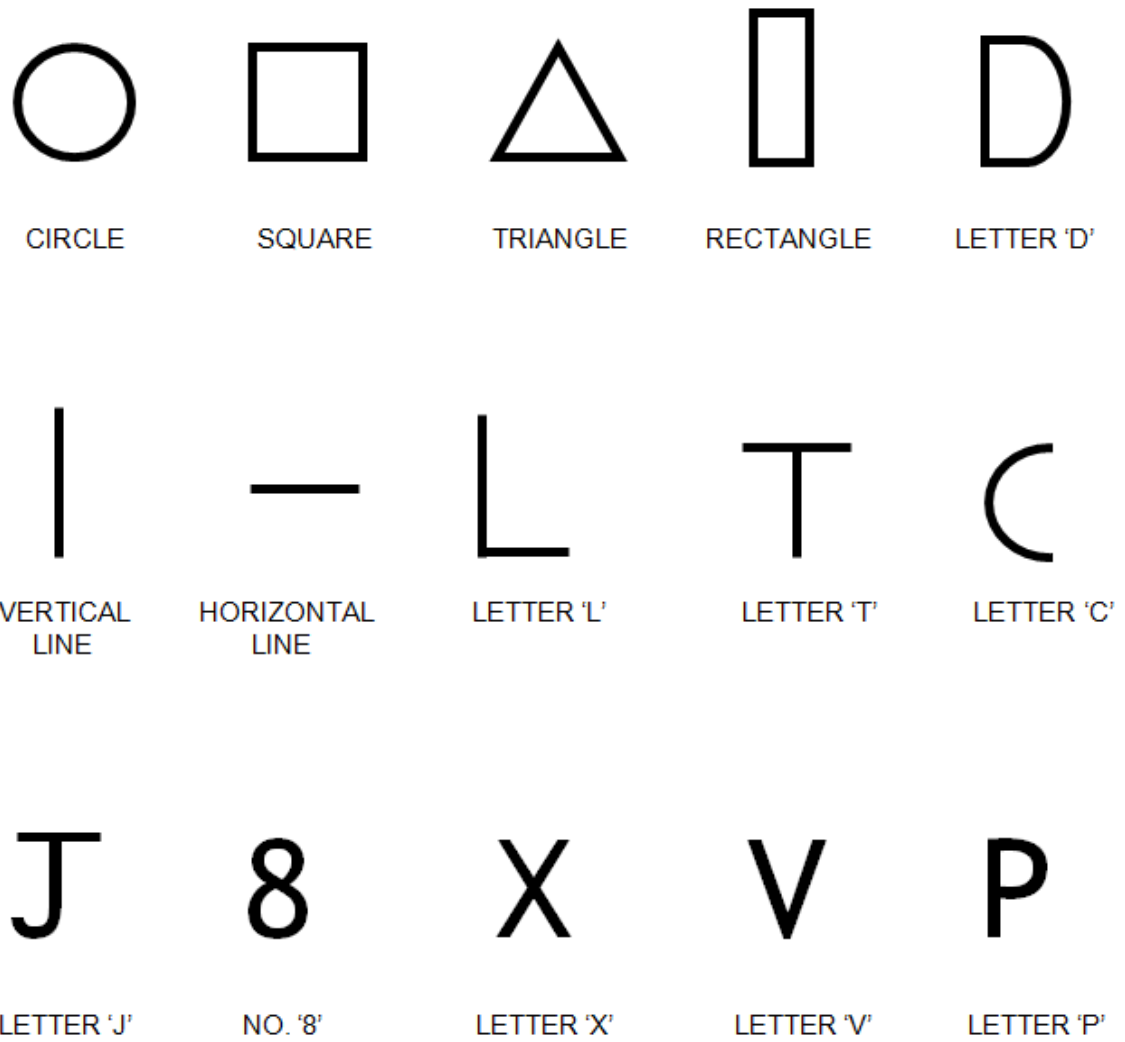
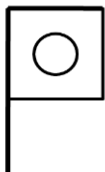


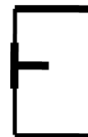
Figure 5.2

Parts used for the creative visualisation task. From Finke and Slayton (1988).

Figure 5.2 shows the shapes used in the CVT from which three were selected at random for each trial. A restriction set by Finke and Slayton was observed, which was that the first 10 items which consist of simple geometric shapes, horizontal and vertical lines, and some capital letters (top two lines of Figure 5.2 were three times as likely to be selected as the last 5 forms). The reason was the same as that provided by Finke and Slayton and is that the bottom line of Figure 5.2 includes more complex forms and the prevalence of more simple forms was desirable. Two examples of recognisable patterns were provided so that the participants had an idea of what the task entailed and are as follows. Example set 1 consisted of a capital letter 'L', a circle, and a square and was accompanied by the image in 5.3 (a). Set 2 included a horizontal line, a capital letter 'L', and a capital letter 'T' and the image is below in 5.3 (b).



(a) 'Flag'



(b) 'Letter E'

Figure 5.3

Examples provided with the CVT practice trials

The individual forms comprising each example image were pointed out as well as being highlighted in the image itself. These examples illustrated the ways the shapes could be

manipulated though were not particularly imaginative so as not to provide participants with ideas for their own creative generations. Once the participant was informed of the three forms for that trial they were asked to close their eyes and combine them in their imagination to create an interesting object or scene. All three of the shapes had to be used and it was not permissible to change or alter their basic form though they could be rotated and altered in size. They were given 2 minutes for each task. On the occasion that the same shape was chosen more than once, participants were instructed to use that shape the designated number of times. Should they come up with more than one image for each set of three forms then they were instructed to choose and report the one they felt was the best. This reflects recent findings which showed that when asked to choose what they considered to be their 'Top 2' responses on divergent thinking tasks, objective ratings of these responses often correlated with these subjective ratings (Silvia et al., 2008). Although participants were not asked to deliberately consider this, in cases where more than one image was created this convention was implied. Participants were not told to be creative when completing this task. Before drawing each mental image, participants were required to record a title for it in the response booklet. This provided certainty that participants were combining and creating images using mental imagery and not discovering creative images from their drawings. If they were unable to think of anything they were instructed to leave the space designated to that particular trial on the response sheet blank. This was repeated for 10 sets of three stimulus shapes.

Scoring: In a modification to Finke and Slayton's scoring procedure, scoring for the CVT was done by two judges. This is because the close proximity and discussion during the experimental sessions meant that impartiality when scoring would not be possible as all sessions were conducted by the researcher and not a naive experimenter. Each image was first rated for *acceptability*, serving as a filter; if the shapes were not suitably represented in the picture, had been changed, or were repeated or absent then participants received a score of zero and no further scoring was conducted on that image. Inter-rater reliability between the judges for acceptability was high, $r = .83, p < .001$. The acceptable images were then scored according to two further criteria. Firstly *correspondence*, where images were rated from 1 (*impossible to identify*) to 5 (*easy to identify*), gave an indication of how well the drawing related to the title which had been provided by the participant before they drew it (inter-rater reliability, $r = .72, p < .001$). Responses which received correspondence ratings of 4 or 5 were then further scored on a scale of 1 (*not very creative*) to 5 (*highly creative*), providing a *creativity* score (inter-rater reliability, $r = .78, p < .001$). These ratings were summed resulting in a potential range for *creativity* indices of 0 - 50 (10 trials). As far as can be ascertained (as no descriptive statistics were reported in their study) this is an additional modification to Finke and Slayton's scoring convention and meant that each participant received creative imagery scores on a continuous scale, rather than nominal ratings of 'creative pattern', 'non-creative pattern', 'wrong parts', and 'no pattern'. Scores could then be taken as an overall measure of these participants' creative visualisation (*CVT Creativity*). Judges were not provided with definitions of creativity but used their own understanding of what

was and was not a creative response when judging the drawings produced in the task (Morrison & Wallace, 2001). Finke and Slayton hadn't specified how to judge the patterns for creativity, and when Anderson and Helstrup (1993) used the same task they also asked their judges to rate the patterns generated by participants as 'creative' or 'non-creative', again, providing no definition or predetermined criteria for classifying an image as such.

Oxford-Liverpool Inventory of Feelings and Experiences

The short version of the *Oxford-Liverpool Inventory of Feelings and Experiences*, *O-LIFE* (Mason, Linney, & Claridge, 2005) was the measure of schizotypy for the present study. This is a 43-item questionnaire which measures four schizotypal subscales and has been designed for use with non-clinical populations. The four dimensions which are measured by this tool are *unusual experiences* ([UnEx] positive-schizotypy), *cognitive disorganization* ([CogDis] disorganized-schizotypy/social anxiety), *impulsive nonconformity* ([ImpNon] asocial-schizotypy) and *introvertive anhedonia* ([IntAn] negative-schizotypy), all of which have been defined previously in the thesis (Chapter 2, and in section 5.1.1 of this chapter). The tool has been found to be a reliable and valid measure for assessing levels of schizotypy (Nelson, Seal, Pantelis, & Phillips, 2013). The symptoms measured by the tool are synonymous with schizophrenia, positive aspects including pseudo-hallucinations, delusions, disorganised symptoms, thought disorder and bizarre behaviour, with the negative symptoms including alogia (poverty of speech),

apathy and amotivation. Schizotypy is dimensional and its prevalence ranges worldwide from 0.8% - 31.4% for those experiencing at least one psychotic symptom, and those reporting one symptom were associated with poorer health status. A linear decrement in health was found to depend on the number of schizotypal symptoms reported (World Health Organisation [WHO] Survey, $n = 256,445$, Neuvo, et al., 2012, cited in Nelson, et al., 2013). The O-LIFE is a multiscale tool and negative components (introvertive anhedonia) tend not to be related to any of the more positive aspects (unusual experiences, cognitive disorganisation and impulsive nonconformity). Example items from each subscale follow:

Unusual experiences

When in the dark do you often see shapes and forms even though there is nothing there?

Are your thoughts sometimes so strong that you can almost hear them?

Have you ever thought that you had special, almost magical powers?

Cognitive disorganisation

Do you find it difficult to keep interested in the same thing for a long time?

Do you often have difficulties in controlling your thoughts?

Are you easily distracted from work by daydreams?

Introvertive anhedonia

Are there very few things that you have ever enjoyed doing?

Do you feel very close to your friends?

Are you much too independent to get involved with other people?

Impulsive nonconformity

Do you consider yourself to be pretty much an average sort of person?

Do you at times have an urge to do something harmful or shocking?

Do you often feel like doing the opposite of what other people suggest even though you know they are right?

Scoring: Each item was scored 1 for 'yes' and 2 for 'no', with 8 items being reversed-scored (5 on the introvertive anhedonia subscale and 3 on the impulsive nonconformity subscale). A score for each subscale was generated (*UnEx Total*, *CogDis Total*, *IntAn Total* and *ImpNon Total*), higher scores indicating a greater number of schizotypal experiences.

5.5.3 Procedure

Participants completed all measures in individual sessions lasting no longer than 1.5 hours. They read an introduction sheet and gave their informed consent (Appendices O and P). The atmosphere in these sessions was kept non-test like and the participants were encouraged to have fun and to try and enjoy the activities. The battery of tests was administered in testing cubicles which were private and allowed for maximum concentration. The creativity (CVT) and imagery control task (ICRT) were administered first due to their more cognitively demanding characteristics and to minimise fatigue. Participants always completed the CVT before the ICRT. This was because it would be possible to use images from successful completion of ICRT items as ideas for their image generations in the CVT as both tasks utilise largely the same set of shapes and letters. The ICRT was completed at a table sitting at a comfortable distance to ensure no sketching took place during the task and to ensure the answer booklet was completed correctly. The O-LIFE, VVIQ and TVIC were presented in pen and paper format questionnaires and were completed at a table away from the examiner to reduce any feelings of discomfort or inhibition resulting from being observed. Presentation of all these measures was randomised. Participants were verbally debriefed after completing the tasks and were given the opportunity to ask any questions. A debrief sheet (Appendix R) was also provided which outlined the full nature of the study and provided contact details for further communications if required.

Data reduction

The initial screening process corrected the dataset for errors and missing data. The VVIQ ratings were reversed so that 1 = *not vivid at all* and 5 = *highly vivid* in order to anchor it in-line with other measures which awarded high scores for ‘better’ imagery. With existing response options ranging from 1 = *Perfectly clear and as vivid as normal vision* to 5 = *No image at all, you only “know” that you’re thinking of an object*, those who received high overall scores on the VVIQ were those who reported having poor mental imagery vividness, which seemed counterintuitive and this reversal ensured ease of interpretation. The mean ratings for each version (VVIQ-O and VVIQ-C) were strongly positively correlated with $r(94) = .58, p < .001$, and a mean of these two scores was therefore taken as an overall measure of self-reported imagery vividness (*VVIQ Mean*).

Visual binning: Where median and quartile splits have been calculated, the visual binning function (in SPSS version 21[©]) was utilised. This command makes cut points in the data according to how you wish your variable to be computed and displayed, and is a common technique when creating ‘high’ and ‘low’ groups for comparison (Meyers, Gamst, & Guarino, 2013).

5.6 Results

None of the variables were skewed or kurtotic. This was demonstrated by no standard error of skew or kurtosis being anywhere close to 2 (Tabachnick & Fidell, 1989) (SE of skew = .249 for all variables; SE of kurtosis = .493 for all variables).

Reliability analyses on the O-LIFE subscales

Four reliability analyses were conducted on the items relating to each of the schizotypy subscales and these are reported below.

UNUSUAL EXPERIENCES

The 12 items measuring unusual experiences (UnEx) had an initial Cronbach's $\alpha = .68$. Not all UnEx items correlated with the total scale (lower $r = .12$, higher $r = .47$) and the removal of 1 item ('When in the dark do you often see shapes and forms even though there is nothing there?') marginally increased Cronbach's $\alpha = .69$ and so all items were retained in the subsequent analyses.

COGNITIVE DISORGANISATION

The cognitive disorganisation (CogDis) scale is comprised of 11 items and initially Cronbach's $\alpha = .68$. Some items correlated poorly with the total score (lower $r = .03$, higher $r = .45$) and removal of 1 item ('Do you dread going into a room by yourself

where other people have already gathered and are talking?') increased the value of Cronbach's alpha to $\alpha = .70$ and so this item was removed from subsequent analyses.

INTROVERTIVE ANHEDONIA

Ten items measure the introvertive anhedonia (IntAn) factor. Initially Cronbach's $\alpha = .60$ and so an item-by-item analysis was conducted to determine whether alpha could be improved. This analysis found that the removal of 3 items ('Do you love having your back massaged?', 'Is trying new foods something you have always enjoyed?' and 'Do you find the bright lights of a city exciting to look at?') improved the reliability of this scale ($\alpha = .67$).

IMPULSIVE NONCONFORMITY

Impulsive nonconformity (ImpNon) is measured by 10 items. Initially Cronbach's $\alpha = .63$ and an item-by-item analysis was conducted on this scale to determine reliability. The removal of 2 items ('Would you like other people to be afraid of you?' and 'Do you consider yourself to be pretty much an average sort of person?') improved the reliability of this scale so that Cronbach's $\alpha = .68$.

Following these scale analyses new total schizotypy subscale scores were computed using the items retained. The four new schizotypy variables were transformed to z scores

and screened for outliers. No cases were removed as there were found to be no standardised scores in excess of ± 3.00 (Tabachnick & Fidell, 1989).

Descriptive statistics and tests for linear relationships

The *ICRT Total* ($M = 9.46$, $SD = 3.57$) and *ICRT Recognition* ($M = 1.72$, $SD = 1.80$) scores were associated as was demonstrated by a positive, medium correlation of $r(94) = .45$, $p < .001$). The *ICRT Total* index was found to have equivalent but stronger relationships with the self-report imagery tools and the creativity measure when compared to *ICRT Recognition* (see Tables 5.1 and 5.2), so this latter index of mental imagery was removed from subsequent analyses in the spirit of reducing the number of variables and increasing power.

Table 5.1

Correlations between imagery and creativity tasks

Variables	ICRT	
	Recognition	
	<i>r</i>	<i>p</i>
TVIC Mean	.07	.516
VVIQ Mean	.07	.495
CVT Creativity	.34	< .001

Note: ICRT = Image Control and Recognition Task; TVIC = Test of Visual Imagery Control; CVT = Creative Visualisation Task. * *r* is significant at .001.

Descriptive statistics are presented in Table 5.2 along with correlations to test for linear relationships between the variables.

Table 5.2

Descriptive statistics and correlations between creativity, imagery and schizotypy variables

Variable	Min.	Max.	Mean	Std. Deviation	Correlations (<i>r</i>)							
					1	2	3	4	5	6	7	
1. ICRT Total	1.00	16.00	9.46	3.57	-							
2. TVIC Mean	1.00	5.00	3.62	0.82	.08	-						
3. VVIQ Mean	2.00	5.00	3.50	0.69	.09	.38**	-					
4. CVT Creativity	0.00	31.50	16.68	6.69	.50**	.20	.22*	-				
5. Unusual Experiences	0.00	9.00	3.92	2.18	-.02	-.17	.07	.12	-			
6. Introvertive Anhedonia	0.00	7.00	1.34	1.59	-.04	.11	-.21*	-.10	.01	-		
7. Cognitive Disorganisation	0.00	11.00	5.76	2.60	-.10	-.13	-.06	-.22*	.14	.19	-	
8. Impulsive Nonconformity	0.00	0.00	3.54	2.20	.01	-.08	.08	-.02	.31**	.19	.42**	-

Note. $N = 96$. ICRT = Image Control and Recognition Task. TVIC = Test of Visual Imagery Control. VVIQ = Vividness of Visual Imagery Questionnaire. CVT = Creative Visualisation Task. * $p < .05$. ** $p < .01$.

The performance-based measure of mental imagery control, ICRT Total, was significantly strongly positively correlated with CVT creativity. No relationship was found between ICRT Total scores and either of the self-report mental imagery tools. The VVIQ and TVIC scores, however, did positively correlate moderately but significantly with each other. TVIC scores were significantly moderately positively correlated with VVIQ scores, and VVIQ scores were weakly but significantly positively correlated with CVT creativity and negatively with introvertive anhedonia. The unusual experiences subscale was unrelated to any creativity or mental imagery index in this correlational analysis and was positively related to impulsive nonconformity. Cognitive disorganisation scores were significantly negatively related to CVT creativity and positively related to impulsive nonconformity. Dovetailing with previous literature, introvertive anhedonia was not found to be related to any of the other schizotypy subscales (Nelson et al., 2013). With the effect of age partialled-out¹⁴, the only significant correlation between any variable and the CVT scores was ICRT Total ($r = .52, p < .001$), with both the negative correlation between CVT and cognitive disorganisation and the positive association between vividness of imagery and CVT scores failing to be observed. This may reflect the self-report nature of the tools involved in these analyses, as well as the nature of the participants recruited for this study and this outcome will be addressed in the discussion.

¹⁴ Further results for other partial correlations which changed only marginally are reported at Appendix S.

Following this analysis, a multiple linear regression model was tested in order to investigate the predictive power of the imagery and schizotypy variables, and to further investigate the possibility of linear relationships between these constructs and creativity.

Predicting creativity on the basis of imagery control aptitudes and schizotypy

MULTIPLE LINEAR REGRESSION

A multiple linear regression analysis was conducted to determine whether any of the imagery or schizotypy subscale variables predicted creativity scores. The predictors were the three imagery indices and the four measures of schizotypy, while the criterion variable was the index of creativity (CVT). Prior to analysis, the data were screened in order to assess violation of assumptions.

Normality

Examination of the histogram of standardised residuals showed that the assumption of independent errors was met as this was normally distributed. The residuals plot also indicated there was consistent clustering and little deviation from normality.

Linearity

The correlations between the predictor variables and the dependent variable, *CVT Total*, were all small to moderate in this analysis, ranging from $r = -.22$ (*CogDis* and *CVT Total*) to $r = .50$ (*ICRT* and *CVT Total*). This indicated that the subsequent multiple linear regression analysis could be reliably employed as the data were suitably correlated with the dependent variable. Scatterplots examining homoscedasticity indicated that there was reasonable consistency of spread through the distributions.

Outliers

Inspection of Mahalanobis' distances indicated that there were no outliers (critical χ^2 value for 7 predictors = 24.32; highest value in sample was $\chi^2 = 17.26$; Tabachnick & Fidell, 1989). Analysis of standard residuals showed that there were no outliers greater than ± 3.29 in the data (Std. Residual Min = -2.72, Std. Residual Max -2.44).

Multicollinearity

As was shown in Table 5.2, none of the predictor variables were significantly inter-correlated more than .7, so multicollinearity was therefore not likely to be problematic. Examination of Cook's distances (TOL) and variation inflation factors (VIF) indicated that influential data points were not a concern (*UnEx*, TOL = .86, VIF = 1.16; *CogDis*, TOL = .79, VIF = 1.26; *IntAn*, TOL = .84, VIF = 1.19; *ImpNon*, TOL = .73, VIF = 1.38;

ICRT, TOL = .98, VIF = 1.02; *VVIQ*, TOL = .75, VIF = 1.34; *TVIC*, TOL = .75, VIF = 1.32).

The order of entry of the predictor variables was decided following the literature which suggests that both mental imagery and schizotypy are related to creative performance. Direct method of entry with backward deletion was used, with the imagery variables being entered as predictors alongside the schizotypy subscale variables. The initial regression model explained 28% of the variance in CVT scores, $F(7, 84) = 6.076$, $\Delta R^2_{\text{adj}} = .281$, $p < .001$ and so this was repeated in order to improve the model. The results of the final multiple linear regression are presented in Table 5.3, with the variables that were removed from the model presented in Table 5.4 in order of removal.

Table 5.3

Multiple linear regression of imagery and schizotypy variables on Creative Visualisation Task scores

Variables	CVT (DV)	ICRT Total	UnEx	CogDis	<i>B</i> (unique)	<i>SE</i>	β	sr^{2a}	<i>t</i>	<i>p</i>
Constant					4.88	3.36			1.45	.15
ICRT Total	.50				.82	.15	.47	.22	5.39	.001*
UnEx	.12	-.02			.49	.25	.18	.03	1.99	.05**
CogDis	-.22	-.10	.14		-.42	.21	-.18	-.03	-2.02	.05 [†]
TVIC	.20	.08	-.17	-.13	.06	.15	.16	.03		

Note. * $p < .001$; ** $p = .047$ (UnEx); [†] $p = .049$ (CogDis); CVT = Creative Visualisation Task; UnEx = Unusual Experiences; CogDis = Cognitive Disorganisation; ICRT = Image Transformation and Recognition Task; ^a sr^2 = the squared semipartial correlations indicate the unique variance explained by the predictor.

Table 5.4

Predictor variables removed from multiple linear regression on CVT

Variable removed (in order of removal)	β	t	p
VVIQ	.10	.95	.34
ImpNon	.02	.17	.86
IntAn	-.07	-.76	.45

Note. VVIQ = Vividness of Visual Imagery Questionnaire; ImpNon = Impulsive Nonconformity; IntAn = Introvertive Anhedonia.

The final regression revealed an R of .57, $R^2 = .32$, and adjusted R^2 of .29 ($F(4, 91) = 10.941$, $\Delta R^2_{\text{adj}} = .295$, $p < .001$), showing three significant predictors of CVT scores; *ICRT Total*, *UnEx* and *CogDis*. The variables uniquely predicted 25% of the variance (.25, sum of the squared semipartial correlation coefficients) and shared 7% explained variance (computed by subtracting the uniquely explained variance from the R^2 value: $.32 - .25 = .07$). The strongest predictor was *ICRT total*, followed by *CogDis*, and for *UnEx*, which were both marginally significant.

Tests for non-linear relationships

Screening of scatterplots indicated the possibility of a curvilinear relationship between CVT and unusual experiences scores (Figure 5.4).

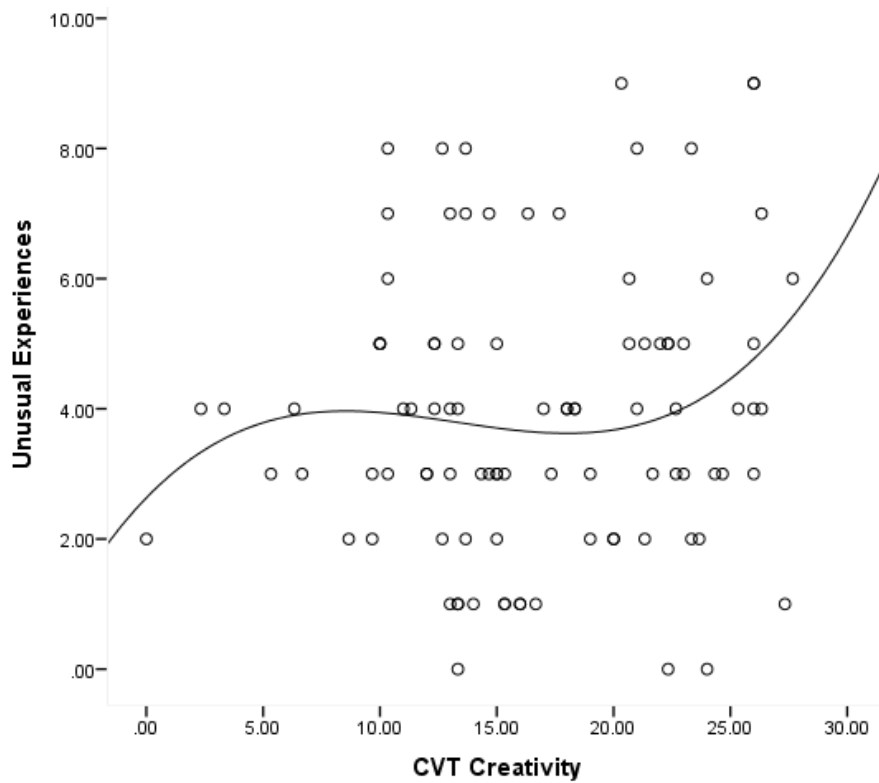


Figure 5.4

Scatterplot indicating the relationship between creativity (CVT) and unusual experiences (UnEx) scores

In order to investigate non-linear relationships between the variables quartile splits were computed on the independent variables, and the 'low' and 'high' groups were compared on their performance on the CVT. Descriptive statistics for these data and t tests between the groups are presented in Table 5.5 below.

Table

Table 5.5

Descriptive statistics and t tests between high and low groups on Creative Visualisation Task (CVT) creativity

Independent variable	Group (<i>n</i>)	CVT Mean	Std. Deviation	<i>t</i>	<i>p</i>	<i>d</i>	Mdiff	95% CIs (Mdiff)
ICRT Total	High (20)	19.68	4.89	5.21	.001*	1.62	-7.70	[-10.69, -4.71]
	Low (21)	11.98	4.57					
TVIC Mean	High (24)	17.90	5.19	1.42	.16	.41	-2.48	[-5.97, 1.02]
	Low (25)	15.43	6.83					
VVIQ Mean	High (23)	18.54	5.79	1.24	.22	.37	-2.26	[-5.92, 1.40]
	Low (23)	16.27	6.52					
Unusual Experiences	High (19)	18.31	6.04	1.31	.20	.35	-2.11	[-5.35, 1.12]
	Low (45)	16.20	5.87					
Introvertive Anhedonia	High (18)	14.52	5.51	1.17	.25	.51	3.03	[-2.23, 8.28]
	Low (32)	17.55	6.34					
Cognitive Disorganisation	High (14)	13.88	5.35	2.54	.01**	.84	4.78	[.98, 8.59]
	Low (31)	18.67	6.05					
Impulsive Nonconformity	High (17)	17.18	5.49	.61	.55	.18	1.04	[-2.40, 4.48]
	Low (34)	18.21	5.90					

Note: * $t < .001$; ** $t < .05$; Bold figures indicate higher means; ICRT = Image Control and Recognition Task; TVIC = Test of Visual Imagery Control; VVIQ = Vividness of Visual Imagery Questionnaire; Mdiff = mean difference. Levene's statistics for equality of variances were non-significant for all *t* tests.

Significant differences were found between low and high ICRT imagery groups on the CVT, while no such a relationship emerged for the self-report imagery tasks. Those high in cognitive disorganisation had significantly lower creativity scores than their lower scoring counterparts. Examples of CVT responses from high and low image controllers are presented in Figure 5.5. The significant relationship between the VVIQ and the CVT was not reflected in this analysis.



(a) 'Face'

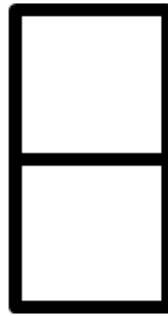


'Snowman'

Stimuli: Triangle, line and number eight



(b) 'House'



'Two boxes'

Stimuli: Rectangle, triangle and line

Stimuli: Two squares and a line

Figure 5.5

Examples of CVT images created by high (a) and low (b) scorers on the ICRT

The ‘high’ and ‘low’ ICRT groups were also compared on TVIC and VVIQ scores using independent groups *t* tests in order to investigate non-linear relationships between objective and self-report mental imagery. No significant differences were found between the groups, ($t(39) = .565$, $p = .575$, and $t(39) = .166$, $p = .869$, respectively). This confirmed that there was neither a linear nor a non-linear relationship between the self-reported and the performance-based measures of visual mental imagery, though this does not discount the possibility of other non-linear relationships which were not tested for.

5.7 Discussion

5.7.1 Discussion of hypotheses

The prediction that Image Control and Recognition Task (ICRT) would not be found to be associated with scores on the Vividness of Visual Imagery Questionnaire (VVIQ) or the Test of Visual Imagery Control (TVIC) was met, with no relationships being revealed between either of the self-report measures and the objective mental imagery control tool. This finding dovetails with the literature which suggests that these two types of mental imagery assessment do not measure equivalent mental imagery abilities, that is, scores obtained using these self-report and objective tools are often found to be unrelated (Burton, 2003). The observed relationship between scores on the ICRT and the CVT is also likely to reflect that the stimuli were similar for both tools. That the ICRT predicted CVT scores was expected, however, the similar stimuli means that cautious interpretation

of this result is necessary as it may not generalise to performance on other types of creative task.

Imagery vividness (VVIQ) failed to predict CVT scores in the regression but was, positively correlated to CVT scores. The other self-report imagery tool, the TVIC, showed no relationship with creativity in the analyses. A body of literature exists implicating the use and importance of mental imagery capabilities in creative performance (the focus of Chapter 1), and this finding is therefore partly in line with this notion. It is noted, however, that the ICRT scores had a stronger relationship with creative performance than both of these self-report tools and that this was the only imagery variable to predict scores on the CVT. The current findings therefore concur with previous research showing significant but moderate relationships between self-reported mental imagery and performance-based creativity (LeBoutillier & Marks, 2003).

Cognitive disorganisation scores shared predictive power with the ICRT and unusual experience variables in the regression, however, cognitive disorganisation was the only schizotypy variable to correlate with creativity scores and this was a negative relationship. Additionally, the relationship between VVIQ scores and CVT was not revealed in the regression, including unusual experiences as a predictor, which indicated the possibility of a suppressor variable. Vividness may have been acting as a suppressor variable in that it may be that vividness scores were associated with an element of

unusual experiences which was not related to the criterion variable in this study. There may be two parts to a predictor, one which is related to the criterion variable, and an element which is unrelated. The relationship between unusual experiences and creativity in the regression may reflect an association between a component of positive schizotypy which is unrelated to vividness, possibly the unusual and magical ideation typical of this trait, a relationship which was 'suppressed' in the correlation analyses. Where the possibility of a suppressor exists it may be that unusual experiences is shown to have no association with the criterion (creativity) or the suppressor variable (vividness) on its own but has predictive power in a regression, as was revealed here. However, further investigation showed suppression to be unlikely as the relationship between CVT and VVIQ scores did not change when unusual experiences were controlled for, nor did the relationship between CVT and unusual experiences change when VIVQ scores were held constant. No relationship was found between positive schizotypy (unusual experiences) and scores on the CVT in the correlational analysis, however, these scores significantly predicted CVT creativity in the regression. That positive schizotypy was able to predict just a small amount of variance in creativity scores was in-line with associations reported in the literature which suggest a relationship but a only small effect size (Acar & Sen, 2013, see Chapter 2, section 2.4, and above in section 5.1.1). The levels of positive schizotypy reported by participants in the sample may provide some clues to the reasons behind this finding, that is, the lack of 'extreme' scores on this trait may partly account for the failure to explain more of the variance in creativity. Scores on this trait were moderate in this sample, with a low mean and a maximum score of 9 out of a possible 12.

This may suggest that the traits which reportedly relate to enhanced creativity, and which are common for those who are referred to in the literature as ‘high’ in unusual experiences, may have not been pronounced enough for relationships to be revealed in this sample of psychology students. The associations between perceptual anomalies, magical ideation, overinclusive and idiosyncratic thought processes and creativity which are reported in the literature usually pertain to those who score especially high on positive schizotypal measures. The results mirror the literature in that negative schizotypy (introverted anhedonia) did not show any relationship with creative performance (Nelson et al., 2013). As expected, cognitive disorganisation shared a negative association with CVT scores and shared some of the predictive power in the regression. The finding is in line with a body of work which suggests that disorganised schizotypy may be negatively related to creative performance (Batey & Furnham, 2008).

PARTIAL CORRELATIONS

Partial correlations holding age constant revealed that the relationship between CVT and cognitive disorganisation scores decreased and became non-significant ($pr = -.09$, $p = .414$, this is a decrease from the significant association of $r = -.22$). This suggested that age may have had partially accounted for the relationship between creativity scores and cognitive disorganisation. A similar result was found for the relationship of vividness

scores to CVT ($pr = .19$, $p = .073$, a decrease from $r = .22$), however, the change in coefficient was marginal (.03).

LINEAR AND NON-LINEAR RELATIONSHIPS

The correlational analysis revealed that ICRT, VVIQ, cognitive disorganisation scores were significantly related to scores on the CVT, while the multiple regression suggested that it was ICRT, unusual experiences and cognitive disorganisation which predicted creativity scores, though the latter two variables were only marginally significant predictors. An association between imagery vividness (VVIQ) and creativity was not observed in the regression analysis, with unusual experiences being one of three significant variables to predict CVT scores. The observation that unusual experiences was not directly related to CVT scores but was a significant predictor in the regression may be because vividness was acting as a suppressor variable, as unusual experiences was not related to imagery vividness or CVT scores on its own.

When the sample was split and comparisons made between the top and bottom quartiles of mental imagery controllers (ICRT Total), significant differences emerged on the CVT creativity index, somewhat unsurprising considering the strong correlation found between the two. When the top and bottom 25% on cognitive disorganisation were compared,

significant differences were again revealed on creativity scores, with lower cognitive disorganisation scoring lower on the CVT task. The 'high' ICRT group generated more creative images in the CVT than the low imagers, which was in-line with predictions and reflects the findings of the regression analysis. When 'high' and 'low' cognitive disorganisation groups were compared on the Creative Visualisation Task it was found that the 'low' group was rated as significantly less creative. This dovetails with literature which has found that disorganised schizotypy is associated with reduced creativity (Acar & Sen, 2013).

Upon comparison of the analyses investigating linear and non-linear relationships, it is apparent that an association between schizotypal thought in the form of unusual experiences and creativity emerged during the regression analysis but not when the high and lower scorers on this positive schizotypy dimension were compared in terms of their creative responding. This means that the possibility of a curvilinear relationship between these variables is unlikely, though other non-linear relationships may exist.

The associations between creativity and cognitive disorganisation were uniform in both the regression analysis and the high/low splits, suggesting a linear relationship exists between these variables. In the regression predicting levels of creativity, cognitive disorganisation also shared predictive power with mental imagery control and positive schizotypy. This trait was also negatively associated with ICRT scores, hinting towards a

certain level of concentration and sustained cognitive focus required for success on these imagery tasks.

5.7.2 Discussion of research questions

As stated above, the fact that the ICRT scores were not found to relate to the self-report imagery measures (the VVIQ and the TVIC) is in line with a body of research which indicates that these types of task, though often purported to measure ‘overall mental imagery ability’, actually tap distinct elements of this construct (Chapter 1, section 1.2.3). The findings suggest that the types of mental imagery measured by these self-report imagery tools are different to the aspects of mental imagery that are tapped by imagery control tools which require respondents to utilise mental rotation, image manipulation, and image inspection (Kosslyn, 1994; Farah, 1984; Bichsel & Roskos-Ewoldsen, 1997; Blajenkova, Kozhevnikov & Motes, 2006).

None of the objective or self-report indices of mental imagery were associated with unusual experiences. The possibility that the imagery characteristic of positive schizotypy is related to creative thought remains, that is, uncontrolled imagery, despite the failure to uncover a direct relationship between these variables. The shared cognitive imaginal and perceptual processes suggest that some relation to creativity may still emerge should more delicate tools be used. The CVT may not be an appropriate task to allow this relationship to be found as it is quite constrained. There are other skills as well

as creative ones which are required for high scores on the CVT, such as imagery evocation, maintenance and manipulation. It is not obvious whether the lack of clear relationship reflects the necessity for possession of these skills in the CVT, which may have served as a rate-limiting factor. A lack of imagery control would have meant little chance of demonstrating any creative skill in the CVT, regardless of creative ability. The question therefore arises of whether the ability to play with imagery is what relates to creativity, or whether this is only revealed within certain samples and with certain tools. A collection of creativity tasks that reflects a collection of creative abilities would allow this to be explored further, as would recruiting participants who may have more varied imagery, and indeed creative abilities.

The ability to control mental images (as measured by the ICRT) predicted high scores in the CVT. It seems apparent that mental imagery control, as measured by the objective ICRT at least, is important for creative thought and production, however, this result was not true for the TVIC. This supports both anecdotal and empirical accounts where mental imagery control, in the form of thought experiments and through the manipulation and reconceptualisation of mental images, has lent itself to exceptionally creative and innovative thought (LeBoutillier, 1999; Finke, 1996; LeBoutillier & Marks, 2003; Morrison & Wallace, 2001; Palmiero, Cardì & Belardinelli, 2011).

The finding that the CVT and ICRT were correlated suggests that the ability to rotate and combine the shapes was not only related to producing something in imagery, indeed, most people could do that to some extent, but these imagery controllers created more unusual and original pictures with the shapes, that is, rather than just creating images that were acceptable and not particularly creative. This supports the Geneplore model (Finke, Ward, & Smith, 1992; Smith, Ward, & Finke, 1995) which proposes that many cognitive processes underlie creativity and that one can study a number of discrete mental operations which comprise creative cognition.

5.7.3 General Discussion

When one considers the results of the regression analysis and compares these to those which were conducted using the top and bottom quartiles in the sample, it can be seen that slightly different associations are uncovered between the imagery, schizotypy and creativity variables. When the strong image controllers were compared to less able imagery controllers on the Test of Visual Imagery Control (TVIC) and the Vividness of Visual Imagery Questionnaire (VVIQ), no significant differences were revealed, providing yet more evidence that self-reported mental imagery scores do not correlate with more objective measures of imagery (Burton, 2003). The TVIC purportedly taps imagery control, yet the lack of association with the ICRT, a tool which is designed so that it is difficult to score highly unless in possession of controlled imagery, may suggest

otherwise. Despite the modifications which were made to the TVIC, that is, the addition of a rating scale in an attempt to assess the 'ease of manipulation and control' in mental imagery, the psychometric properties may still be called into question, and supports the findings of LeBoutillier and Marks (2001-2002). The lack of relationship between the VVIQ and the ICRT may result from the fact that the aims of the VVIQ are to measure imagery vividness and not control (McKelvie, 1995), however, self-reported vividness has been found to correlate with other visual tasks such as visual memory (Marks, 1983) and visual perception tasks such as gestalt closure (Wallace, 1990). Additionally, it has been argued that self-report instruments such as the VVIQ do correlate with object imagery however fail to show a relationship to spatial imagery (Heuer et al., 1986; Kozhevnikov et al., 2005; Reisberg, Culver, Heuer, & Fischman, 1986). This could be supported by the current results because the ICRT requires spatial imagery to solve successfully.

The finding that mental imagery control, unusual experiences and cognitive disorganisation shared predictive power of a substantial amount of the variability in creativity scores is interesting considering that no significant relationship was initially found between positive schizotypy and mental imagery (however VVIQ scores were negative related to introvertive anhedonia).

The mental imagery control scores, as measured by the ICRT, most strongly predicted creative performance in the CVT, which was expected and is in line with suggestions that mental imagery abilities are important for visual creativity, but may also be resultant of the nature of the respective tasks.

The fact that unusual experiences also predicted some of the variability scores in the creativity tasks is also in line with expectations outlined at the start of this chapter, and also complements other studies that have revealed similar relationships (Nettle, 2006).

The experiences, characteristics, and cognitive styles of those high in positive schizotypy appear to influence the ability to make creative images, though the relationship was not linear but trended towards a curvilinear one. The *t* tests looking at high and low positive schizotypy groups did not support this trend, however.

This predictive model emerged only after the impulsive nonconformity and introverted anhedonia subscales were removed from the regression, and cognitive disorganisation and unusual experiences were still only marginally significant predictors.

5.7.4 *Limitations and future directions*

There were a number of limitations to the previous study. Had a different measure of creativity been used then more decisive results may have been found. For example, an alternative version of the creative visualisation task described by Finke (1996) involves alternative stimuli and task requirements. The shapes are 3D, and categories of the types of item that should be created may also be provided to participants either prior to the image generation phase, or once the image has been created and drawn. A somewhat surprising finding often reported in studies utilising tools of this nature is that the patterns which are assigned a title or purpose *after* they have been generated in visual imagery and drawn, are often scored as more creative than those which are invented in imagery according to some predefined category (Finke, Pinker, & Farah, 1989; Finke, 1996).

A further limitation related to the creative visualisation task was that participants did not complete the post experimental questions which were posed by Finke and Slayton in their original 1988 study. These related to the strategies employed during the image manipulation phase of the task and options were as follows: (1) *I tried combining the parts by 'trial and error' in my image until I happened to recognise a familiar shape;* (2) *I first thought of a possible shape, and then tried to combine the part in my image to see whether that particular shape could be made out of those parts;* (3) *I didn't form an image at all, but just thought about how the parts might be combined in a more abstract way,* and (4) *I used some other strategy.* These questions would have allowed closer

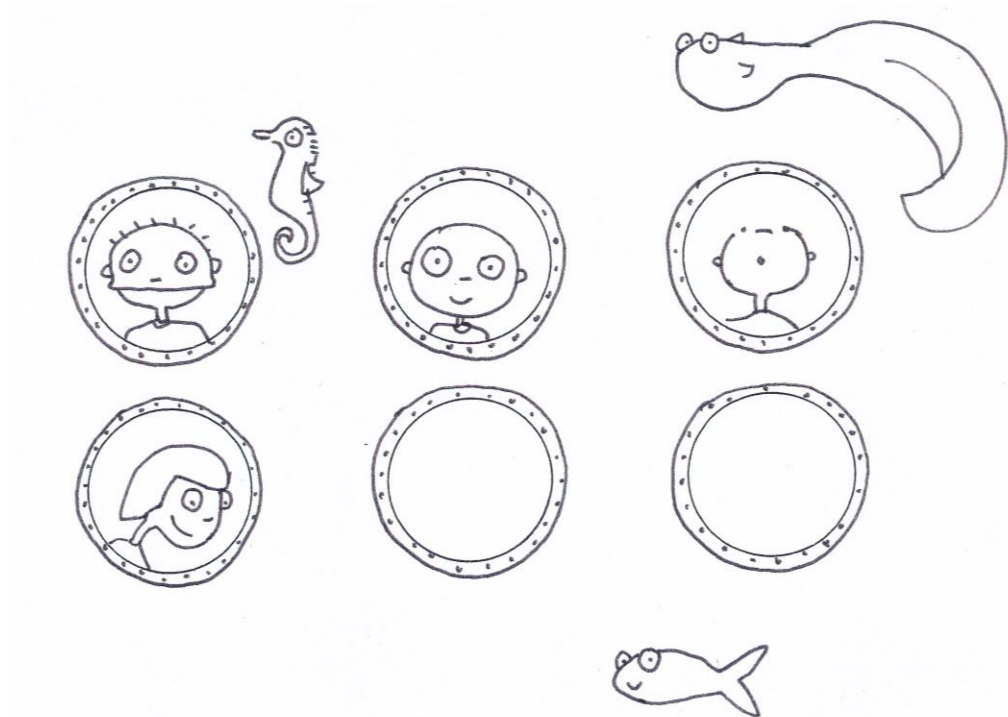
inspection of the creative imagery processes employed during this and related tasks. The next study intends to move away from use of the CVT in favour of more varied creativity tasks, and so this avenue of research will be explored in the next and final study in this thesis.

Only one creativity task was administered to participants, which was possibly too constrained and may also have relied too much on mental rotation and other imagery abilities. A verbal divergent thinking task would have allowed exploration of associations between other kinds of creativity, schizotypy and imagery (Blajenkova, Kozhevnikov, & Motes, 2006; Blajenkova & Kozhevnikov, 2010), and it is possible that differential relationships with imagery and schizotypy variables may exist for verbal creativity compared to visual creativity.

The curvilinear results may be explained in terms of controlled and uncontrolled imagery (*schizotypal imagery*). Positive schizotypy scales may indirectly measure uncontrolled imagery, and negative relationships were indeed revealed between the two measures of imagery control, the ICRT and the TVIC (though these associations were small and non-significant).

The imagery-creativity relationship will be further explored in Study 6 using varied and dissimilar creativity measures as well as an adapted measure of schizotypy which more aims to delicately address the nature of this construct and its relation to creative output.

CHAPTER 6 CREATIVITY, SCHIZOTYPY AND MENTAL IMAGERY IN VISUAL ARTISTS AND NON-ARTISTS



15

6.1 Introduction

Upon reaching the final study and this penultimate chapter in the present investigation into the associations between creative thought, mental imagery and schizotypy, it appears that elements of all three constructs are associated in a somewhat convoluted manner. There appears to be a link between imagined perceptual experiences and enhanced

¹⁵ Image provided by a participant in the Torrance Tests of Creative Thinking in the subsequent study. For illustration.

creative ability, however, the nature of this relationship is unclear (this was the focus of Chapters 1 and 3). Both controlled and uncontrolled visual imagery have been associated with exceptional creativity, the former in the form of deliberate and structured imaginings, the latter being demonstrated by sudden flashes of insight or solutions to problems which often accompany elaborate imagery but which are rarely controlled. The main tenet of the final study is to therefore investigate this possibility through administration of a varied and suitable battery of tasks. The studies reported in Chapters 3, 4 and 5 of this thesis have demonstrated the efficacy of the Image Control and Recognition Task (ICRT) in the objective measurement of a range of mental imagery abilities relevant to creative thought, namely, image evocation, control, transformation, and rotation, so the relation of controlled imagery to creative performance will be determined with this tool. The results of Study 4 (Chapter 5) indicated that there was a large association between objective mental imagery control and creative visualisation ($r = .50$).

While the results reported in the previous study provided further construct validity for the ICRT, it was not clear whether the association with this tool and creativity scores was influenced by the nature of the two tasks used to measure these constructs. As was noted in the discussion in Chapter 5, it is likely that the ICRT and the CVT utilise similar cognitive skills due to the comparable stimuli within each tool. The final study in this

thesis will therefore administer a spectrum of creativity tools in an attempt to tap a wider variety of creative ability.

When considering whether individuals from the same creative domain share similar cognitive abilities and personality traits, a body of literature seems to suggest that there are indeed characteristics that are common within respective creative groups. As has been mentioned throughout the thesis, specifically in Chapters 2 (section 2.3.2) and 5 (section 5.7.4), the relationships between schizotypy and creativity appear to vary depending on which types of tools are used. The possibility that indices of unusual experiences may indirectly represent a facet of imagery which is uncontrolled will be addressed.

Baer (2011) supports a model of creativity which focuses on expertise and one which is domain-specific. He notes that some may have expertise in one, a few or several areas, and believes that creativity is much the same. His argument is that a general test of creativity makes as much sense as “a test of all-round, multipurpose, domain-general expertise” (p. 311). However, after interviewing individuals who excelled in science and the arts, Root-Bernsteins (1999) found that that there were “basic thinking skills that underlie creativity, whatever the domain” (cited in Kim, 2011, p. 314). These are observing, imaging, abstracting, recognising patterns, pattern forming, analogising, body thinking, empathising, dimensional thinking, modeling, playing, transforming and

synthesising (Starko, 2011). It is clear to see how imagery control may be relevant for demonstrating efficacy in these skills and abilities.

There is agreement that divergent thinking is an important part of the creative process (Fisher et al., 2004) though it has been suggested that it cannot be equated with creativity (though, as has been mentioned, many do). It is instead better to conceive of divergent thinking as predicting creative potential (Runco, 1991). von Stumm, Chung and Furnham (2011) failed to find evidence that any schizotypy subscale was related to creativity as indicated by measures of divergent thinking and self-reported creative ideation and behaviour, with the creativity tools themselves being only “loosely interlinked” (p. 113). Armstrong (2012) looked at both creative cognition and schizotypal symptoms in relation to creative achievement in students and found that creative performance scores (as measured by a single task from the TTCT) were positively associated with creative problem solving (as measured by the Remote Associates Test) but not creative problem solving, however, this latter task required participants to “develop an advertising campaign for a new product” (p. 181), a highly dissimilar task to those often used as indicators of creative ability. Fink et al. (2013) take a ‘neuroscience perspective’ of creativity and schizotypy, and suggest that during creative cognition the high schizotypy group in their study were more likely to “gather external and internal information” (p. 385). This is akin to previously described overinclusive modes of thought which may, according to Eysenck (1995) at least, be common in both psychotic-prone and creative individuals. In Abrahams and Windmann’s (2008) investigation no relationship was revealed between high or low schizotypy on creative

imagery (as measured by the CVT). Individuals with high schizotypy (as measured by the SPQ) showed no advantage on the Conceptual Expansion Task (CET, Ward, 1994) either.

Though the aforementioned studies recruited students, the results further emphasise the complex nature of creativity and its manifestations (Mumford, 2003; Silvia et al., 2008) and their results also highlight that the use of a single psychometric test for the measurement of creativity is unlikely to operationalise the true scope of creativity. Study 5 seeks to investigate domain-specific creativity, by inclusion of visual artists, varied creativity performance measures that measure more than one type of creative ability, and a validated measure of creative achievement, in addition to looking at tasks which may elucidate whether there are creative traits that can be said to be domain-general. In order to put this final study into context, research which has recruited creative individuals and has considered levels of schizotypy and relationships with creativity and other relevant aspects is presented in the section below.

6.1.1 Schizotypy, imagery and different creative domains

Research carried out by Burch, Pavelis, Hemsley, and Corr (2006a) revealed that it was possible to use scores on the unusual experiences and impulsive nonconformity scales to distinguish visual artists from the non-artist group in their sample. They also showed that the visual artists scored higher on measures of unusual experiences, impulsive

nonconformity (asocial schizotypy), introvertive anhedonia, neuroticism, openness and divergent thinking (uniqueness) as measured by the Instances and Uses Test, which includes providing alternative uses for household objects (Wallach & Kogan, 1965, cited in Burch et al., 2006a). They reported that the unusual ideas elicited by positive-schizotypal traits meant that participants were able to generate more creative responses, demonstrating both fluency and originality of thought.

The positive and negative dimensions of schizotypy, namely unusual experiences and introvertive anhedonia, are associated with creativity but show opposite relationships (Nettle, 2005). That is, unusual experiences correlate positively with creativity while the dimension of introvertive anhedonia is typically negatively related (Acar & Sen, 2013). Additionally those who are high on scales which measure positive traits but who do not score highly on negatives ones perform well on divergent thinking tasks (Green & Williams, 1999). This is purportedly because individuals who are high on unusual experiences scales have the tendency to make broad associations and therefore to link previously 'un-linked' ideas. This appears to be enhanced in artists, as Nettle (2005) found that, compared to the control group in his study, the artists (and, incidentally, the poets) scored higher on unusual experiences. Additional research has revealed similar relationships. Unusual experiences scores were shown to be positively associated with creativity in writers, and actors (Brod, 1997), though Brod reports less of a clear-cut

relationship between positive schizotypy and creativity specifically related to the arts, as heightened scores were also found for students and professors.

Poets and visual artists were found to have higher unusual experiences and impulsive nonconformity scores when compared to non-poets and non-artists, after controlling for age and gender (Nettle, 2006). In related work, Rawlings and Locarnini (2008) found increased positive schizotypy and introvertive anhedonia in the artists in their sample, which also included mathematicians and scientists.

In their study with Fine Arts students, Perez- Fabello and Campos (2011) found that dissociative experiences, in the form of transient experiences of absorption and enhanced imagination, was associated with creative performance in these students, yet more evidence that phenomenological experiences influence artistic and creative thought. Similarly, in a study which investigated the personalities and characteristics of 157 artists, Booker, Fearn, and Francis (2002) found increased psychoticism and neuroticism in these artists compared to normative data. Botella, Zenasi, and Lubart (2011) conducted a study looking at the similarities and differences between art students and ‘non-art’ students in terms of emotion-related traits such as alexithymia and ‘affect intensity’. Alexithymia is a dimensional personality trait which manifests itself through problems processing the emotions of the self and others, while affect intensity, a “stable personal characteristic” (Larsen & Diener, 1985, 1987, cited in Botella et al., 2011)

refers to the tendency to experience emotions that are extreme when faced with emotional situations. The art students in their study scored higher than the non-arts students in both alexithymia and affect intensity, with the authors of this study concluding that “art students presented a higher level of [emotional] negative intensity than the general population” (p. 5). This provides further evidence for the inclination that visual artists share certain cognitive characteristics and by extrapolation could support claims that these specifics somehow enhance, or at least contribute to, creative endeavour. Investigations into overinclusive thought processes in especially creative individuals have been conducted (Weinstein & Graves, 2002; Eysenck, 1995; Anderson & Powers, 1975) which have suggested that highly creative writers have overinclusive thinking styles. Glazer (2009) states both that “overinclusive thought implies an abnormally high access to a range of thoughts, as envisaged in other description of creativity”, and that “divergent thought and associative models incorporate this basic idea... the creative individual forms novel combinations of otherwise distinct concepts” (p. 761).

An area which has received little attention is whether the associated levels of incommensurability which may be experienced by those high in schizotypal traits influences the relationships between positive schizotypal traits and creativity. It may be that the levels of distress, intrusion and the frequency of aberrant perceptual experiences mean that associations with creative thought and otherwise innocuous unusual ideation are prevented. This may be especially difficult to disentangle as the literature suggests

that positive schizotypy has an association with creativity in some areas, such as visual art and poetry (Nettle, 2005), however it is unclear specifically which elements of positive schizotypal thought underlie this relationship. It may be the idiosyncratic thinking styles exhibited in individuals high in this trait that determine this association, or alternatively, perhaps the uncontrolled and aberrant mental imagery which accompanies unusual experiences influences the finding that creativity and positive schizotypy are linked.

Schizotypy in visual artists

In addition to research from the image generation approach, specifically, the Geneplore model, which demonstrated that mental imagery was a fundamental aspect of visual creativity (Finke, Ward, & Smith, 1992), there exists recently published research which connects visual imagery with creative performance. In their comprehensive study of the visual imagery preferences and qualitative characteristics of visual artists, scientists and humanities professionals, a number of interesting findings were revealed by Blajenkova et al. (2006). Building on previous work (Blajenkova et al., 2006) which suggested that visual artists have a preference for object imagery that is detailed and bright, while scientists more frequently report engaging in spatial imagery that is schematic and abstract, Blajenkova and Kozhevnikov (2010) found that visual-object imagery was uniquely related to expertise in visual art, with visual artists scoring high on all visual-object tasks, as well as finding that abstract thought and information processing was

supported by abilities in visual-object imagery. Engagement in visual art was uniquely related to object but not spatial imagery, which is contrary to some literature which suggests that spatial ability is related to engagement in the visual arts (Eisner, 1985; Gardner, 1999; Perkins, 1994, all cited in Blazhenkova & Kozhevnikov, 2010). They investigated the subjective functional role and the qualitative characteristics of object and spatial imagery using protocol analysis and revealed some intriguing results relevant to the present thesis. They looked at Kosslyn's (1980, 1994; Kosslyn, Ganis, & Thompson, 2001; Kosslyn, Ganis, & Thompson, 2006) four main visual processing components: generation, maintenance, inspection and transformation, whilst noting that this theory of mental imagery does not look at each stage systematically. In Kosslyn et al.'s view, both object and spatial imagery are associated with components of visual processing, for example, object imagery may be associated with imagery maintenance and inspection, whilst spatial imagery is associated with the transformation of images. Visual artists, scientists and humanities/social science professionals were asked specific questions about the different stages of imagery processing and covered a variety of characteristics relating to these processes. In relation to image generation, participants were asked whether they experienced visual-object or visual-spatial, holistic or sequential and controlled or uncontrolled imagery. The responses were coded as object imagers if they described pictorial, vivid, colourful and detailed images and most of the visual artists were coded as such. However some were classified as 'mixed', meaning that they utilised both object and spatial imagery, while a smaller percentage of visual artists described images that were classified as spatial in nature. Holistic imagery was suggested by most visual artists

who reported they experienced their visual images as single units with colour and structure. When asked questions about whether visual images were controlled or uncontrolled it was revealed that visual artists tended to overwhelmingly experience imagery that was uncontrolled and experienced as spontaneous and accompanied by a feeling of inspiration. Triggers of visual images reportedly included life events and emotional experiences and often occurred outside of the artists' volition. This is relevant because a similar claim could be made for the type of imagery that is encountered in persons high in positive schizotypy which may be uncontrolled, frequent, distracting, even unpleasant. Participants were then asked questions about their ability to inspect visual images. Visual artists reported that they could intentionally do this and that it was important for their visual processing as further detail and understanding could be gained from this, as well as some stating that image inspection allowed them to understand the art which could be created from the images. In terms of image maintenance, whether maintaining images required effort and whether they were persistent was also investigated, with visual artists reporting that to maintain visual images required little effort and that these images persisted without being "consciously maintained" (Blazhenkova & Kozhevnikov, 2010, p. 294). Questions relating to the ability to transform visual images were asked. These focused on visual-object or visual-spatial imagery and the intentionality of image transformation. The visual artists reported both object and mixed imagery (comprising both visual-object and visual-spatial imagery), with only a small proportion reporting visual-spatial imagery. The artists used spatial transformation when manipulating and rearranging the composition of mental images

which are to be “translated to physical form” (Blazhenkova & Kozhevnikov, 2010, p. 295), with object transformations being associated with colour, texture and shape of images.

The results of the previously outlined protocol analyses revealed a number of visual artists who said that transforming and manipulating their images was not always possible and that sometimes it was easier to create an altogether new visual image. This study found that visual artists varied in the intentionality of their image transformations, with most being categorised as unintentional, but similar proportions being classified as ‘mixed’, that is, image transformations being performed both intentionally and unintentionally, with some visual artists reporting that they do not transform their visual images at all. The functional role of visual imagery was investigated, specifically, whether it hindered or facilitated completion of “professional tasks” (Blazhenkova & Kozhevnikov, 2010, p. 295). This study found that visual artists regarded their visual imagery as crucial at all stages of their work and reported a substantially emotional content to their visual images, either through emotional motivation, when emotional experiences influenced their images, or when emotion was intended in these images. Many of the imagery-related statements by visual artists pertaining to each of the components of imagery which were provided by Blazhenkova and Kozhevnikov (2010) are also worthy of mention, for although these are individual, qualitative accounts of

visual imagery processes, they were chosen as they were representative of the sample of visual artists' imagery experiences. A selection of these is presented in Table 6.1.

Table 6.1

Examples of imagery-related statements from visual artists

Category	Statements by visual art professionals
Image generation	<p>Images come in flash, it's almost a little muse, so real you just have to grab the idea and visualize it</p> <p>There are images that come from nowhere...</p>
Image inspection	I have these weird colours and creepy images, but I don't know what they are...but I can translate them into paintings
Image maintenance	<p>I never really forget about my first idea. So...I always have this image in my head of what I want to do, or this feeling that I want to express. I always have a visual image in my head, no matter what like...it's just, it's always there</p> <p>Sometimes the image is so persistent, it's just standing in my eyes</p>
Image transformation	Sometimes it is hard to control my images; they just change their colour and shape themselves
Functional role of visual-object vs. visual-spatial imagery	I see images in my head and then I just transfer them onto paper. I draw what I imagine, so it's critical for me to have imagery. Usually, I see an image, and the next task is to find the material and technique to draw it
Role of emotion in visual-object vs. visual-spatial imagery	Instead of throwing a glass at the wall to break it, when I really want to, I can just imagine it – imagine how it will break into tiny pieces, and how they will scatter. Then, I can collect them back together in my imagery. This calms me down

Note. From Blazhenkova and Kozhevnikov (2010).

Some recent research has demonstrated that some objective and self-report measures of imagery ability correlate (Blajenkova et al., 2006; Dean & Morris, 2003; Blazhenkova & Kozhevnikov, 2009) and that tools which are used to measure the same visual dimension, that is, object or spatial imagery, load onto the same factor regardless of whether they are self-report or objective performance tools.

Morrison and Wallace's (2001) investigation into imagery in visual artists which found that participation in art was a better predictor of imagery ability than was creative achievement is of particular interest.

Some of the literature surrounding the creativity-schizotypy debate appears to make an assumption that the positive relationship of certain schizotypal traits with creativity, for example, unusual, magical and fantastical ideation, perceptual experiences that may be considered to be 'out of the ordinary', loose-associations and remote connections in cognition, and the ability to generate and the willingness to express a large number of ideas, are just that: positive, or at least 'not negative'. The notion that the creative benefits of schizotypal thought arise due to the lack of debilitating symptomology is frequently reported, implying by stating this, perhaps, that schizotypal traits are never experienced as debilitating, distressing or distracting. Put differently, there is an implicit message which suggests that people who experience these phenomena benefit from them and that this is demonstrated through heightened creative performance and endeavour.

To express this yet another way, the overwhelming tone of many of these papers is that ‘unusual experiences are good’, for creativity at least. The inclusion of the CAPS rating scale with the items in the O-LIFE, which assesses these possible negative aspects of the experiences, will allow the issue of whether there is evidence for a debilitating effect of schizotypy on creative performance as measured by divergent thinking tasks, creative drawings and self-report measures.

Pérez-Fabello and Campos (2007) found an association between visual imagery and creativity that fifth-year visual arts students reported higher imagery vividness and visual elaboration than less experienced arts students. There are however different types of creativity and imagery, as has been outlined. Researchers have often failed to select appropriate measurement tools to reflect this, which may explain why many fail to find consistent relationships between vividness of imagery and creative performance (Palmiero, Nakatani, Raver, Olivetti Belardinelli, & van Leeuwen, 2010), with only some subcomponents of creativity being associated with vividness, for example ‘practicality’ of objects (Palmiero, Cardi, & Belardinelli, 2011) but not ‘originality’. Unusual perceptual experiences, dissociative experiences and ‘depersonalisation’ have also been associated with creativity and artistic production (Wolfradt & Pretz, 2001; Pérez & Campos, 2011).

The evidence cited heretofore appears to suggest that progress has been made in the field of research into creativity and mental imagery, with advances in the tools and protocols employed when investigating this relationship (LeBoutillier & Irving, 2014).

6.2 Rationale

This study seeks to uncover further layers of the relationships between mental imagery, creativity and schizotypal traits. The studies conducted thus far have recruited university students and subsequently there may be limitations to the conclusions drawn from the results in terms of individual levels of creative imagery. That is, had ‘professionally’ creative individuals been recruited it may have revealed more of a range of both mental imagery and creative abilities. Eminent creative individuals have reported to use mental imagery (LeBoutillier & Marks, 2003) and this ‘special imagery’ explanation of creativity suggests that recruiting samples of ‘ordinary’ individuals to participate in creativity-imagery research may not allow relationships to be unearthed. Additionally, while Study 4 revealed some interesting findings about the use of mental imagery in creative tasks, the creativity task itself was too constrained and participants may not have been given the chance to fully demonstrate their creative capabilities, with participants gifted in other ‘creative areas’, such as verbal creativity, possibly finding it difficult to demonstrate abilities such as storytelling, humour, and satire, for example. Therefore this final study intends to increase the likelihood of finding pronounced differences in imagery control capabilities and will allow a more thorough investigation of the

relationships between mental imagery and creativity by using a variety of creativity tasks and by also recruiting a sample of especially creative individuals. This will also allow for the investigation of schizotypal thought in both visual artists and non-artists.

A clearer operationalisation of creativity as a dependent variable will mean that relationships between creative performance and the nuances of schizotypal traits may be explored, while the inclusion of a tool that provides an accurate indication of imagery ability will mean that elements of creative cognition and potential further relationships with schizotypy may be examined. As was mentioned earlier in this chapter, as well as in other sections of this thesis (Chapter 1, section 1.2.1), discussions and disagreements about whether creativity should be treated as a generalised ability or whether it is domain-specific are ongoing (Kim, 2011). An assumption of domain-generality is made when divergent thinking tests are used as the sole measures of creative responding, that is, scores on these tasks are taken to represent a general 'creative ability'. However researchers also contend that a domain-specific view should be adopted in creativity research whereby specific measures are employed in order to measure specific aptitudes (Kaufman & Baer, 2004). This view is reflected in the creativity measures chosen for the present study which are not only measures of divergent thinking but also of conceptual expansion, strengths in creative thought and creative achievement. Kim (2011) also notes that it is preferable when administering tasks measuring creativity to encourage a non-test like atmosphere, so participant instructions incorporated language to establish this and as

has been the case for all previous studies, care was again taken to ensure this standard for every testing session.

6.3 Justification for inclusion of all measures

The large number of tasks meant that keeping the battery as short as possible was important, so short versions of measures and subsets of tasks were selected where possible. The creativity tools selected for Study 5 were chosen so that a more diverse range of creative abilities could be analysed. Rather than including just one measure of creativity, as was the case in Study 4, a selection of tasks tapping creative imagery, concept expansion and divergent thinking were chosen, alongside a self-report measure of creative achievement. This also reflects recent claims that differential cognitive processes are triggered by verbal and figural creativity tests (Acar & Sen, 2013), therefore both were included in order to further investigate this.

Creativity measures

By utilising four different types of measure, including a divergent thinking task, a self-report creativity measure, and incorporating both figural and verbal creativity, it is hoped that the many nuances in creative ability may be investigated.

A subset of the Torrance Tests of Creative Thinking (TTCT, Torrance, 1974) was chosen which taps into divergent thinking, originality, fluency, and Torrance's 'creative strengths'. It has been suggested that if only a subset of activities from the TTCT battery are selected for use then one should choose the tasks which will be likely to give the most accurate measurement of creativity (Cramond, 1999, cited in Cramond, Matthews-Morgan, Bandalos, & Zuo, 2005). The present study recruited visual artists to take part and so tasks from the *figural* section of the TTCT only were selected for administration. A common practice is to use a total of all TTCT subscale scores as an overall indication of creative thought however this is not intended for Study 5. Kim, Cramond, and Bandalos (2006) support the use of individual subscale indices and indeed Torrance has discouraged the use of composite scores for the TTCT. He warned that using a single score such as a composite score may be misleading because each subscale score has an independent meaning (Torrance, 1974).

Composite scores are used frequently and the practice appears to undermine the many nuances of creativity that exist and that can be tapped by the TTCT. For example, the 'Checklist of Creative Strengths', which awards points for a series of creative qualities which are shown in the responses, gives an indication of creative ability which is quite different to, say, the measure of fluency, or that of resistance to premature closure, however these differences are lost when composite scores are computed. Therefore it may arguably be unwise to use composite scores made up of the subscales of the TTCT

when the aim is to comprehensively study creativity and its many manifestations. Using a selection of Torrance's activities, however, is more common and is consistent with Armstrong (2012), who states that using a subset of the tests can be justified in situations where psychometric 'profiling' for classification purposes (Torrance's initial objective) is not intended on the basis of the tests, as neglecting to use Torrance's norms may result in a reduction in reliability. The subscales can be used to create individual 'profiles' with information from several scores. Where this is done, lower reliabilities can be tolerated in exchange for the increase in detail about creative functioning that these scores can provide. Using selected activities can thus give an idea of creative potential. Cramond (1999) does offer some words of caution when using the five main subscales of the TTCT in this way. As with any psychometric tool, the reliability diminishes when using selected parts of a test and Cramond states that this is especially a problem for the index of elaboration because such a broad range of quantities of responses are possible when scoring for this, that is, there are an infinite number of ways to elaborate on something.

Guilford's (1967) Alternative Uses Task (AUT) is a measure of originality and divergent thinking in which alternative uses for common household objects are generated. This is a verbal creativity task which will complement the other creativity tasks in the battery. The AUT taps the ability to generate a large number (fluency) of responses which are then scored for their statistical originality.

Ward's (1994) Conceptual Expansion Task (CET) requires participants to imagine creatures from another galaxy. These are scored according to how conceptually different these are to those found on earth. The ability of individuals to go beyond the more common category exemplars may tell us something about that person's creative thinking, as the majority of people tend to follow these trends and cognitive shortcuts and generally draw 'aliens' that resemble earth creatures. A surprising finding related to the CET is that even people who one may assume would be excellent at this task, science fiction writers, for example, often fall into the trap of basing their creature on those on earth (Kozbelt & Durmysheva, 2007; Ward, Patterson, & Sifonis, 2004). These aliens typically have sensory organs and appendages which have evolved for the purposes of living on earth, and people make these shortcuts even when they are told that the planet they are 'on' is very different from earth. The creativity index for this task is obtained by scoring drawings for a number of characteristics which are conceptually unusual and dissimilar to earth-animals.

The Creative Achievement Questionnaire (CAQ, Carson, Higgins, & Petterson, 2005) is a self-report tool which provides an indication of creative accomplishments and attainment in a number of creative domains. The use of a self-report creative achievement questionnaire was in place for a number of reasons. It would be interesting to see whether the self-report creativity scores of professional artists, whose creative achievement will most likely be higher than the non-artists in the sample, correlate with

the more objective measures of creative thinking. It has been found that students in particular are not very good at rating their own creativity, and while this tool does not require participants to rate their own creativity, there may be a risk of over-stating of creative achievement. Kaufman, Evans, and Baer (2010) conducted a study investigating whether students were good at judging their own creativity. To describe the finding that in general students were not good at it, Kaufman and his colleagues conceived of 'The American Idol Effect', another name for the Dunning-Kruger effect (Dunning & Kruger, 1999) and a humorous reference toward mainstream reality television where positive self-assessments, that is, occasions where a self-judgement is made and is found, one must assume, to be 'good', do not always appear to match 'objective talent levels', so to speak. Put differently, these subjective and objective-talent ratings are at odds. This is similar to the finding that self-ratings of participants' own creativity may bear no relation to the ratings of expert judges on the creative responses and so relying solely on self-report measures of creativity would be limited in terms of validity. A similar finding to this latter one has also been found in studies utilising self-report imagery tools, as was outlined in Chapters 1, 3 and 4. When people are asked to rate their imagery abilities using self-report scales these ratings rarely correlate with scores on objective and performance-based measures of imagery ability (for an example, see McKelvie, 1995).

Schizotypy measures

The measure of schizotypy, the Oxford-Liverpool Inventory of Feelings and Experiences (O-LIFE, Mason, Linney, & Claridge, 2005) has been amended for this study. Previously answers to the items in this tool were simply ‘yes’ or ‘no’ which provided an overall index of schizotypy, as well as scores on the four subscales (unusual experiences, introverted anhedonia, cognitive disorganisation, and impulsive nonconformity). While this gives a clean set of scores relating to overall schizotypal traits it does not tell us anything about the nature of these experiences and characteristics of thought for the individual. A tool which was briefly described earlier looks specifically at anomalous perceptions, the Cardiff Anomalous Perceptions Scale (CAPS, Bell, Halligan, & Ellis, 2006), asks participants to rate their experiences in terms of their *distress*, *intrusiveness* and *frequency*, thereby giving an indication of how incommensurate these experiences are for the experient. Bell et al. (2006) looked at anomalous perceptions in ‘general population’ samples as well as psychotic inpatients and found a positive relationship between these dimensional ratings and unusual experiences. These ratings were not found to be significantly different from each other, suggesting that they may be highly linked factors, and the authors concluded that anomalous perceptual experience is not a unitary dimension. The CAPS rating scale has been added to the items in the O-LIFE so that, in addition to overall and subscale levels, it will be possible to examine how incommensurate these schizotypal traits may or may not be. This change was made because it is suggested that these differences may be associated with differences in creative imagery, creative thought and creative achievement.

Imagery measure

The imagery tool to be employed in this study is the Image Control and Recognition Task (ICRT; Irving et al., 2011) which objectively measures imagery control and the ability to recognise images that have been constructed in mental imagery. The lack of inclusion of a self-report imagery ability measure reflects the findings of Study 4, which did not find any strong relationships between self-report measures and either creativity or any schizotypy factor. Although a weak correlation was revealed between VVIQ and CVT, vividness scores were not significant predictors of creative performance in a regression analysis. Additionally the decision not to include self-report measures was to limit the length of the battery and number of variables in Study 5.

6.4 Aims and expectations

The aims of Study 5 are to address the limitations found with the creativity measure employed in the previous study and to administer more appropriate measures reflecting a number of creative abilities. Another aim is to examine whether differences exist between visual artists and non-artists in both their mental imagery abilities and their schizotypal tendencies. One final overarching aim is to explore whether the two groups of participants who were recruited, that is, visual artists and non-artists, differ in their mental imagery abilities, their levels of schizotypal thought, and their creative responses.

The visual artist group are expected to achieve higher scores on the tasks in the creativity battery than the non-artist group, and it is expected that this will be associated with utilisation of enhanced mental imagery abilities demonstrated by this group. Based on previously research described in the introduction, is also expected that the artists will have higher scores than the non-artists on the unusual experiences and introvertive anhedonia schizotypy subscales and that unusual experiences and impulsive nonconformity will explain some of the variance in creativity scores.

The modification of the schizotypy measure may help to differentiate between participants who find their schizotypal traits to be particularly troublesome and those who do not. This will allow the question of whether varying levels of schizotypal characteristics are associated with varying levels of creative output and achievement. Importantly, this modification also means that it will be possible to investigate the phenomenology of all types of schizotypal experience, that is, not just perceptual anomalies (as is the case with the CAPS scale by Bell, Halligan, & Ellis, 2006). An understanding of what these traits *feel like* to both the creative and the less-creative experient would be a valuable contribution to the field. Whether the levels of distress caused by schizotypal traits, the amount of distraction they induce, and how often they occur bears any influence on levels of creative aptitude is a worthwhile avenue of exploration.

6.4.1 Research Aims

1. To understand whether differential relationships exist between four indices of creativity, levels of schizotypy which take into account accompanying levels of incommensurability, and mental imagery control.
2. To investigate the predictive power of imagery control and schizotypy scores in three creativity tasks and to ascertain whether levels of control and schizotypy predict creative achievement.
3. To conduct analyses to study whether relationships between creativity and imagery control vary dependant on the measure of creativity.
4. To look at whether visual artists exhibit superior mental imagery control and higher scores on measures of schizotypy when compared to the non-artist group, and whether relationships between these variables depend on the types of tasks considered.
5. To ascertain whether relationships between creativity, positive schizotypy and visual imagery may be explained in terms of controlled and uncontrolled imagery.

6. To investigate whether participants can be classified as an artist or a non-artist according to their scores on the imagery, creativity and schizotypy variables.

6.4.2 *Hypotheses*

1. Mental imagery control as measured by the ICRT will show relationships with all four indices of creativity.
2. Differential results are expected to emerge with ICRT and schizotypy scores as predictor variables dependant on the type of creativity used as the criterion variable.
3. Unusual experiences will be associated with increased creativity on all four indices and will be more pronounced in visual artists.
4. Cognitive disorganisation will be negatively associated with mental imagery control, though no predictions are made about the relationships cognitive disorganisation will have with creativity variables.
5. Introvertive anhedonic schizotypal traits are expected to be negatively associated with creative achievement.

6. Impulsive nonconformity is tentatively expected to be associated with increased scores on the Alternative Uses Task.

7. Artists' and non-artists' scores will reveal similarities in the cognitive styles of these distinct groups, and their scores on the measures of creativity, imagery and schizotypy will accurately discriminate between the groups.

6.5 Method

6.5.1 Participants

Ninety six participants took part and this sample consisted of 'non-artists' and visual artists. The 'non-artist' group ($n = 56$, 41 females, M age = 24.06; $SD = 6.04$) was an opportunity sample of psychology undergraduates in the first year of an undergraduate course who took part in exchange for course credits. The 'creative' group ($n = 40$, 27 females, M age = 44.90; $SD = 15.55$) was comprised of professional artists and these participants were recruited in a number of ways. Advertisements, or 'flyers', (Appendix S) were displayed on notice boards at artists' studios in London (Bow Arts Trust), Kent (Creative Foundation), and Sussex (The School Creative Centre, Rye), and a number of organisations who provide studio space for artists were contacted and requested to display advertisements and contact details. Additionally, artists who had their profile displayed on the websites for the following organisations were invited to take part: South East London Artists; Folkestone Arts Collective; The Creative Quarter Folkestone;

Folkestone Art Society; AXIS – The Online Resource for Contemporary Art; ArtworkLondon.com and E17 Designers. These individuals were contacted directly via the email that was displayed on their public profile. The invitation to participate was also included in newsletters sent out by the following organisations: South East Open Studios; the Enterprise Collective at the University of the Arts (UAL) and Début Art & The Coningsby Gallery. ‘Snowballing’ was also employed as a method of recruitment, with a number of artists forwarding details to interested friends and artist groups that they were affiliated with. An incentive of a £150 Amazon gift voucher ‘prize-draw’ was offered for artists who agreed to participate and they were also offered a ‘profile’ containing details of their results should they wish to receive it. There were two reasons for taking this latter decision. Firstly, having given up such large amounts of their time it was felt that this would be a nice gesture. Secondly, the fact they knew they would potentially be learning something about their ‘cognitive characteristics and thinking styles’, (as was described on the flyer), meant they may have been less likely to provide dishonest responses or to respond in ways which may have an impact on their results.

Participant demographics

Table 6.2 displays the artists’ and non-artists’ education levels. The artists overall are educated to a higher degree than the non-artist group.

Table 6.2

Information about participants' levels of education in Study 5

Highest level of education	Non-artists	Artists
GCSE/GSE	2%	0
A/AS Levels	64%	0
1 + years of college	17%	12%
Bachelor's/Associate degree	9%	50%
Master's degree	4%	20%
Declined to say/missing	4%	17%

6.5.2 *Materials.*

A total of six measures were utilised in the present study. Each of these is described in turn below.

Image Control and Recognition Task

The Image Control and Recognition Task (ICRT; Irving et al., 2011) measures components of mental imagery control. The eight imagery tasks which make up the refined tool require participants to manipulate shapes and letters in their mental imagery according to verbally presented instructions (Table 6.3). These manipulations include rotations, changes in size or shape, and the addition of extra lines, shapes or capital letters. If these manipulations are followed correctly, the shapes will combine to make

recognisable objects (Figure 6.1). These tasks are fully described in Chapters 3 and 4 (and Appendix E), however, an example follows:

Table 6.3

Example of a five-stage Image Control and Recognition Task

Five-stage Image Control and Recognition Task

1. Imagine a long thin triangle pointing left
 2. Add a plus sign to the right of the shape so that it is touching
 3. Move the vertical line of the plus sign right, to the end of the shape
 4. Rotate the entire shape 90° to the right/clockwise
 5. Elongate the bottom horizontal line in both directions
-

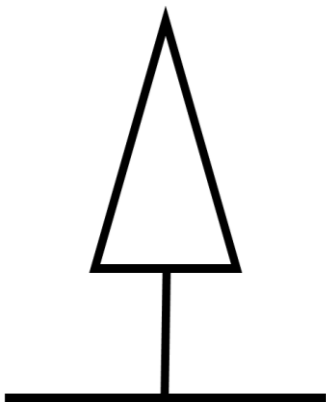


Figure 6.1

Intended image from the Image Control and Recognition Task 'Tree'

Scoring: Participants received one point for each intended image they correctly recognised and named from their imagery (*recognition score*) and one point for each item they correctly drew after all instructions were presented (*imagery control score*).

Torrance Tests of Creative Thinking

Two tasks from the *Figural* form (Form B) of the Torrance Tests of Creative Thinking (TTCT), *Thinking Creatively with Pictures Form B* (Torrance, 1974) were selected. A set of ten incomplete figures and two pages of circles (36 circles in total) were provided to the participants who were required to use these to create interesting pictures and stories.

Scoring: In the absence of newly published norms for this tool, an adapted scoring procedure was adopted which utilised a combination of Torrance's later scoring adaptations as well as Guilford's (1967) methods. The 1974 version of the TTCT assesses five indices of creative thought: *fluency, elaboration, originality, resistance to premature closure* and *abstractness of titles*. Torrance's scoring conventions are described below and these ratings were made by two judges who were unaware whether the responses were from artists or non-artists.

Fluency

Fluency was a count of the number of relevant ideas, that is, how many images the participant 'produced'. Exact repetitions were not counted, so if participants drew the same thing twice but in a different way (for example, multiple different planets; lots of different faces) they only received a score of one for the idea of 'planets' or 'faces'. Scribbles or completely unrecognizable responses were not counted.

Elaboration

Elaboration was a count of the number of ideas that were added to each drawing beyond the minimum details that would be necessary for the basic response (as intended by the title). The index looked at the ability to develop, embellish and carry out elaborate ideas. Participants were awarded one point for each additional idea they added to the basic

response and in the surrounding space, with examples of additional ideas including decoration, details, shading, body position and mood.

Originality

This was a count of the number of statistically infrequent ideas. The titles for each response were transcribed, coded and compared to all other responses given by the sample. Responses that were given by 1% of participants or less were considered 'unique' and were awarded two points. Any responses which were given by 5% of participants or less were classified as 'unusual' and were awarded one point, and any responses that were given by more than 5% of respondents received zero. A corrective calculation was applied to prevent contamination from increased fluency scores (Guilford, 1967) and so originality scores were calculated using the formula $\text{Originality} = \text{Originality} / \text{Fluency}$. High scores on this index therefore demonstrate an ability to produce uncommon or unique responses.

Resistance to premature closure

This score refers to the degree of 'psychological openness' that participants were able to demonstrate in their responding. Obtaining a high score on this index supposedly requires the ability to keep an 'open mind' and tolerate ambiguity for long enough to be able to consider wide ranging options, as well as the resistance to go with any initial

inclinations to draw the image which was most obviously suggested by the shape. This is indexed by the degree to which participants complete the figures using straight or curved lines and how much they resist the most obvious drawings. Those who lacked the ability to resist premature closure received 0, while those who demonstrated they could do this received 1 each time. Overall this index looked at the ability to stay open and tolerate ambiguity long enough to come up with a creative response.

Abstractness of titles

This index measured the degree a title went beyond concrete labeling of the pictures and is illustrated in Figure 6.2.



Figure 6.2

Response by a participant in the TTCT Incomplete Figures task

Example titles for the image in Figure 6.2 may be; 0 = simple class title “boat”, 1 = class title with descriptor(s) “boat on the sea”, 2 = imaginative title that goes a little beyond the picture “Setting sail” and 3 = abstract but appropriate title “The S.S. Montana”. The ratings for the five indices are typically summed to create a single *Profile of Creative Thinking* score, however, due to a number of challenges faced when scoring TTCT

responses (outlined and discussed fully in Appendix U), each participant was given an overall score on the 13 criterion-referenced indicators, or *Creative Strengths*. The TTCT Checklist of Creative Strengths (TTCT-CS) appears to be a valuable addition to the TTCT as it attempts to more accurately capture the quality and ‘essence’ of the drawings produced during completion of this tool. The TTCT-CS were added as Torrance was concerned that the TTCT failed to adequately measure the “breadth of creative manifestations” he had seen (Hébert, et al., 2002; Torrance, 1979, in Kim, 2011). It was reported by Kim (2011) that the new tests “predicted creative achievement and increased validity” and made them “true creativity tests, not just tests of divergent thinking” (p. 304, Kim 2011). The creative strengths are described below:

Emotional expressiveness: how much expression the participants used in their drawings

Internal visualization: showed something in cross-section or ‘inside’ something else

Storytelling articulateness: implied story or relationship between objects drawn

Extending or breaking boundaries: could be demonstrated as depth perception or using shapes in unusual ways

Movement or action: motion lines or images which imply action or movement of the body

Humour: this was for intentional humour and responses were rated for examples of word play, satire, silliness and absurdities

Expressiveness of titles: going beyond the obvious and expressing emotion and feeling

Fantasy: this could be original fantasy or fantasy from literature

Unusual visualization: scored when views are presented which are drawn from below or above, or from an unusual angle

Colourfulness of imagery: rated on how appealing the image was and whether it included fantasy figures, or nudes

Richness of imagery: lively, vivid, intense, varied and memorable imagery. Five examples of such images received 1, six or more received 2

Synthesis of incomplete figures: combinations of shapes received 1, two or more combinations received 2

Synthesis of circles: 1 point for each occurrence of synthesis of circles, however if all stimuli on a page were included in one image then 2 points were awarded

Apart from the final three cases listed above, participants received 2 points where three or more instances of each strength was demonstrated, 1 point for one or two instances and zero if they failed to show evidence of that strength.

Alternative Uses Task

The Alternative Uses Task (AUT; Guilford, 1967) requires the generation of novel uses for common household objects. Measuring creativity using the AUT is considered to be an acceptable method as it is a divergent thinking task which requires flexibility in thought and originality in responding (Cox & Leon, 1999; Silvia, Martin, & Nusbaum, 2009). Two stimuli were selected for the present study; *Brick* and *Newspaper*.

Scoring: The scoring method was consistent with Guilford's conventions (1967). A trained judge who was blind to whether the respondents were artists or non-artists computed the alternate uses which were generated. In order to achieve a high score participants needed to provide statistically infrequent alternate uses for the objects (see Data Reduction section below). Alternative uses that were given by less than 1% of other participants were considered 'unique' and were awarded two points. Uses given by less than 5% of participants were classified as 'unusual' and awarded one point, and alternative uses that were given by more than 5% of respondents received zero. These responses were then summed to provide overall '*unusualness*' scores. A corrective calculation was applied to prevent contamination from increased fluency scores, fluency being the total number of responses provided, so *originality* scores were calculated using the formula *unusualness / fluency*. Examples of alternate uses provided by participants are presented in Table 6.4:

Table 6.4

Examples from the Alternative Uses Task

Score	Brick	Newspaper
Zero points	Door stop	Papier-mâché
	Paperweight	Animal bedding
	Weapon	Wrapping paper
One point	To stand on	To make a palm tree
	As a bookend	For pass-the-parcel
	To prop up a car with a missing tyre	To use as wallpaper
Two points	To support a skateboarding ramp	To scare birds (by tearing)
	To open a water melon	To stop frost on a car windscreen
	To use as a pivot in a see-saw for small creatures	For laminating interesting articles and putting them under a glass-topped table

Conceptual Expansion Task

The Conceptual Expansion Task (CET; Ward, 1994) involves imagining a visit to a planet in a distant galaxy and considering an encounter with two different species from that planet. The fact that the planet to be imagined was to be very different from Earth was strongly emphasised. This creative cognitive ability task addresses the capacity for participants to broaden common parameters of concepts. Most studies utilising this

measure use the word ‘animal’ when instructing participants on the conceptual expansion task. However an adapted version of this tool was used in the present study. This explicitly replaced the word animal with the word ‘creature’. This was to investigate whether participants were still prone to drawing earth-like creatures despite not reading the word ‘animal’. Both terms were entered into the online version of the Edinburgh Associate Thesaurus (Kiss, Armstrong, Milroy, & Piper, 1973) and the most common word associations for each are presented in Table 6.5 below.

Table 6.5

Edinburgh Associative Thesaurus word associations for ‘animal’ and ‘creature’

Animal	Proportion of occurrence	Creature	Proportion of occurrence
Dog	12%	Animal	24%
Cat	11%	Thing	6%
Vegetable	7%	Dog	4%
Magic	5%	God	4%
Man	4%	Man	4%
Bird	3%	Beast	3%
Farm	3%	Being	3%
Bear	2%	Monster	3%
Behaviour	2%	Animals	2%
Cow	2%	Ant	2%
Fox	2%	Comforts	2%
Horse	2%	Creator	2%
Instinct	2%	Small	2%
Rat	2%	Spider	2%
Zoo	2%		

Note. A sample of 98 participants provided responses to these words. Only

responses which were given by > 2% of people are reported here.

As can be seen from Table 6.5 above, the most common associations for the word ‘animal’ include, unsurprisingly, names of animals and concrete examples relating to places in which animals may be seen, as well as some examples which appear to link the word animal to common sayings such as ‘animal magic’, ‘animal instinct’ and the idea of behaving ‘like an animal’. Considering the CET is a measure of concept expansion, it would be preferable if these commonly associated concepts were not triggered by the instructions. Word associations for ‘creature’ on the other hand are more abstract. Although nearly a quarter respond with “animal”, the remaining associations are diverse and relate to concepts, instead of primarily being associated with specific articles and entities as is seen with ‘animal’.

The full instructions provided to participants for the CET are below:

Imagine you travel to a distant galaxy and visit a planet that is wholly unlike Earth. While exploring, you encounter two creatures of different species. Consider what each of these creatures looks like.

Please use the space below to draw these creatures and provide a title or description if you would like. Remember that the planet is very different from Earth.

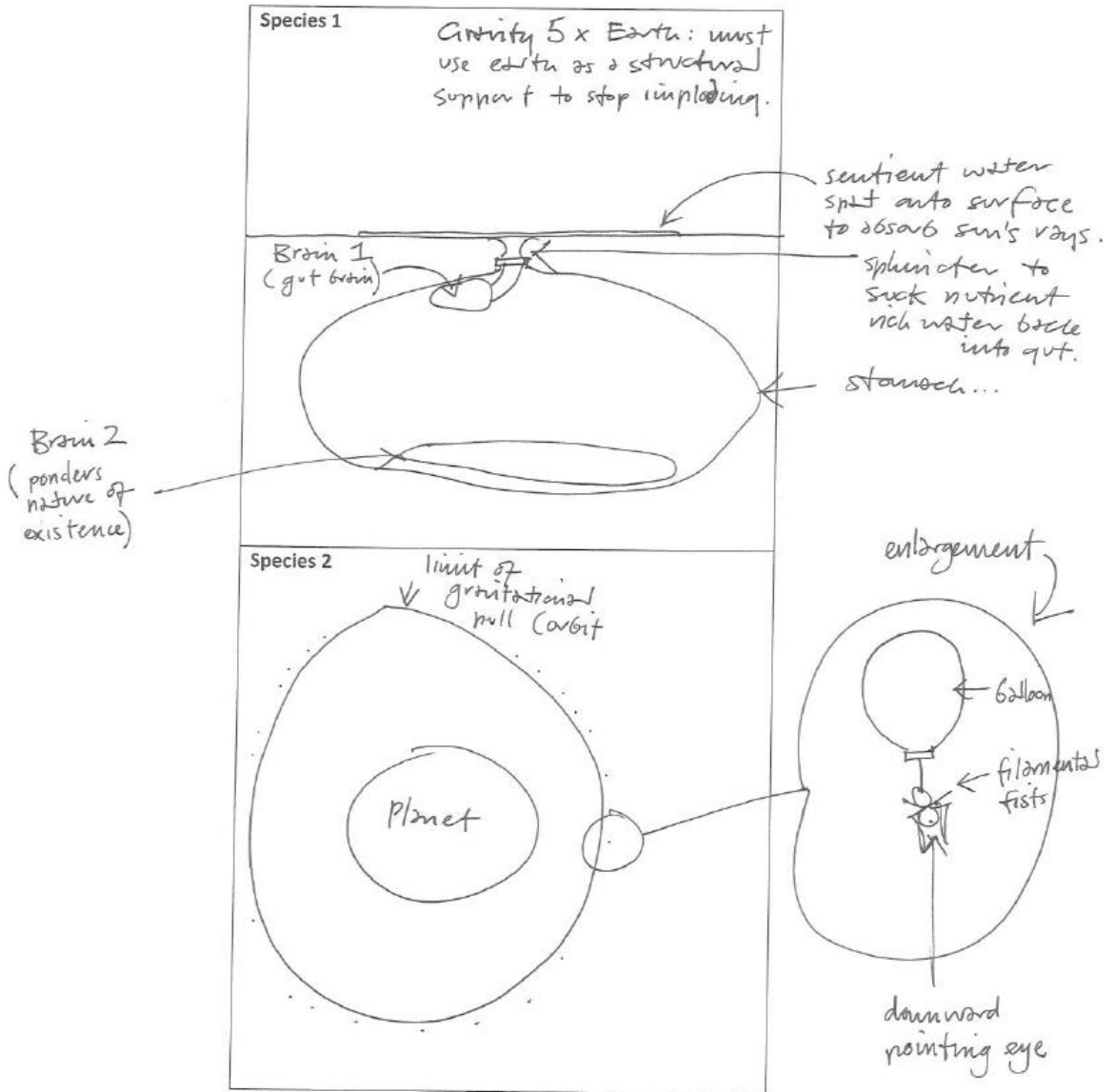
Participants were provided with an answer sheet with the space to draw each of these creatures and were given five minutes to consider each one.

Scoring: The scoring procedure was adapted from Ward's (1994) method. Two scorers noted the presence or absence of the following atypicalities: *lack of appendages*; *lack of sense organs*; *bilateral asymmetry*; *unusual appearance* and *unusual sense organs*. Presence or absence of one of these elements gave rise to a score of one or zero (respectively) and these were tallied, resulting in a total expansion score for each picture ranging from 0 - 5. The judges knew the instructions which participants had been given and they were aware that the task was about measuring concept expansion. The responses depicted in Figure 6.3 (a - c) illustrate examples of high scoring creatures on this task.



(a) Description: Because of their giant brains they developed the technology to exist simply and without need for anything except their minds and hands

(b) Description: This one developed so much that it doesn't require anything at all and is merely a figment of its own imagination



(c) Description: Provided with image

Figure 6.3

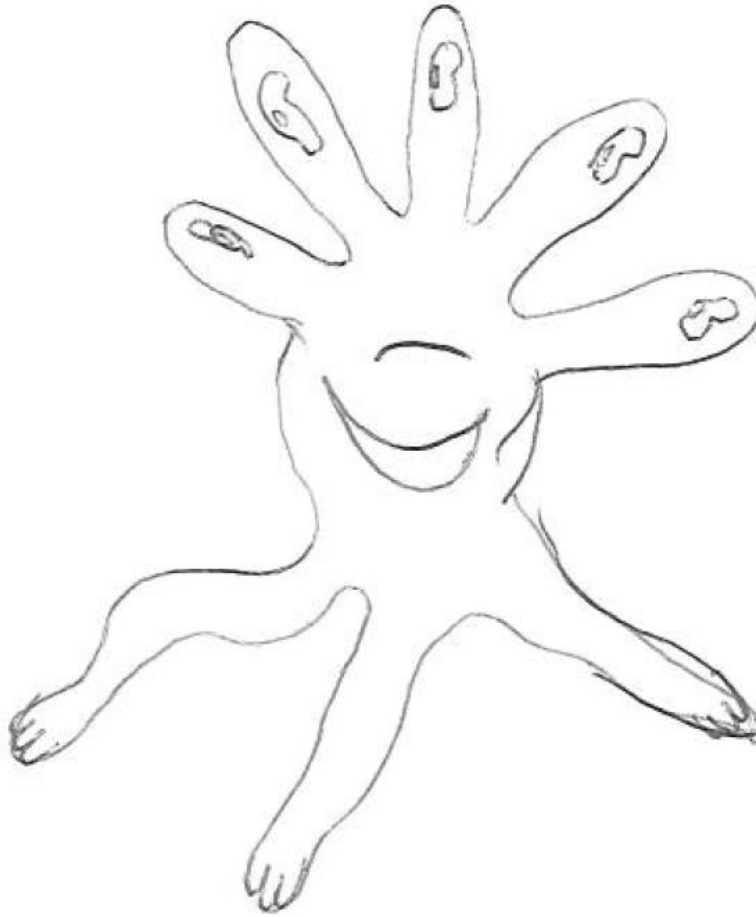
Examples of high scoring creatures from the Conceptual Expansion Task

Figure 6.4 (a-c) below includes some low scoring creatures provided by participants in the CET.

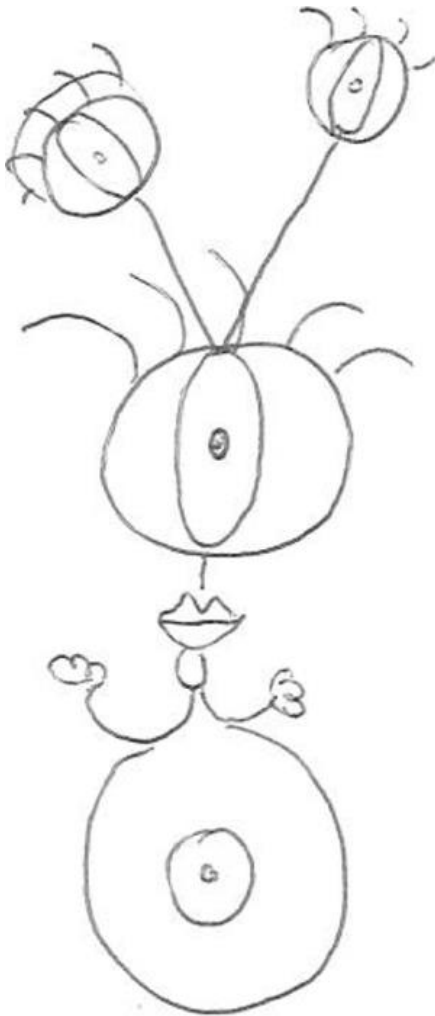


(a) Description: Giant man with 6 legs and scary skin

00000000



(b) Description: All hearing kind



(c) Description: All seeing kind

Figure 6.4

Examples of low scoring creatures from the Conceptual Expansion Task

Scores for each participant were computed by averaging the points obtained on both of the drawings. The reliability between raters for these scores was acceptable ($r = .73, p = .003$).

Creative Achievement Questionnaire

The Creative Achievement Questionnaire (CAQ; Carson et al., 2005) is a self-report measure looking at creative achievement in 10 different domains: Visual Arts, Music, Dance, Architectural Design, Creative Writing, Humour, Inventions, Scientific Discovery, Theatre and Film, and Culinary Arts, and is a valid and extensively used tool (Silvia, Wigert, Reiter-Palmon, & Kaufman, 2012). The questionnaire is in three parts. Part One includes 13 areas of talent comprising the 10 described above as well as individual sports, team sports, and entrepreneurial ventures. Areas in which the participant feels he or she has above-average talent or ability are endorsed. For Part Two participants must endorse items from a range of concrete achievements in each of the 10 standard domains (listed above). Part Three allows participants to indicate how they feel others perceive their creative characteristics.

Scoring: For Part One, the number of endorsed items is summed. For Part Two the eight ranked questions within each domain are weighted and range from zero to seven. These ratings correspond to a ‘*no achievement*’ item with a weight of zero points (“I have no training or recognized talent in this area”), a ‘*training*’ item with a weight of one point (“I

have taken lessons in this area”) and six additional items of ascending achievement (“I have won a national prize in the fields of science or medicine”, from Carson et al., 2005). Participants also indicate how many times each achievement has been earned. Each of the ten domains provided a Domain Score and participants also received a Total Creative Achievement score.

Oxford-Liverpool Inventory of Feelings & Experiences (O-LIFE)

The short version of *Oxford-Liverpool Inventory of Feelings and Experiences* (O-LIFE, short version, Mason, Linney, & Claridge, 2005) was administered to participants. This tool was described in the Materials section of Chapter 5, however, a modification was made to this tool for the present study. The 43-items of this questionnaire do not address how much distress and distraction accompanies schizotypal traits, nor how frequently they occur. However, the *Cardiff Anomalous Perceptions Scale* ([CAPS], Bell, Halligan, & Ellis, 2006), is theoretically linked to positive schizotypal symptoms (i.e. unusual experiences) and directly assesses these aspects. The rating scale used in the CAPS was added to the items in the O-LIFE in order to investigate these additional aspects of schizotypy. This modification has been made to ascertain whether the same applies to cognitive disorganisation, impulsive nonconformity and introvertive anhedonia. Upon endorsement of items measuring each of the four schizotypy subscales, that is, when participants replied ‘yes’ to the question, they were also required to rate this response on

a 5-point Likert-type scale from 1 ‘not at all distressing’/‘not at all distracting’/‘happens hardly at all’, to 5 ‘very distressing’/ ‘completely intrusive’/‘happens all the time’.

Scoring: For each of the O-LIFE subscales (unusual experiences = 12 items, cognitive disorganisation = 11 items, introverted anhedonia = 10 items and impulsive nonconformity = 10 items) participants receive one point each time “yes” is indicated and zero for all “no” responses. Subscale scores were obtained by summing each of the “yes” items, taking into account the reverse-scored items (Oliver, Linney, & Claridge, 2005). To obtain scores for levels of *distress*, *intrusion* and *frequency* of schizotypy symptoms, ratings for items within each of these dimensions were summed. This resulted in discrete distress, intrusion and frequency CAPS ratings for each subscale.

6.5.3 Procedure

All participants read the same information sheet and provided informed consent (Appendix V). They were informed of their right to withdraw at any time and were told that their results would be kept confidential from other participants. The student group completed the first battery of tasks in testing cubicles at Middlesex University in individual sessions. Participants in the artist group completed the tools in individual sessions at their studios with two exceptions; two groups of four were tested in a group session at an art studio, and one pair of participants was tested together at their home.

During the experimental sessions, pens, pencils and erasers were available (they could choose which they used) and it was ensured that participants had a light and comfortable space in which to work. For the creativity battery they sat at a separate table so that they did not feel they were being observed as they contemplated their drawings. For completion of the ICRT, participants sat at the same table with the researcher at a comfortable distance¹⁶. A relaxed and fun atmosphere was maintained. The fact that there were no right or wrong answers in the creativity battery was emphasised, as was the fact this was not an investigation of drawing ability.

Participants were given the creativity tools along with two separate response booklets, each containing one TTCT figural task. The CET was presented on a single sheet with the vignette at the top and space to depict two space creatures provided below it. Participants were told that they had around 40 minutes (longest time \approx 42 minutes)¹⁷ to complete the battery of tasks. They were told that 20 minutes had been allotted for the TTCT tasks and 10 minutes for the CET. Upon completion of each task participants

¹⁶ For the group session, participants completed the ICRT individually in a separate room.

¹⁷ This simply meant that if the participant had not quite finished drawing when the time elapsed it was not in the interests of the study to stop them for the sake of one or two minutes. Participants were alerted when allotted time slots had elapsed and in cases where participants were still drawing as the end of the 40 minutes approached they were informed that time was nearly over and were requested to complete the drawing they were currently working as soon as was possible. This was preferable to receiving a sample containing unfinished drawings.

indicated that they were moving on to the next one if it was before the allotted time had elapsed.

Prior to commencement of the creativity tasks the following information was provided:

You are going to do three activities that look at how good you are at thinking up new ideas and solving problems. They will call for you to use your imagination in interesting ways, so don't hold back or worry about any answers that may be shocking or 'taboo', this is fine. It's likely that you will enjoy the tasks; think of them as a game.

The tasks will give you a chance to use your imagination to think of ideas and to put them together in various ways. In each activity, I would like you to think of the most interesting and unusual ideas you can – ideas that no one else would think of.

You will be given a time limit on each activity (around 10-15 minutes), so make good use of your time. Work fast but don't rush. Try to keep thinking of ideas, but if you run out of ideas it is fine to go onto the next task.

Please ask now if you have any questions otherwise you may start the first task.

For the TTCT tasks the following instructions were provided:

Picture completion

By adding lines to the incomplete figures on this and the next page, you can sketch some interesting object or pictures. Try to think of some picture or object that no one else will think of. Try to make it tell as complete and as interesting a story as you can by adding to and building up your first idea. Make up an interesting title for each of your drawings and write it down at the bottom of each block next to the number of the figure.

Circles

In ten minutes see how many objects or pictures you can make from the circles below and on the next page. The circles should be the main part of whatever you make. Add lines to the circles to complete your picture. You can place marks inside the circles, outside the circles, or both inside and outside the circles – wherever you want in order make your picture. Try to think of things that no one else will think of. Make as many different pictures as you can and put as many ideas as you can in each one. Make them tell as complete and as interesting a story as you can. Add names or titles below the objects.

Once the creativity tasks had been completed the ICRT was then administered in which participants completed a series of verbal instructions related to the manipulation of shapes and forms in imagery. The responses generated during the ICRT were recorded

by the participants in a separate four page answer booklet (Appendix F), each page containing four sections in which to provide titles and the accompanying drawings. Instructions for completing the ICRT were read aloud followed by three practice trials (two three-stage and one four-stage). Participants were given an opportunity to ask questions prior to the beginning the ICRT. The presentation of the imagery control tasks was randomised in terms of the number of stages, that is, these were not presented in order of difficulty, so participants could receive a three, four, five, or six-stage task to start with.

Following completion of the first battery of tests (the ICRT, CET and TTCT) participants were verbally debriefed for that session and any questions about the three tasks were answered, taking care not to reveal anything about the intentions and aims of the study. Participants were then sent an email containing a unique participant code and a link to an online survey (hosted on www.SurveyGizmo.com) in order to complete the remaining measures (O-LIFE, AUT and CAQ). The use of online methods of participant recruitment and data collection is a relatively new way of conducting research with its own fresh set of ethical issues (BPS, 2013). An example surrounds participant autonomy and the issue of privacy of collected data. Previous BPS Code of Ethics and Conduct definitions for the treatment of and the distinctions between ‘private’ and ‘public’ information do not fit with internet-mediated research because the lines between them are more difficult to delineate. People communicate online both in private and in public, that

is, individuals use their computers and devices in their own private spaces whilst at the same time communicating in public forums and social networks. The online component of Study 5 was done in accordance with the guidelines provided by Hewson (2003) and involved the following: participants were not required to provide their name online, only their unique participant code; clear and explicit instructions were ensured at all stages; the time taken for completion of the items was inspected in order to check for suspiciously out of range responses which may indicate cheating (in the case of the AUT); gathering appropriate details in order to identify multiple and erroneous submissions, such as date, time and regional location; simple item presentation to avoid possible problems displaying the page on older web browsers and those with slower internet connections with the intention that the 'view' was the same for all no matter how they accessed the page and, finally, a small pilot study ($n = 5$) was done in which the online component was tested by friends of the researcher in order to detect and rectify any issues prior to commencement of the study proper. Participants were asked to complete the online questionnaires as soon as was convenient, ideally on the same day as they participated in the one-to-one session. They were told to be in a quiet room free from distraction when they accessed the website and were given an accurate estimation of how long it was likely to take (around 30-45 minutes). Once they had completed the online questionnaires they were debriefed in an email (Appendix W) which fully explained the nature of the study. They were invited to ask any questions, were offered further debriefing in person or by phone and the artist group were told they would be

receiving their profiles once the results had been analysed¹⁸. The online component was presented in the following order: O-LIFE, AUT then CAQ.

6.6 Results

Analyses were carried out in order to obtain a comprehensive picture of similarities and differences between artists and non-artists. After data screening satisfied that the data were appropriate for parametric analysis, a series of correlational analyses were conducted to guide further exploration.

DATA REDUCTION

Errors and missing data

Of the 96 participants who initially took part, three non-artists were removed at the outset as they did not fully complete the online battery of questionnaires (O-LIFE including CAPS ratings, AUT and CAQ). Prior to computing total O-LIFE subscale scores reversed items were re-coded. Initially all data were screened for univariate outliers. One out-of-range value which was an input error was identified and recoded, and missing demographic data were coded as such. Any spelling errors in responses generated in the AUT were corrected to streamline the scoring for originality and fluency. AUT responses were then categorised and sorted so that the frequency of common responses

¹⁸ A number of particularly inquisitive psychology students expressed an interest in the findings of the study as well as a wish to receive their results and this was agreed.

could be calculated, for example, as alternative uses for a brick, both “to hit someone” and “to protect myself” were categorised as ‘Weapon’. Each use was compared to the total number of uses provided by the sample. The same process of transcribing and sorting for the purposes of calculating originality and fluency was observed for TTCT titles.

ICRT, O-LIFE, CAPS subscales, CAQ, CET, TTCT-CS and AUT scores were converted to standardised z scores and any which were in excess of ± 3.00 were removed from further analyses (Tabachnick & Fidell, 1989). Just one participant (a student) was removed at this stage as their CAQ score was an outlier (non-artist group $n = 52$; artist group $n = 40$).

Reliability analyses

A series of reliability analyses were conducted on the four schizotypy subscales followed by the ‘Distress’, ‘Distraction’ and ‘Frequency’ variables in order to assess the underlying constructs. This resulted in a total of 20 reliability analyses which are reported below.

RELIABILITY ANALYSIS OF THE O-LIFE SUBSCALES

Unusual Experiences

The 12 items which measure Unusual Experiences were found to be reliable (Cronbach's $\alpha = .66$). Not all Unusual Experiences items correlated with the total scale (lower $r = .21$, higher $r = .42$), however, since alpha would not have increased with the removal of any item, all were retained. The items are as follows:

1. When in the dark do you often see shapes and forms even though there is nothing there?
2. Are your thoughts sometimes so strong that you can almost hear them?
3. Have you ever thought that you had special, almost magical powers?
4. Have you sometimes sensed an evil presence around you, even though you could not see it?
5. Do you think that you could learn to read other's minds if you wanted to?
6. When you look in the mirror does your face sometimes seem quite different from usual?
7. Do ideas and insights sometimes come to you so fast that you cannot express them all?
8. Can some people make you aware of them just by thinking about you?
9. Does a passing thought ever seem so real it frightens you?
10. Do you feel that your accidents are caused by mysterious forces?

11. Do you ever have a sense of vague danger or sudden dread for reasons that you do not understand?
12. Does your sense of smell sometimes become unusually strong?

Cognitive Disorganisation

Eleven items measured Cognitive Disorganisation and initially Cronbach's $\alpha = .66$. Items on this scale correlated with the total scale moderately (lower $r = .27$, higher $r = .47$) and removal of items would not have increased the value of Cronbach's alpha. The following items comprise the Cognitive Disorganisation subscale:

1. Are you easily confused if too much happens at the same time?
2. Do you frequently have difficulty in starting to do things?
3. Are you a person whose mood goes up and down easily?
4. Do you dread going into a room by yourself where other people have already gathered and are talking?
5. Do you find it difficult to keep interested in the same thing for a long time?
6. Do you often have difficulties in controlling your thoughts?
7. Are you easily distracted from work by daydreams?
8. Do you ever feel that your speech is difficult to understand because the words are all mixed up and don't make sense?
9. Are you easily distracted when you read or talk to someone?
10. Is it hard for you to make decisions?

11. When in a crowded room, do you often have difficulty in following a conversation?

Introvertive Anhedonia

Introvertive Anhedonia was measured by 10 items. Initially Cronbach's $\alpha = .46$ and so an item-by-item analysis was conducted to determine whether alpha could be improved. This analysis found that it was necessary to remove 7 items in order to improve the reliability of this scale and even then the level of alpha was still unacceptable ($\alpha = .55$). The three remaining items measuring introvertive anhedonia were as follows:

1. Do you love having your back massaged?
2. Do you find the bright lights of a city exciting to look at?
3. Is trying new foods something you have always enjoyed?

As a result of this it was decided to that no further analysis could reliably be conducted on this subscale.

Impulsive Nonconformity

Impulsive Nonconformity was measured by 10 items. Cronbach's $\alpha = .51$ at the start of the analysis. An item-by-item analysis was conducted on this scale to determine reliability. The removal of 7 items improved the reliability of this scale so that $\alpha = .71$. The items that were retained were as follows:

1. Do you at times have an urge to do something harmful or shocking?
2. Do you ever have the urge to break or smash things?
3. Have you ever felt the urge to injure yourself?

Following these scale analyses new schizotypy subscale scores were computed using the items retained. The four new schizotypy variables were transformed to z scores and screened for outliers that were in excess of ± 3.00 (Tabachnick & Fidell, 1989). There were no outliers on these new variables.

The CAPS subscale ratings were transformed to z scores and 10 cases were found to contain outliers, nine of which were mild, one of which was extreme as it fell more than 3 interquartile ranges (IQR) above the mean for Introvertive Anhedonia *frequency* ratings, while the others were less than 1.5 IQR above the mean (IBM Corp., 2012). This same case was also a mild outlier on Introvertive Anhedonia *distraction*. In the interests of power and in consideration of the planned analyses, it was decided to remove only the extreme outlier leaving an overall final sample size of 92 (non-artist group $n = 52$; artist group $n = 40$).

New composite scores were created by summing ratings for all four schizotypy subscale scores and the Distress, Distraction and Frequency ratings for each of these subscales. These were included in subsequent analyses as overall measures of dimensional

schizotypal traits which included the levels of incommodiousness for each subscale. These were titled *Unusual Experiences-C*, *Cognitive Disorganisation-C*, *Impulsive* and *Nonconformity-C* to reflect the fact they included the CAPS ratings of elements of incommodiousness that were experienced as a result of the related schizotypal characteristics, traits and experiences.

No standard error of skew or kurtosis was anywhere close to 2 (Tabachnick & Fidell, 1989) (*SE* of skew = .251 for all variables; *SE* of kurtosis = .498 for all variables).

DESCRIPTIVE STATISTICS AND CORRELATIONS

For the following analyses involving the schizotypy and creativity variables, ICRT Total was used as the indicator of mental imagery. The ICRT Total and ICRT Recognition variables shared similar relationships with the schizotypy variables and were themselves highly correlated, $r(90) = .66, p < .001$ and so only ICRT Total scores were selected for subsequent analyses. Table 6.6 on the next page displays descriptive statistics and correlations between the creativity, imagery and new composite schizotypy variables.

Table 6.6

Correlations between the new schizotypy scores, creativity and imagery

Variables	Min.	Max.	Mean	Std. Deviation	1	2	3	4	5	6	7
1. Unusual Experiences-C	.00	105.00	45.56	23.76	-						
2. Cognitive Disorganisation-C	.00	142.00	51.59	32.58	.41**	-					
3. Impulsive Nonconformity-C	.00	68.00	21.06	16.95	.25*	.42**	-				
4. ICRT Total	.00	8.00	3.97	2.14	.06	.03	.22*	-			
5. TTCT Creative Strengths	.00	12.00	4.47	2.56	-.03	.04	.03	.23*	-		
6. Alternative Uses	.00	1.95	.79	.47	-.03	-.06	.10	.36**	.16	-	
7. Conceptual Expansion	.00	10.00	4.82	2.34	.19	.02	-.03	.25*	.44**	.30**	-
8. Creative Achievement	2.00	112.00	21.65	17.97	.26*	.03	.06	.27*	.22*	.16	.38**

Note. $N = 92$. * $p < .05$. ** $p < .01$. ICRT = Image Control and Recognition Task; TTCT = Torrance Tests of Creative Strengths. With age partialled-out the significant correlation between ICRT and TTCT-CS was not found, while a significant correlation emerged between ICRT and AUT scores. These results are presented in Appendix X and this issue is addressed in the Discussion.

The Unusual Experiences-C index of schizotypy was significantly but weakly positively correlated with Creative Achievement, as were ICRT scores. None of the other indices of schizotypal thought and discomfort, correlated with any index of creativity. The ICRT scores were however correlated positively with all four creative indices and the strongest relationship was between ICRT and AUT scores. The creativity measures were themselves moderately inter-correlated.

Multiple Linear Regression analyses

A series of multiple linear regression analyses was conducted in an attempt to tease apart these associations. Each creativity measure was used as the criterion in four regressions which included the ICRT and reliable schizotypy variables as predictors. The data were screened for multivariate outliers and an analysis was conducted concerning whether the assumptions for multiple regression analyses had been met and is reported below, followed by the results of the regression analyses.

Normality

Examination of the histogram of standardised residuals showed that the assumption of independent errors was met as this was normally distributed for all regression analyses. The residuals plots also indicated there was adequate and consistent clustering and little deviation from normality in all models.

Linearity

The correlations between the predictor variables and the four criterion variables in the respective analyses were all small, ranging from $r = -.01$ (*CogDis-C* and *AUT*) to $r = .36$ (*ICRT Total* and *AUT*). This indicated that the subsequent multiple regression analyses could be reliably employed as the data were suitably correlated with the dependent variables. Scatterplots examining homoscedasticity indicated that there was reasonable consistency of spread throughout the distributions.

Outliers

There was one outlier which was indicated by a Mahalanobis' distance above the critical value for 5 predictors of $\chi^2 = 18.47$ (this figure was 18.52) and so this case was removed from the multivariate analyses. Analysis of standardised residuals showed that there were no outliers greater than ± 3.29 in the data (Std. Residual Min = -2.17, Std. Residual Max 2.63).

Multicollinearity

None of the predictor variables were significantly inter-correlated more than .7, so multicollinearity was therefore not likely to be problematic. Examination of Cook's distances (TOL) and variation inflation factors (VIF) for all variables indicated that

influential data points were not a concern (*UnEx-C*, TOL = .83, VIF = 1.21; *CogDis-C*, TOL = .72, VIF = 1.39; *ImpNon-C*, TOL = .77, VIF = 1.30; *ICRT Total*, TOL = .95, VIF = 1.06, highest figures reported for each).

Non-linear relationships

Scatterplots indicated no clear-cut relationships between variables, and so quartile splits were conducted on the independent variables to identify the top and bottom quartiles of scorers and compared on all indices of creativity. Tables 6.7, 6.8, 6.9 and 6.10 show the results of these analyses.

Table 6.7

Comparison of top and bottom quartiles on TTCT Creative Strengths (TTCT-CS)

Variable	Quartile (<i>n</i>)	TTCT-CS Mean	Std. Deviation	<i>t</i>	<i>p</i>
ICRT Total	Top (23)	4.61	2.67	1.77	.08
	Bottom (27)	3.37	2.27		
Unusual Experiences-C	Top (23)	4.09	1.86	.87	.39
	Bottom (24)	4.75	3.16		
Introvertive Anhedonia-C	Top (21)	4.95	2.27	1.15	.26
	Bottom (26)	4.08	2.83		
Cognitive Disorganisation-C	Top (23)	4.48	2.06	1.20	.24
	Bottom (23)	3.69	2.34		
Impulsive Nonconformity-C	Top (22)	4.68	2.83	1.06	.29
	Bottom (23)	3.87	2.26		

Note. ICRT = Image Control and Recognition Task; TTCT-CS = Torrance Tests of Creative Thinking Creative Strengths.

No significant differences were found between high and low scorers (top and bottom 25%) on any of the schizotypy or imagery variables.

Table 6.8

Comparison of top and bottom quartiles on the Alternative Uses Task (AUT)

Variable	Quartile (<i>n</i>)	AUT Mean	Std. Deviation	<i>t</i>	<i>p</i>
ICRT Total	Top (23)	1.07	.50	4.03	< .001
	Bottom (27)	.59	.36		
Unusual Experiences-C	Top (23)	.75	.47	1.17	.25
	Bottom (24)	.92	.49		
Introvertive Anhedonia-C	Top (21)	.87	.47	.90	.37
	Bottom (26)	.74	.53		
Cognitive Disorganisation-C	Top (23)	.68	.50	.51	.61
	Bottom (23)	.75	.44		
Impulsive Nonconformity-C	Top (22)	.83	.54	.54	.59
	Bottom (23)	.74	.51		

Note. ICRT = Image Control and Recognition Task; AUT = Alternative Uses Task; significantly higher figure is in bold.

When participants were split into top and bottom 25% by their ICRT Total scores and compared using an independent groups t-test a significant difference was found in Alternative Uses creativity scores, with the high scorers on ICRT producing more original alternate uses for the common household objects.

Table 6.9

Comparison of top and bottom quartiles on the Conceptual Expansion Task (CET)

Variable	Quartile (n)	CET Mean	Std. Deviation	<i>t</i>	<i>p</i>
ICRT Total	Top (23)	5.85	2.11	2.40	.02
	Bottom (27)	4.31	2.36		
Unusual Experiences-C	Top (23)	5.17	2.04	1.01	.32
	Bottom (24)	4.54	2.25		
Introvertive Anhedonia-C	Top (21)	5.69	2.40	1.84	.07
	Bottom (26)	4.36	2.49		
Cognitive Disorganisation-C	Top (23)	4.56	2.04	.15	.88
	Bottom (23)	4.67	2.66		
Impulsive Nonconformity-C	Top (22)	4.79	2.32	.39	.70
	Bottom (23)	4.25	2.42		

Note. ICRT = Image Control and Recognition Task; CET = Conceptual Expansion Task; significantly higher figure is in **bold**.

Top and bottom ICRT scorers (top and bottom 25%) were the only significantly different group on the Conceptual Expansion Task scores, the better imagery controllers created more unusual creatures.

Table 6.10

Comparison of top and bottom quartiles on the Creative Achievement Questionnaire (CAQ)

Variable	Quartile (<i>n</i>)	CAQ Mean	Std. Deviation	<i>t</i>	<i>p</i>
ICRT Total	Top (23)	26.78	24.79	2.16	.04
	Bottom (27)	15.30	11.45		
Unusual Experiences	Top (23)	26.74	24.90	1.50	.14
	Bottom (24)	17.54	16.48		
Introverted Anhedonia	Top (21)	26.00	25.76	1.00	.32
	Bottom (26)	19.92	15.63		
Cognitive Disorganisation	Top (23)	21.61	21.82	.01	.99
	Bottom (23)	21.52	15.36		
Impulsive Nonconformity	Top (22)	21.55	23.58	.88	.38
	Bottom (23)	16.61	12.63		

Note: ICRT = Image Control and Recognition Task; significantly higher figure in **bold**.

The same pattern emerges when comparing Creative Achievement scores between top and bottom 25% of ICRT imagers, the stronger imagery controllers being awarded significantly higher creativity scores.

A comparison between artists and non-artists on the four measures of creativity was conducted using independent groups *t* tests in order to demonstrate the validity of the creativity measures. The results of these analyses are presented in Table 6.11.

Table 6.11

Comparison of artists and non-artists on indices of creativity

Artist or non-artist (<i>n</i>)	Creativity Index	Std. Deviation	<i>t</i>	<i>p</i>
Torrance Creative Strengths				
Mean				
Artist (40)	5.80	2.59	4.91	< .001
Non-artist (52)	3.44	2.01		
Alternative Uses Task				
Mean				
Artist (40)	.94	.47	2.72	.008
Non-artist (52)	.68	.45		
Conceptual Expansion Task				
Mean				
Artist (40)	6.09	2.21	5.16	< .001
Non-artist (52)	3.85	1.95		
Creative Achievement Questionnaire				
Mean				
Artist (40)	21.07	19.43	5.65	< .001
Non-artist (52)	13.63	11.70		

Note: Significantly higher figures in **bold**.

Inspection of the results of this collection of *t* tests indicates that a clear relationship exists between two of the three main constructs of interest, namely, imagery and

creativity. When the top and bottom quartiles on the ICRT variable are selected and compared on the creativity tasks, significant differences are revealed between these groups on three of the four indices; AUT, CET, and CAQ. There are no differences on any of the creativity tasks when the participants are split into quartiles all schizotypy measures and the top and bottom 25% are compared on each measure of creativity. However, when the artists were compared with the non-artist group, significant differences are found on all four creativity measures. There were no significant differences between the artists and non-artists on any of the newly computed schizotypy measures, which included an indication of the accompanying levels of distress, distraction and frequency for each subscale.

CONCEPTUAL EXPANSION

The order of entry of the predictor variables was consistent with the previous study also reflected the finding that suppressor variables may influence the relationships between the variables entered into the regression. Direct method of entry with backward deletion was used, with the ICRT being entered as a predictor alongside the three reliable schizotypy subscale variables which include the CAPS ratings. The initial regression model explained just 7% of the variance in CET scores, $F(4, 86) = 2.830$, $\Delta R^2_{\text{adj}} = .074$, $p = .029$ and so this was repeated in iterations, each time removing the predictor with the lowest non-significant regression coefficient in an attempt to improve the model. The results of the final multiple linear regression analysis are presented in Table 6.12, with

the variables that were removed from the model presented in Table 6.13 in order of removal.

Table 6.12

Multiple linear regression of imagery and schizotypy variables on Conceptual Expansion Task scores

Variables	CET (<i>r</i>)	ICRT Total (<i>r</i>)	<i>B</i> (unique)	<i>SE</i>	β	sr^{2a}	<i>t</i>	<i>p</i>
Constant			2.94	.65			4.50	.001*
ICRT Total	.25		.23	.12	.23	.05	2.25	.03**
Unusual Experiences-C	.22	.11	.19	.01	.19	.05	1.10	.06

Note. * $p < .001$; ** $p < .05$; ICRT = Image Transformation and Recognition Task; ^a sr^2 = the squared semipartial correlations indicate the unique variance explained by the predictor.

Table 6.13

Predictor variables removed from multiple linear regression on CET

Variable removed (in order of removal)	β	<i>t</i>	<i>p</i>
Cognitive Disorganisation-C	-.01	-.13	.90
Impulsive Nonconformity-C	-.16	-1.48	.14

The final regression revealed an R of .32, $R^2 = .10$, and adjusted R^2 of .08 ($F(2, 88) = 4.866$, $\Delta R^2_{\text{adj}} = .079$, $p = .010$), explaining 8% of variance in concept expansion. The only clearly significant predictor of CET scores was *ICRT Total*, although *Unusual Experiences-C* scores were only marginally insignificant. The variables uniquely predicted 10% of the variance (.10, sum of the squared semipartial correlation coefficients) and shared no explained variance (calculated by subtracting the uniquely explained variance from the R^2 value: $.10 - .10 = 0$).

ALTERNATIVE USES

The four predictors were entered into the model with AUT as the criterion variable. This model explained 8% of the variance in AUT scores, $F(4, 86) = 3.044$, $\Delta R^2_{\text{adj}} = .083$, $p = .021$. The same process of removing poor predictors was repeated as before. The results of the final model are presented in Table 6.14, with the variables that were removed from the model presented in Table 6.15.

Table 6.14

Multiple linear regression of imagery and schizotypy variables on the Alternative Uses Task (AUT)

Variables	AUT (<i>r</i>)	ICRT Total (<i>r</i>)	<i>B</i> (unique)	<i>SE</i>	β	sr^{2a}	<i>t</i>	<i>P</i>
Constant			.49	.11			4.59	< .001*
ICRT Total	.35		.08	.02	.35	.11	3.39	.001*
Impulsive Nonconformity-C	.08	.21	.00	.00	.01	.00	.09	.92

Note. * $p < .05$; ICRT = Image Transformation and Recognition Task; ^a sr^2 = the squared semipartial correlations indicate the unique variance explained by the predictor.

Table 6.15

Predictor variables removed from multiple linear regression on AUT scores

Variable removed (in order of removal)	β	<i>t</i>	<i>p</i>
Unusual Experiences-C	-.02	-1.44	.88
Cognitive Disorganisation-C	-.05	-.48	.63

The final regression revealed an *R* of .35, $R^2 = .12$, and adjusted R^2 of .10 ($F(2, 88) = 6.09$, $\Delta R^2_{adj} = .102$, $p = .003$), and *ICRT Total* was the single significant predictor. This variable uniquely predicted 11% of the variance in alternative uses provided.

CREATIVE STRENGTHS

With TTCT-CS as the criterion variable, the same four predictors were entered into the model. This explained just 1% of variance and was found to be non-significant ($F(4, 86) = 1.357, \Delta R^2_{\text{adj}} = .015, p = .259$) and so no further regressions were conducted.

CREATIVE ACHIEVEMENT

With CAQ as the criterion variable, the ICRT was entered as a predictor alongside the three reliable schizotypy subscale variables which include the CAP ratings. The initial regression model explained 11% of the variance in creative achievement, $F(4, 86) = 3.698, \Delta R^2_{\text{adj}} = .107, p = .008$ and so this was repeated in iterations as before. The results of the final model are presented in Table 6.16, with the variables that were removed from the model presented in Table 6.17 in order of removal.

Table 6.16

Multiple linear regression of imagery and schizotypy variables on Creative Achievement (CAQ)

Variables	CAQ	ICRT	<i>B</i>	<i>SE</i>	β	sr^{2a}	<i>t</i>	<i>p</i>
	(<i>r</i>)	Total (<i>r</i>)	(unique)					
Constant			5.34	4.95			1.08	.284
ICRT Total	.25		2.02	.85	.24	.05	2.37	.02*

Unusual Experiences-C	.30	.11	.23	.08	.30	.08	2.89	.00*
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Note. * $p < 05$; ICRT = Image Transformation and Recognition Task; ^a sr^2 = the squared semipartial correlations indicate the unique variance explained by the predictor.

Table 6.17

Predictor variables removed from multiple linear regression on creative achievement

Variable removed (in order of removal)	β	t	p
Cognitive Disorganisation-C	-.02	-.23	.82
Impulsive Nonconformity-C	-.09	-.87	.39

These analyses reveal that the creativity measures selected for this study each have unique relationships with mental imagery and schizotypy. The predictive power of the imagery and schizotypy variables varies depending how creativity is measured.

In order to build a more comprehensive understanding of these interrelationships, all 92 cases were entered into a discriminant function analysis to investigate whether the variables could be used to predict whether a participant was a visual artist or not.

Discriminant Function Analysis

A discriminant analysis was conducted to ascertain whether it was possible to predict membership of the groups 'visual artist' and 'non-artist' based on schizotypy, mental imagery and creativity scores. Predictor variables were ICRT Total, Unusual Experiences-C scores, (which included the CAPS ratings of how distressing, distracting, and frequent their positive schizotypal experiences were), and creativity scores (TTCT-CS, AUT, CET, and CAQ). Significant mean differences were observed for five of the predictors on the dependent variable. Box's M was greater than .001 which indicated that the assumption of equality of covariance matrices was met (Box's $M(21, 25838245) = 36.239, p = .040$).

The discriminate function revealed a significant association between groups and the variables, accounting for 51.41% of between group variability, i.e. whether someone is an artist or not (canonical correlation = .717). Each group has a normal distribution of discriminant scores (Figures 6.11 and 6.12). Wilks' Lambda indicated a highly significant discriminant function (Wilks' $\Lambda(6) = .486, \chi^2 = 62.73, p < .001$) and showed that 48.6% of variability remained unexplained.

Closer analysis of the structure matrix revealed four significant predictors, namely (in order of magnitude) CAQ score (.579), CET score (.529), TTCT-CS score (.504) and

ICRT score (.391). The AUT coefficient was .279 so just fell short of meeting the selection criterion (greater than .3). Unusual Experiences scores were not found to be a significant predictor of group membership (-.112). The cross validated classification showed that overall 84% of participants were correctly classified. Table 6.18 contains details of predicted group membership and proportions resulting from this analysis.

Table 6.18

Classification table for discriminant function analysis

		Predicted Group Membership			
			Non-artist	Artist	Total
Original	Count (%)	Non-artist	47 (90.4)	5 (9.6)	52 (100)
		Artist	10 (25)	30 (75)	40 (100)
Cross-validated	Count (%)	Non-artist	47 (90.4)	5 (9.6)	52 (100)
		Artist	10 (25)	30 (75)	40 (100)

Note. $n = 92$.

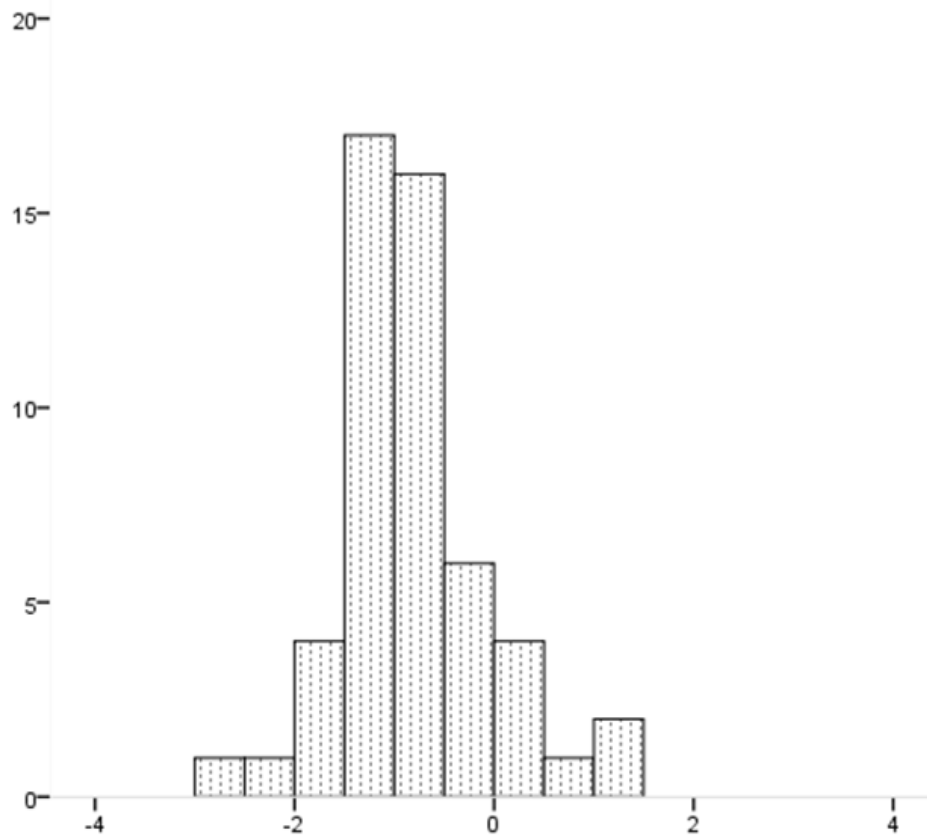


Figure 6.6

Non-artist group cluster scores. *Note:* $n = 52$, $M = -0.84$, $SD = 0.76$.

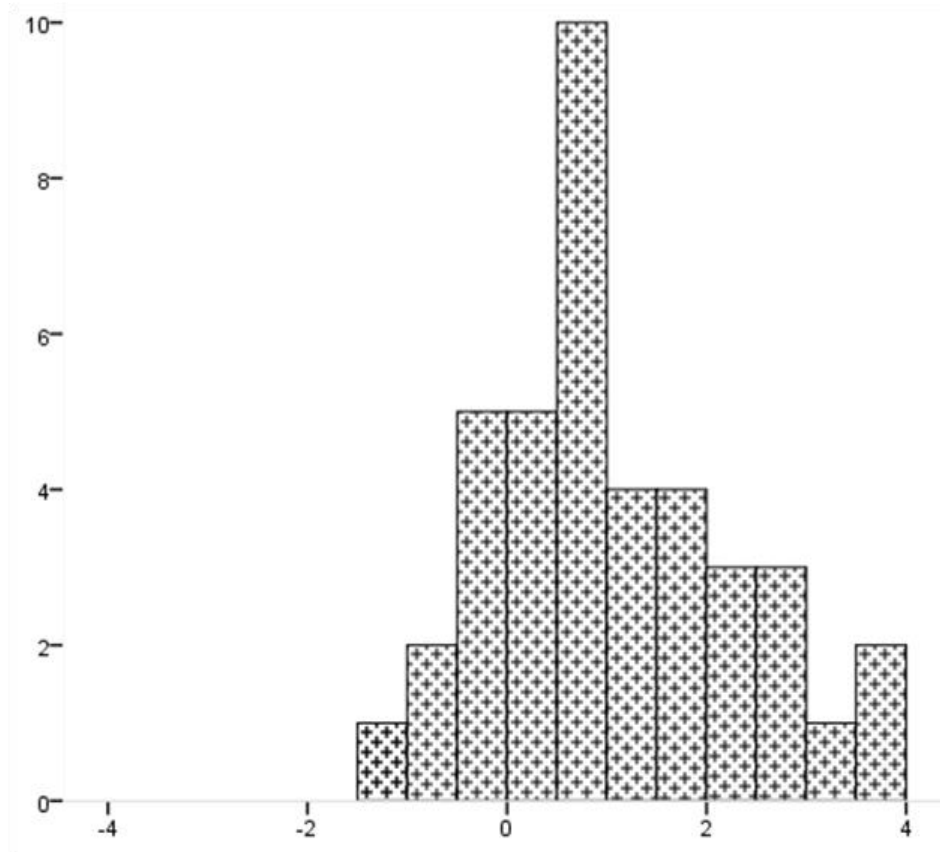


Figure 6.7

Artist group cluster scores. *Note:* $n = 40$, $M = 1.10$, $SD = 1.24$.

Figures 6.11 and 6.12 indicate that there is some overlap between these two group distributions and so there is a possibility that some misclassifications of cases may have occurred.

6.7 Discussion

Study 5 sought to investigate a number of potential relationships between mental imagery control, schizotypal symptomology and creative thought. Strong associations were found between mental imagery control and all of the creativity measures, supporting the supposition that mental imagery control may be important for many types of creativity. The relationships between creativity and mental imagery abilities were found to differ depending on the creative task, with imagery control predicting performance on some creative tasks but not others. However, mental imagery was implicated in all creative tasks, and especially controlled mental imagery was found amongst the visual artists, further buttressing claims that creativity and imagery are linked (LeBoutillier, 1999; Glazek, 2012).

The best model was for predicting AUT scores, with 10% of variance being explained by both ICRT and impulsive nonconformity scores. This suggests that participants may have used their mental imagery control aptitudes to imagine the stimulus items (a brick and a newspaper) in a variety of ways, possibly mentally rotating and ‘playing with’ their mental image in order to see it from alternate angles and subsequently think of new alternative uses and circumstances in which these items could appear, while their tendency to ‘go against the norm’ may have fostered more unusual suggestions, which, when compared to the others in the sample who were lower in this schizotypal trait, would have received higher scores for originality.

The association between mental imagery control and conceptual expansion scores, with ICRT explaining 8% of variance, hints towards the use of mental imagery when creating images of 'alien' creatures. Although there were no rules against sketching in this task, few did, and this supports the notion that it is likely that many participants conceived of their creatures using their mental imagery before drawing them, as opposed to using the time to sketch in order to generate responses in this task. Additionally, unusual experiences was just marginally insignificant as a predictor for CET scores, which may suggest that a more unusual conceptual style and approach was implicated for this task. The findings of this study are related to Blajenkova and Kozhevnikov (2010) who found that visual-spatial ability did not predict specialisation in visual art. This study found that imagery control did predict some of the variability in CAQ scores, however, it was unusual experiences which predicted most of the variance on this scale.

Creative achievement scores were most strongly predicted by unusual experiences, which shared predictive power with imagery control scores. This is an interesting result. The fact that this pair of traits was implicated in the ability to achieve creative stature provides evidence that positive schizotypy and mental imagery are indeed related to creativity, but that this may only be observed with exceptionally creative individuals, that is, those who are creative as part of their job. This association supports both the evidence implicating mental imagery abilities and schizotypal thought in eminent creative

performance (see Chapter 2, section 2.5). Those achieving high scores on the CAQ were successful in their field, which for the ‘creative’ sample was obviously most likely the domain of ‘visual arts’, but high scoring participants who were not visual artists would have reported significant achievements in one or more of the remaining nine domains of creativity which are tapped by the CAQ. These results encourage the use of the ICRT in studies to investigate mental imagery abilities in many creative domains. Unusual experiences scores were positively correlated with creative achievement scores and this was in line with predictions. The finding that the CAQ was in fact the only creativity variable that correlated with positive schizotypy is especially noteworthy. High scores on the CAQ reflect a considerable amount of creative success, and given the literature which has demonstrated an increased presence of positive schizotypy amongst visual artists, art students, and other individuals whose career would be described as ‘creative’ (Nettle, 2005; Rawings & Locarnini, 2008; Nettle & Clegg, 2005), this finding may even seem unsurprising. This finding also gives weight to the conclusion of the previous study which suggested that the levels of unusual experiences may not have been high enough for stronger relationships to be revealed, and also supports the literature which reports evidence of high levels of positive schizotypy in visual artists (Nettle, 2006).

‘Creative strengths’, as measured by Torrance’s checklist, were also found to be positively associated with mental imagery control, but again, the association between the two variables was weak. This checklist awards points to participants based on their

ability, for example, to tell stories with sets of unrelated figures, to use rich and colourful imagery and to show unusual perspectives in their drawings, and surprisingly it appears that the ability to control mental images was not especially related to skills of this nature. This may have been because there was no need to generate an initial mental image to work with, for the task stimuli were presented on the response sheet. Initially it was intended that the scoring of the TTCT included all five indices as well as the Checklist of Creative Strengths, however, as was outlined in the results section (with further discussion at Appendix U), the decision was taken to eliminate some of the scores in light of the scoring instructions and issues encountered by judges. Mental imagery control was positively related to all four indices of creativity and predicted variance in all of the regressions.

In order to check for non-linear associations the scores belonging to the top and bottom quartiles on each of the independent variables were compared on each of the measures of creativity. The comparisons of top and bottom ICRT imagery control, unusual experiences, introverted anhedonia and impulsive nonconformity groups on the Torrance Creative Strengths (TTCT-CS) scores revealed no significant differences between any of the groups on this measure. The ability to control mental imagery did not result in significantly enhanced creative strengths on this task. It may be that this subscale alone does not tap creative ability as well it does when included with the other subscales of creative thought which are included in the TTCT (when up-to-date norms are available).

The scores reported by the top and bottom ICRT groups on the AUT were significantly different. However, high and low groups on unusual experiences, introvertive anhedonia and impulsive nonconformity were not significantly different in terms of the alternative uses generated. This reflects the possibility discussed earlier that participants were more successful on this task if they were able to manipulate and control mental imagery, the tentative conclusion being drawn that this is what they did with their mental image of the brick and the newspaper. The subjectivity was removed from the scoring of this task, that is, the responses were not scored for elaboration, and it is argued that this modification improved the scoring of this measure of divergent thinking. The regression to predict variance in AUT scores found that ICRT was the sole significant predictor.

The scores of the top and bottom ICRT groups on the CET were significantly different, and this suggests that strong mental imagery control may have contributed to participants' ability to conceive of particularly unusual creatures prior to drawing them. Contrary to hypotheses however, the high and low on unusual experiences, introvertive anhedonia and impulsive nonconformity groups were not significantly different in their conceptual expansion. The lack of relationship between this measure and unusual experiences is surprising because 'fantasy proneness' and 'magical ideation' certainly sounds as though they may influence the creation of alien creatures. However, when the variables were entered into a regression to predict conceptual expansion, imagery control

was the strongest predictor, and unusual experiences scores were also found to be a significant predictor of scores in this variable.

The comparisons of the top and bottom quartile groups' ICRT scores found that these differed significantly on the CAQ, and theoretically the inclusion of the visual artists in the sample may explain this finding. The unusual experiences, introverted anhedonia and impulsive nonconformity groups did not differ in their self-reported creative achievement. The regression with CAQ as the criterion variable, however, found that unusual experiences scores and ICRT both predicted creative achievement, with imagery control exhibiting the most predictive power.

The visual artists' scores were significantly higher than the non-artists' scores on the four measures of creativity. This was somewhat expected due to the inclusion of artists which served as a type of 'manipulation check' in the design of the study. The inclusion of these individuals meant there was more variability in the responses provided, which meant that a more in-depth analysis could take place. A marked difference was not found between unusual experiences scores for the visual artists compared to the non-artists, as had been hypothesised, while it was not possible to reliably investigate whether visual artists differed significantly on their levels of introverted anhedonia as this scale was found to be unreliable. With this in mind it may be worth noting that these participants reporting more of a tendency for these schizotypal traits, which concurs with previous

findings by Nettle (2006, see also Rawlings & Locarni, 2008), and unusual experiences did predict creative achievement.

The discriminant function analysis was able to correctly classify a sizeable portion of the sample as either a visual artist or a ‘non-artist’, and this was calculated on the basis of their creativity scores, their levels of positive schizotypy, and their ability to control their mental imagery. This is an encouraging result as it indicates that, despite no especially large effects being revealed in this study, the materials and measures selected to provide indices on the variables of interest nonetheless accurately reflected the characteristics and patterns of responding of the participants in terms of their individual levels of creativity, mental imagery control and unusual experiences.

In an early paper discussing the use of Torrance’s creative thinking battery, Harrington (1975) notes that Torrance (1966) asked respondents to produce as many solutions as possible and to produce ‘interesting’ and ‘clever’ solutions. He states, “inadequately informative instructions fail to create conditions necessary for either the accurate assessment of divergent thinking abilities or for the meaningful evaluation of qualitatively-orientated scoring procedures” (p. 435), and this was certainly felt to be the case in the present study. He discusses the effects of explicit instructions to ‘be creative’ on the psychological meaning of divergent thinking test scores. At the time Harrington’s paper was published scant attention had been paid to investigate the influence of

instructions on task performance in measures of divergent thinking. Explicitly instructing participants to 'be creative' when completing these tasks appeared to influence their responding as they appeared to be threatened by this requirement, which additionally was found to be an "anxiety-arousing" component of the testing session (Harrington, 1975, p. 451).

Simonton states that "creativity is a very complex phenomenon with multiple determinants, some cognitive and others dispositional (Simonton, 2007, cited in Roberts, 2007, p. 355)". He asserts "Because so many variables are involved in the makeup of the creative individual, the contribution of any single factor will be necessarily small" (p. 355). This was supported by the findings of Study 5, as is highlighted by the respective creativity tasks yielding differential associations with both imagery control and schizotypy. Another potential confusing element to the domain-specificity debate in creativity research is the finding that cognitive and dispositional variables may actually interact, "rather than being the additive function of separate components, creative capacity may be a multiplicative function of them" (Roberts, 2007, p. 355). Creativity, imagery, and schizotypy clearly interacted in different ways in Study 5, supporting the assertion that numerous separate components combine in creative exploration and thought.

6.7.1 Limitations

The Torrance Tests of Creative Thinking (TTCT) proved to be only a marginally effective tool for assessing creative ability in the study, for a number of reasons. Some participants commented that there was not enough room for them to elaborate on their drawings in the TTCT circles task, and there were problems with scoring the titles of the images that the participants produced. The scorers were unable to agree on their initial originality ratings because the titles provided were often unique and in the form of a sentence, having followed the instruction to make the images ‘tell a story’. However what this meant was that the obvious originality that was clear to the scorers when looking at the images was lost due to the generic scoring procedure traditionally employed for this element of the TTCT. Torrance has stated that he added the Checklist of Creative Strengths for this very reason, namely, the fact that the true essence and creativity of these images is lost when scoring with the conventional methods. Despite this, none of the predictors were significantly related to TTCT-CS scores, a finding which supports the use of multiple creative thinking tasks in order to tap a range of creative abilities (Simonton, 2012; Armstrong, 2012).

The participants completed the Alternative Uses Task online and this may have been a limitation of the study. The webpages timed out after participants had spent two minutes providing alternative uses for each item, however, the lack of control here requires acknowledgement. Though it is unlikely that respondents would have taken the

opportunity when completing this measure to cheat on this task in the absence of the experimenter, there is the possibility that they may have obtained help on their generated alternative uses from someone else who was with them (they were requested to complete the online tasks alone). It was requested at the end of the experimental session and in the email containing the link to the online component that they concentrated and moved through the tasks as quickly as possible. Inspection of the times taken to respond meant that any conspicuous responses may be studied and removed if necessary, and it was unlikely that participants did cheat on this task. Participants also completed the schizotypy measure online, and it is recommended when completing psychometric questionnaires of this type that one goes with their instinct and resists deliberating on their responses too much. Therefore the request to move quickly had two intentions; one, to reduce the likelihood that participants sought out external resources when responding to the AUT, and two, to ensure that they would not over-think their responses to the schizotypy measure. One last limitation concerns the finding that the introverted anhedonia subscale was unreliable. This prevented an investigation of previous findings reported in the literature which suggest this trait may be negatively related to creative output. This was revealed despite evidence which suggests that the short version of the O-LIFE is a valid and reliable tool for measuring the four schizotypy subscales, and so it is uncertain what led to this result.

6.7.2 Further research

The findings that visual artists differed when compared to non-artists in all of the creativity tools suggests that creative individuals are able to generate unique and original responses in a number of areas. However, apart from the Alternative Uses Task, a verbal fluency task, these were primarily visual creativity tasks, as was intended due to the evidence suggesting that suitable measures should be employed when conducting research with different creative groups. However, future research may want to consider how other creative groups, such as writers, scientists, mathematicians and computer programmers, perform in these differential tasks, and whether they demonstrate creative abilities in one or many areas. Additionally, it may be that, as well as having different creative abilities, these individuals show marked differences in their mental imagery control skills.

While statistical infrequency tells us something about the uniqueness of responses, this is contaminated by sample size. As is noted by Silvia et al. (2008), research of this type is atypical in science because large sample sizes conflate the number of unique responses given. As the responses are compared to the other participants in the sample, smaller samples are likely to have more original answers simply due to there being fewer participants. Therefore people may be awarded points for 'creativity' when actually their

response is an otherwise common one which, by chance, has not been generated by anyone else. Similarly, it is pointed out that with large sample sizes, the likelihood that any response will be given increases as a function of the number of participants in the study.

Overall the results of Study 5 suggest that associations between imagery, schizotypy and creativity vary according to the type of creativity that is being measured. Imagery control appears useful for expanding conceptions about creatures from out-space, with schizotypy having little influence on this. Control of imagery and a tendency towards impulsive nonconformity may engender high scores on measures of verbal fluency, while positive schizotypal traits, which may also represent uncontrolled imagery, may lead to greater creative achievement, with imagery control being implicated in this also.

CHAPTER 7 EXTENDED DISCUSSION AND CONCLUSIONS

7.1 Main findings of the thesis

Five studies were conducted and are reported within this thesis. Table 7.1 summarises the key findings from each study. Following this, each is discussed in turn and then contributions, conclusions, limitations and directions for future research are discussed.

Table 7.1

Summary of key findings from the thesis

Chapter number	Study number(s) and Title(s)	Key findings
3	Studies 1 and 2 Pilot and development of the ICRT	The ICRT effectively measures individual differences in levels of mental imagery control The psychometric properties of this tool should be explored to investigate whether memory or order were confounding variables New items need to be developed and existing ones refined
4	Studies 3a, 3b and the construct validity and reliability of the ICRT	The nameability study found that the intended-images accurately depict what they intend to, resulting in greater confidence when using this tool to measure image recognition. The ability to rotate shapes in mental imagery appears to be an essential feature of mental

		imagery control.
		The refined ICRT measures abilities in more than one area of mental imagery control, namely, image evocation, image manipulation, image recognition, and spatial and object imagery.
5	Study 4 Relationships between creativity, mental imagery and schizotypy	<p>Mental imagery control as measured by the ICRT was related to creative performance, however, self-reported mental imagery abilities were not.</p> <p>Self-reported mental imagery and objectively measured mental imagery scores were not related. Overall this supports the discriminant validity of the ICRT.</p> <p>No direct association was found between mental imagery control and levels of schizotypy, however, mental imagery control, unusual experiences, and cognitive disorganisation accounted for variance in scores on the creative visualisation task.</p>
6	Study 5 Creativity, mental imagery and schizotypy in artists and non-artists	<p>Mental imagery control was found to be related to creative achievement, conceptual expansion, generating alternative uses for household objects, and creative strengths, findings which were supported when comparing strong image controllers to participants less able in imagery control. Unusual experiences scores were related to high creative achievement. Regression analyses showed that differential results emerged dependant on the creative measure, with ICRT predicting concept expansion and alternative uses, impulsive nonconformity also contributing to the latter index. Neither imagery control or schizotypy variables predicted TTCT creative strengths, but the strongest predictor of creative achievement was found to be unusual experiences,</p>

followed by imagery control skill.

Visual artists were no different to the non-artists on levels of positive schizotypy though their imagery control skills differed significantly.

The scores on creativity and mental imagery control accurately discriminated whether a participant was a visual artist or a non-artist for almost 84% of the sample, while the level of positive schizotypy was not found to be a discriminant predictor of group membership.

7.1.1 Developing the ICRT

The first studies were designed to pilot and test a new mental imagery control tool, the Image Control and Recognition Task (ICRT). Mental imagery control was shown to contain many facets which were individually measurable by the tool. These involved the visualisation and rotation of objects, combining and restructuring of mental forms, and the ability to then see the image in a new, previously unanticipated way. Not everyone who was tested was capable of all of these abilities, with some showing only moderate imagery control skills, while others were able to quickly move through the mental imagery tasks with ease and efficiency. Others still were able to accurately complete all of the imagery manipulation tasks, but were unable to recognise a single image that they had created, while a small percentage of participants were able to easily recognise the pictures from their mental image, possibly demonstrating a mental shift from using spatial to object imagery. This supports multidimensional theories of mental imagery and shows that, rather than being either a ‘spatial imager’, or an ‘object imager’

(Blajenkova, Kozhevnikov, & Motes, 2006), some show enhanced abilities in both types of mental imagery. There also appears to be a threshold of difficulty beyond which only a few are able to go, that is, those who are strong in their mental imagery control can easily and successfully complete very long mental imagery tasks, involving 7, 8 and 9 stages. These studies provided acceptable support for the use of this tool in future investigations into mental imagery abilities.

7.1.2 Construct validity and reliability of the ICRT

The intended-images which materialise in mental imagery having correctly followed the ICRT instructions are unambiguous in what they depict, and so this tool has many potential applications in terms of methodologies of administration and what it is able to measure. It was shown that the Image Control and Recognition Task (ICRT) shared relationships with performance-based measures of mental imagery ability which provided construct validity for the tool.

7.1.3 The relationships between creativity, schizotypy and mental imagery

The results of study 3 were mixed in terms of the hypotheses that had been made. The participants with high positive schizotypy scores did not perform better on the creative imagery task, though unusual experiences did share some of the predictive power with cognitive disorganisation and ICRT indices in explaining CVT scores. This supports the contention that mental imagery control and creativity are inherently linked, and may

support the argument that an element of schizotypy, namely, unusual, uncontrolled perceptual and imaginal experiences, may also be associated with creative performance, and that the literature implicating schizotypy in creative performance may reflect this. However, the possibility remains that these results reflected a relationship between the cognitive processes that underlie both the imagery control tasks and creative visualisation, which were similar in nature. A battery of varied creativity measures would have allowed this possibility to be explored, so this was planned for the final study.

7.1.4 Creativity, schizotypy and mental imagery in artists and non-artists

A number of interesting results were uncovered in Study 5. The visual artists were shown to have distinct patterns of responding on some of the measures employed. When compared to the non-artists, the visual artists were stronger in terms of performance on all of the creativity tasks, receiving significantly higher scores on all three performance measures, providing some evidence for domain-general creativity. The schizotypy measure indicated that artists were more prone to flat affect (introvertive anhedonia) than the non-artists (this scale was, however, unreliable), though the two groups had similar unusual experiences (positive schizotypy) scores. This could be due to the fact that one group were a student sample, and schizotypy scores are higher generally for this population (Nettle, 2001), and the other group were artists, also reportedly more likely to report frequent unusual experiences, magical ideation, and other strange, anomalous

perceptual occurrences. Measuring creative performance has many nuances which need to be considered when designing research investigating the relationships between creativity and both schizotypy and mental imagery. This is because different patterns of results are revealed depending on the way creativity is measured, that is, whether divergent thinking, conceptual expansion, thinking creatively with pictures, or self-report measures of creative achievement are used.

The related studies which were conducted in the present thesis investigated three infamously convoluted constructs. These investigations were designed to ‘iron-out’ the hypothesised relationships inherent in these. Initially an effective tool was developed in order that the construct be measured appropriately. This was then scrutinised, the skills which it tapped were delineated and the tool refined. The ICRT subsequently provided a useful tool to look at the relationships with creativity, imagery control and schizotypy.

7.2 Contributions of the thesis

A mental imagery tool which effectively differentiates levels of ability was lacking in the field. The objective tools which exist certainly measure differing types of spatial ability, however, the ICRT offers mental imagery researchers the opportunity to study a number of imagery control aptitudes at once. A secondary, equally pleasing but arguably less important aspect of the tool is that the majority of people who completed it during its

development (over 300) thoroughly enjoyed doing it. An electronic version of the Image Control and Recognition Task (ICRT) for use on tablets, smartphones and PCs is in development, which will allow imagery researchers more flexibility and the ability to test mental imagery control and recognition remotely.

The construct and convergent validity of the ICRT were scrutinised and its psychometric properties analysed. Agreement on what the resultant-images of the ICRT represented was generally high which means that researchers who wish to investigate only the *recognition* element of the tool may do so without requiring participants to draw. Although *ICRT Recognition* was not included in some of the analyses in the thesis (due to issues of power and having the same pattern yet slightly smaller relationships with imagery and creativity), it deserves further analysis. Visual artists recognised significantly more ICRT images than non-artists. As well as being proficient in terms of their ability to generate, rotate, manipulate, and combine the shapes accurately, their ability to inspect and view these newly formed images ‘as a whole’ was also enhanced. Though related, these are slightly different imagery abilities.

Support for the role of positive schizotypy in creativity was found here and adds to the body of literature supporting the contention that the two are linked. Two contributions of note are related to this. Firstly, the amendment to the Oxford-Liverpool Inventory of Feelings and Experiences (O-LIFE) allowed the levels of intrusion, distress, and

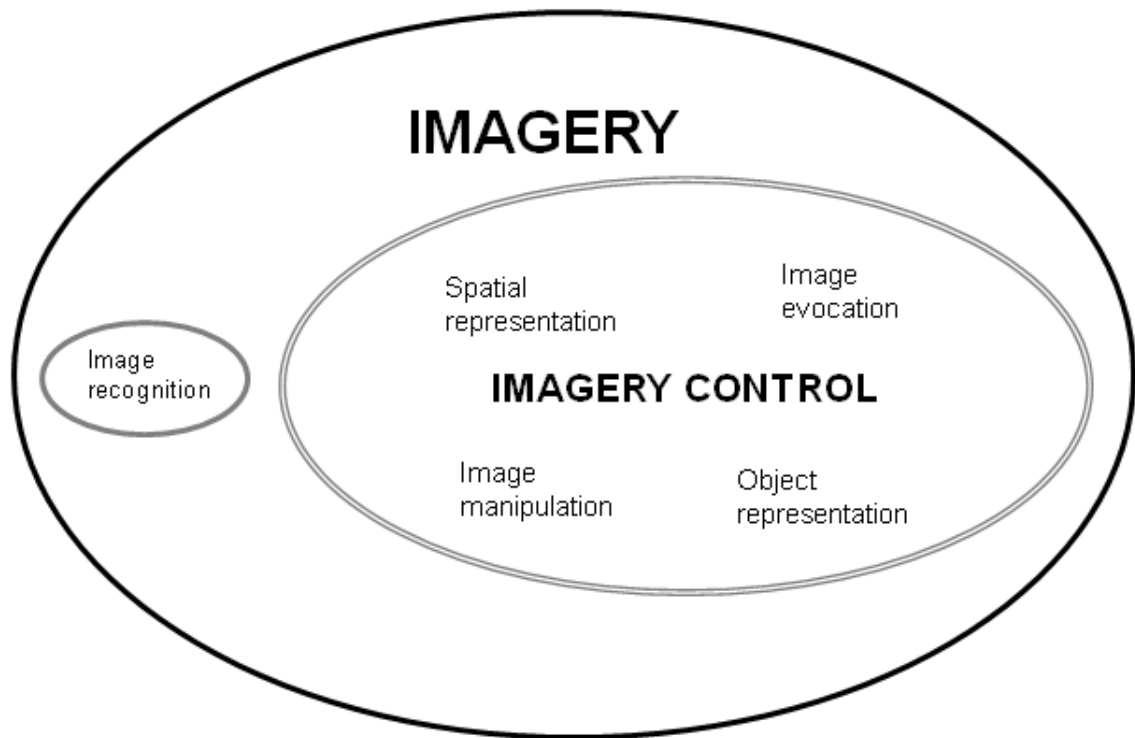
frequency of schizotypal experiences to be accounted for when considering relationships with creativity and imagery.

Additionally, evidence for both domain-general and domain-specific creativity was found, with both artists and non-artists showing differential abilities in the varying types of creativity task employed.

A new model of mental imagery is proposed, one which addresses different types of imagery ability (Figure 7.1). There appears to be a difference between ‘imagery’, as it is generally conceived, ‘image recognition’, and ‘imagery control’, which this thesis has suggested is comprised of a number of abilities. The ICRT has allowed investigation into each of these aspects of mental imagery for there are a number of elements, or phases, to completing the tool. Differences in the ability to generate, maintain, manipulate, and rotate mental images may be assessed, abilities which are collectively conceived of as ‘imagery control’. However, an unexpected finding was that ‘image recognition’ appears to be a separate ability, one that requires different skills to those necessary for success on imagery control tasks. It seems to be an additional ability, one that is not possessed by everyone with skills in imagery control. This model of imagery is depicted at Figure 7.1 below.

Figure 7.1

New model of mental imagery



7.3 Conclusions, limitations, future studies and directions

The methods and collection of studies employed in this thesis were unique in their design. Mental imagery and creativity researchers now have a new tool with which to investigate abilities in these areas. Researchers interested in schizotypy and the dimensions underlying it may now also get an indication of whether individual differences in the levels of these traits are differentially related other to psychological

characteristics and constructs. The adapted O-LIFE ratings and the scores revealed with these, which include the levels of distress, distraction and the frequency of schizotypal thought, represent an interesting avenue of research for investigators of the schizotypy-creativity relationship, as well as in studies into the relation of schizotypal imagery to creativity. What would be interesting would be to conduct investigations on these subscales individually to ascertain whether these have differential associations with creativity, or imagery control. A detailed analysis of these individual indices was not conducted due to issues of power and sample size, though investigation of the incommensurability of schizotypal traits and any relation this has to creativity may help to elucidate this convoluted relationship.

There were some limitations in the studies in this thesis, mainly related to the creativity tasks employed. The first task was problematic because it contained stimuli which were the same as those in the mental imagery task. The second problem was that for the creativity tool employed in the study with the visual artists, conventional scoring lost all 'flavour' of the creative responses on some tools. The inclusion of a visual memory task would have been beneficial in Study 6. A different memory measure may have highlighted differences in imaginal performance as a result of abilities in visual memory, the digit span tasks instead measuring other elements of working memory and, indirectly, executive function. Additionally, any differences in visual memory between artists and non-artists may have been enlightening. Recent evidence provided by fMRI imaging has

suggested that visual memory and visual mental imagery involve similar neural processes (Slotnick, Thompson, & Kosslyn, 2012), namely frontal-parietal control regions and occipital-temporal sensory regions, however, Slotnick et al. concluded that their findings “implicate differences in the specific degree to which particular process contributed to each task” (p. 19). It has been argued that, to a certain degree, enhanced memory capacities are an implied but essential feature of mental imagery control, and this is supported by the finding that the two cognitive processes share neural connectivity. A conclusion that may be drawn from this could be that the apparently effortless and exceptional imagery control exhibited by some during transformation tasks depends upon the efficacy of these interconnected brain regions.

Future research could look at the differences between imagery control and image recognition as measured by the Image Control and Recognition Task. This tool can be used to measure overall abilities in imagery control, but can also be utilised to obtain indications of the seemingly less common ability to recognise newly constructed mental images before drawing them. The ability to do this would be useful for creative exploration and is akin to the process of ‘combinatory play’ which is often cited in creative visualisation and discovery (Finke & Slayton, 1989).

In conclusion, this thesis has contributed to the fields of imagery, creativity and schizotypy research through the development and adaptation of a number of tools, and

has provided evidence to support the supposition that both imagery control and elements of schizotypal thought are related to creative output. These associations depend on the measure of imagery, levels of schizotypal thought, and the index of creativity which is considered, reflecting the multidimensional nature of these distinct yet subtly related constructs.

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APPENDIX A

Study 1 information sheet

**Psychology Department
Middlesex University
Queensway, Enfield, Middlesex, EN3 4SA**

Nature of the study

You are being invited to take part in the development and validation of a new psychological tool. Prior to giving your consent, it is important that you understand what is being investigated. Take as long as you need to read the following information and please ask should you have any queries relating to the study. If you no longer wish to take part once reading this information sheet you do not have to.

Procedure

You will be asked to complete a series of image transformation tasks whereby you will follow verbal instructions and imagine combining and manipulating the shapes in your head. At the end of each stem you will be asked to draw the resultant image.

At the end of this, you will be asked some questions and will have an opportunity to ask any questions of your own.

Potential Risks/Discomfort

The task poses no potential risk or discomfort whatsoever.

Confidentiality

All information and data collected in this study will remain confidential and will be destroyed after completion.

Participation and Withdrawal

Should you agree to participate in this study, you are free to withdraw at any time without further question.

All proposals for research using human participants are reviewed by an Ethics Committee before they can proceed. The Middlesex Psychology Department's Ethics Committee has reviewed this proposal.

Any Questions

Should you have any questions relating to your participation in this study, please contact l.irving@mdx.ac.uk and these will happily be answered.

Thank you for reading this information sheet. Please take time to decide if you would like to take part in the study and sign the consent form if so.

APPENDIX B

Study 1 consent form

School of Health and Social Sciences Department of Psychology

Written Informed Consent

I have understood the details of the research as explained to me by the researcher, and confirm that I have consented to act as a participant.

I understand that my participation is entirely voluntary, the data collected during the research will not be identifiable, and I have the right to withdraw from the project at any time without any obligation to explain my reasons for doing so.

I further understand that the data I provide may be used for analysis and subsequent publication, and provide my consent that this might occur.

This sheet will be removed before data entry to ensure further confidentiality.

Print name: _____

Sign

Name:

Date: _____

Student

No:

Researcher: Lucy Irving

APPENDIX C

Study 1. Debrief sheet

**Psychology Department
Middlesex University
Queensway, Enfield, Middlesex, EN3 4SA**

Debrief

Thank you for participating. The study you have just taken part in concerns the development of a new measure for assessing mental image controllability.

The ability to control mental imagery has been implicated in certain creative pursuits. Famous people such as Albert Einstein and Salvador Dali utilised mental imagery when working on their creations, utilising thought experiments and dream-like images respectively.

A tool which effectively measures the ability to control mental imagery is lacking in the psychological field, partly because of the subjective nature of mental imagery itself.

The task you completed was a pilot of a new performance-based measure of image controllability.

Please do not discuss the contents of your experimentation with any other student at Middlesex University.

Further Reading:

Kosslyn, S.M., Reiser, B.J., Farah, M.J., & Fliegel, S.L. (1983). Generating visual images: Units and Relations. *Journal of Experimental Psychology: General*. Vol. 112, 278-303.

Finke, R.A., Pinker, S., Farah, M.J. (1989). Reinterpreting Visual Patterns in Mental Imagery. *Cognitive Science*. Vol. 13, 51-78.

APPENDIX D

Amended version of the Image Control and Recognition Task for Study 2

Thing (3 stages)

- Imagine the number '5'
- Superimpose a capital letter 'K' of the same height and width on top of it
- Remove the bottom diagonal line of the letter 'K'

Shape (3 stages)

- Imagine a vertically standing rectangle
- Add a capital letter 'Y' to the inside of the rectangle so that the lines of the letter touch the surrounding lines
- Add a circle of the same width as the rectangle to the top of the shape

Walkie Talkie (4 stages)

- Imagine a rectangle with the long edge at the bottom (horizontal)
- Outside the rectangle, at the bottom of the right hand edge, attach a short horizontal line
- Add a square inside of the rectangle towards the right hand side but do not let it touch the sides
- Rotate the entire shape configuration 90° to the LEFT/anti-clockwise

Candle (4 stages)

- Imagine a tall thin rectangle so it is standing vertically
- Add a very short vertical line to the bottom of it so it looks like it's sticking out
- Rotate the entire shape configuration 180°
- Attach a teardrop to the top of the shape so that it is touching it

Heart (4 stages)

- Imagine a capital letter 'B'
- Rotate it 90° to the LEFT/anti-clockwise
- Add a triangle directly below it having the same width and pointing down so that the horizontal lines overlap
- Remove the horizontal line

TV (4 stages)

- Imagine a capital letter 'K'
- Put a square of the same height next to it to the left so the lines are touching
- Put a circle inside of the square
- Rotate the entire shape 90° to the LEFT/anti-clockwise

Cottage (5 stages)

Imagine a rectangle so that it is standing vertically

- Enclose the rectangle within a larger square lining up the bottom line of the rectangle with the bottom line of the square
- Add a small square just inside the top right corner of the large square, but ensure that it does not touch it
- Imagine a large triangle on top of the outer square. This should be the same width as the square, pointing upwards
- Add a small circle just inside the top left corner of the large square, but it must not touch it

Sailing Boat on Water (5 stages)

- Imagine a capital letter 'D'
- To the left of it, imagine a triangle pointing left with the vertical edge nearly touching the side of the letter 'D', but not touching it
- Join the two shapes with a short horizontal line
- At the right of the 'D', outside it, imagine a vertical wavy line touching the curve
- Rotate the entire shape 90° to the RIGHT/clockwise

Clock Tower (5 stages)

- Imagine a capital letter 'K'
- Enclose it within a circle but do not let the lines of the letter touch the circle
- Enclose this shape within a tall **rectangle**
- Add a triangle to the top of the shape so that it points up
- Remove the bottom half of the capital letter 'K'

Christmas Tree (6 stages)

- Imagine 3 triangles in a line all pointing down
- Stretch the triangle on the left so that it is twice as wide but retains its' height
- Add a small upright rectangle on top of the left triangle
- Put the middle triangle directly underneath the triangle on the left so that it is touching it
- Move the right triangle so that it is underneath the middle triangle and is touching it
- Now rotate the entire shape configuration 180°

Cat (6 stages)

- Imagine two O's next to each other so that they are touching
- Make the one on the left bigger than the one on the right
- Add a question mark to the top of the big O but imagine that the dot is obscured by it – the line of the question mark should be touching the top of the big O
- Stretch the question mark upwards so that it is long and thin
- Rotate the entire shape 90° to the LEFT/anti-clockwise
- Add an upside down 'W' to the top of the shape

Snowman (6 stages)

- Imagine two circles that are next to each other,touching
- Stretch the circle on the left horizontally so that it is twice as wide as the circle on the right
- Add a short vertical line just to the right of the circle so that it is touching it
- Add a small square to the right of the line you just added so that it is touching it
- Rotate the entire shape 90° to the LEFT/anti-clockwise
- Add three spots in a vertical line in the centre of the shape which is at the bottom

Stick Man (7 stages)

- Imagine a number '7'
- Straighten the longer line so that it makes a right angle
- Move the horizontal line down so that it is half way down the vertical line
- Rotate the shape 90° to the LEFT/anti-clockwise
- Move the horizontal line down so that it crosses over the vertical line
- Attach a small circle to the top of the vertical line
- Attach an upside-down 'V' to the bottom of the vertical line

Bow Tie Face (8 stages)

- Imagine a triangle pointing left
- Imagine a triangle pointing right
- Make these two triangles point to each other
- Imagine a large circle directly underneath the triangles
- Add a dot to the middle of the circle
- Just above the dot, also inside the circle, imagine an arch
- Rotate the entire shape configuration 180°
- Inside the circle, add two circles slightly above the dot

Shape (8 stages)

- Imagine a capital letter 'A'
- Rotate it 90° to the LEFT/anti-clockwise
- Add a vertical line to the right of the letter so that it joins the lines of the rotated letter nto make an enclosed shape
- Add a capital letter 'P' so that the vertical line of it overlaps the vertical line you just added
- Add a plus sign to the left of the shape so that the horizontal line is touching the left of the shape
- Move the curved bit of the 'P' down so that it is halfway down the line
- Rotate the entire shape 90° to the right
- Remove the horizontal line from the centre of the shape

Star (9 stages)

- Imagine a plus sign
- Enclose it within a square so that the lines touch the edges of the square
- Add a diagonal line from the top right corner to the bottom left corner of the square
- Remove the right vertical line of the square
- Remove the top horizontal line of the square
- Add another diagonal line from the top left of the shape to the bottom right
- Remove the left vertical line
- Elongate the vertical line you are left with so that it is twice as long as it was
- Remove the bottom horizontal line

APPENDIX E

Pool of all Image Control and Recognition Tasks

9 items (marked with *) came from the previous version.

Image Control and Recognition Task items

- 1 Imagine a triangle pointing upwards
 - 2 Imagine another downward pointing triangle so that it is directly underneath and the horizontal lines overlap
 - 3 Remove the horizontal line
-

- 1 Imagine a rectangle lying sideways/horizontally
 - 2 Add a right pointing triangle to the right of the shape so it is touching
 - 3 Rotate the entire shape 90° left/anti-clockwise
-

- 1 Imagine a right pointing triangle
 - 2 Add a sideways/horizontal oval to the right of the shape so it is touching it
 - 3 Add a dot inside the oval, towards the right
-

1. Imagine a capital letter 'D'
 2. Rotate it 90° to the left
 3. Add a capital 'J' directly underneath it
-

1. Imagine a letter 'V'
 2. Rotate it 180°
 3. Add a circle to the bottom of each line of the upside-down 'V'
-

1. Imagine an oval lying sideways/horizontally
 2. Add a left pointing triangle to the right of the shape so it is touching
 3. Add a right pointing triangle to the left of the shape so it is touching
-

1. Imagine a circle
 2. Add a tall triangle pointing upwards to the top of the circle so that it is touching
 3. Add a horizontal line to the top of the circle, underneath the triangle so the horizontal lines overlap
-

1. Imagine two circles side-by-side so that they are touching
 2. Add a larger circle directly underneath so that it is touching
 3. Add an even larger circle than the one you just added directly underneath the
-

shape so it's touching it

1. * Imagine a capital letter 'B'
 2. Rotate it 90° to the left/anti-clockwise
 3. Add a triangle pointing downwards so it lines up with the bottom of the shape and is touching
 4. Remove the horizontal line in the middle
-

1. Imagine an upside-down capital 'U'
 2. Add a wide/sideways rectangle directly underneath so that it is touching
 3. Rotate the entire shape 90° to the right/clockwise
 4. Add a short wavy line 'coming out' of the top of the rectangle
-

1. * Imagine a rectangle with the long edge at the bottom (horizontal)
 2. Outside the rectangle, at the bottom of the right hand edge, attach a short horizontal line
 3. Add a square inside the rectangle towards the right side but do not let it touch the sides
 4. Rotate the entire shape 90° to the left/anti-clockwise
-

1. * Imagine a tall thin rectangle so it is standing vertically
 2. Add a very short vertical line to the bottom of it so it looks like it's sticking out
 3. Rotate the entire shape 180°
 4. Attach a teardrop to the top of the shape so that it is touching it
-

1. * Imagine a plus sign
 2. Add a circle to the bottom of the vertical line
 3. Add a capital 'V' to the top of the vertical line
 4. Rotate the entire shape 180°
-

1. Imagine a triangle pointing upwards
 2. Superimpose another triangle of the same size but pointing down on top of the first one
 3. Add a vertical line underneath so it touches the bottom of the shape
 4. Rotate the entire shape 180°
-

1. Imagine a square
 2. Add a plus sign inside the square so all the lines reach the surrounding lines
 3. Add a 'smaller than' sign (left facing arrow) to the right of the shape so that it is halfway down and touching
 4. Rotate the entire shape 90° to the left/anti-clockwise
-

-
1. Imagine a downward pointing triangle
 2. Add two dots side-by-side above the triangle but do not let them touch it
 3. Enclose everything within a large circle
 4. 'Fill in' or 'colour in' the triangle
-

1. * Imagine a capital letter 'D'
 2. To the left of it, imagine a triangle pointing left with the vertical edge nearly touching the side of the 'D', but not touching it
 3. Join the two shapes with a short horizontal line
 4. At the right of the 'D', outside it, imagine a vertical wavy line touching the curve
 5. Rotate the entire shape 90° to the right/clockwise
-

1. * Imagine a capital letter 'K'
 2. Enclose it within a circle but do not let the lines of the letter touch the circle
 3. Enclose this shape within a tall rectangle so the circle is towards the top
 4. Add a triangle to the top of the shape so that it points up
 5. Remove the bottom half of the capital letter 'K'
-

1. * Imagine a rectangle so that it is standing vertically
 2. Enclose the rectangle within a larger square lining up the bottom line of the rectangle with the bottom line of the square
 3. Add a small square just inside the top right corner of the large square, but ensure that it does not touch it
 4. Imagine a large triangle sitting on top of the outer square. This should be the same width, pointing upwards, and touching
 5. Add a small circle just inside the top left corner of the large square, but it must not touch it
-

1. Imagine a rectangle with the long edge at the bottom (horizontal)
 2. Add a capital 'U' inside the rectangle, at the top right, so that the top of the letter touches the top of the rectangle
 3. Rotate the shape 90° to the left/anti-clockwise
 4. Add a long and thin triangle outside the shape, to the right of it, pointing right
 5. Rotate entire shape 90° to the left/anti-clockwise
-

1. Imagine a capital letter 'D'
 2. Rotate the entire shape 90° to the left/anticlockwise
 3. Add a trapezoid, with the longer horizontal line at the top, underneath the shape so that the horizontal line of the trapezoid overlaps that of the rotated 'D'
 4. Add a small circle on top of the shape so it is touching
 5. 'Fill in' or 'colour in' the circle
-

-
1. Imagine a long thin triangle pointing left
 2. Add a plus sign to the right of the shape so that it is touching
 3. Move the vertical line of the plus sign right, to the end of the shape
 4. Rotate the entire shape 90° to the right/clockwise
 5. Elongate the bottom horizontal line in both directions

-
1. Imagine a capital letter 'U'
 2. Rotate it 90° to the right/clockwise
 3. Add a square to the right of the shape so that it is touching
 4. Reduce/shrink the square so that it becomes an upright rectangle
 5. Rotate the whole shape 90° to the right/clockwise

-
1. Imagine a long right-pointing triangle
 2. Rotate it 90° to the right/clockwise
 3. Add a horizontal line inside the triangle, about halfway down
 4. Add a short, upward pointing triangle underneath the shape so that it is touching
 5. Add a diagonal line, leaning right, so that it looks like it is sticking out of the top of the shape

-
1. * Imagine two O's next to each other so that they are touching
 2. Make the O on the left bigger than the one on the right
 3. Add a question mark to the top of the big O but imagine that the dot is obscured – the line of the question mark should be touching the top of the big O
 4. Stretch the question mark upwards so that it is long and thin
 5. Rotate the entire shape 90° to the left/anti-clockwise
 6. Add an upside down 'W' to the highest point of the shape so it is touching it
-

-
1. * Imagine two circles that are next to each other, touching
 2. Stretch the circle on the left so that it becomes a wide oval
 3. Add a short vertical line just to the right of the **circle** so that it is touching it
 4. Add a small square to the right of the line you just added so that it is touching it
 5. Rotate the entire shape 90° to the left/anti-clockwise
 6. In the centre of the shape which is at the bottom, add three spots in a vertical line

-
1. Imagine a capital letter O
 2. Add a short line to the left of the O so that the O is at the top of the line, to the right of it
 3. Add another capital letter O so that it appears directly below the first O and is touching it
 4. Add a left pointing triangle to the left of the shape so that it joins the line to the left of the O's
 5. Rotate the entire shape 90° to the left/anti-clockwise
 6. Add another O so that it sits on top of the O's you already have

-
1. Imagine a capital 'X'
 2. Add a vertical line to the right side of the letter so that it is the same height and touching
 3. Add a vertical line to the left side of the letter so that it is the same height and touching
 4. Add two horizontal lines, one across the top and one along the bottom of the shape so that they are the same width and touching
 5. Rotate the entire shape 90° to the right/clockwise
 6. Remove the bottom half of the 'X'

-
1. Imagine a capital 'T'
 2. Add a horizontal line underneath the letter so that it is the same width, and touching
 3. Superimpose a diagonal line across the shape so that it joins the top right of the shape with the bottom left of it
 4. Superimpose a diagonal line across the shape so that it joins the top left of the shape with the bottom right of it
 5. Remove the vertical line
 6. Rotate the entire shape 90° to the right/clockwise
-

-
1. Imagine a vertically standing rectangle
 2. Stretch it upwards so that it is long and thin
 3. Rotate it 90° to the right/clockwise
 4. Add a square to the left of the rectangle so that it is the same height and touching it
 5. Add a right pointing triangle to the right of the shape so that it is the same height and touching it
 6. Rotate the entire shape 90° to the left/anticlockwise

-
1. Imagine a rectangle so that it is lying sideways (horizontally)
 2. Inside this rectangle, imagine a circle in the middle of it
 3. Imagine another circle to the right of the first one but do not let them touch
 4. Imagine another circle to the left of the first circle, but do not let them touch
 5. Rotate the entire shape 90° to the left/anticlockwise
 6. Add a vertical line directly underneath the shape so that it is sticking out
-

APPENDIX F

Image Control and Recognition Task response booklet (1 page)

Title:	Title:
Title:	Title:

APPENDIX G

Study 2. Debrief sheet

**Psychology Department
Middlesex University
Queensway, Enfield, Middlesex, EN3 4SA**

Debrief

Thank you for participating. The study you have just taken part in concerns the development of a new measure for assessing mental image controllability.

The ability to control mental imagery has been implicated in certain creative pursuits. Famous people such as Albert Einstein and Salvador Dali utilised mental imagery when working on their creations, utilising thought experiments and dream-like images respectively.

A tool which effectively measures the ability to control mental imagery is lacking in the psychological field, partly because of the subjective nature of mental imagery itself.

The tasks you completed were to pilot a new performance-based measure of image controllability. The memory task was administered to ascertain whether memory or imagery were more crucial to the ability to solve the image transformation tasks.

Please do not discuss the contents of your experimentation with any other student at Middlesex University.

Further Reading:

Kosslyn, S.M., Reiser, B.J., Farah, M.J., & Fliegel, S.L. (1983). Generating visual images: Units and Relations. *Journal of Experimental Psychology: General*. Vol. 112, 278-303.

Finke, R.A., Pinker, S., Farah, M.J. (1989). Reinterpreting Visual Patterns in Mental Imagery. *Cognitive Science*. Vol. 13, 51-78.

APPENDIX H

Study 3a. Information sheet

HSSC, Department of Psychology Participant Information Sheet

Researcher: Lucy Irving

You are being invited to take part in a very short research study. Before you decide it is important for you to understand why the research is being done and what it will involve. Please take time to read the following information carefully. Ask if there is anything that is not clear or if you would like more information. Take your time to decide whether you wish to take part.

This study is related to a piece of research being conducted into mental imagery. Some imagery tasks have been developed, and your task is to look through the images and to give each one a name. Please do not try to be creative, just write the name which you feel best suits the shape.

All responses will be kept confidential and this booklet should take no longer than 15-20 minutes to go through. Participation is entirely voluntary. You do not have to take part if you do not want to. If you do decide to take part, you will be asked to sign a Written Informed Consent Form. You may withdraw at any time without giving a reason.

The research data collected will be anonymous. Your answers will be kept confidential during the research and after the study has been completed. All information will only be seen by members of the research team and all proposals for research using human participants are reviewed by an Ethics Committee before they can proceed. Middlesex University's Psychology Ethics Committee has reviewed and approved this study.

If you have any concerns, questions or comments about this study please contact **Lucy Irving**. Department of Psychology, Middlesex University, Hendon, room R109; email l.irving@mdx.ac.uk

Thank you for reading this information. Please feel free to keep this sheet.

APPENDIX I

Study 3a. Consent form

School of Health and Social Sciences Department of Psychology

Written Informed Consent

I have understood the details of the research as explained to me by the researcher, and confirm that I have consented to act as a participant.

I understand that my participation is entirely voluntary, the data collected during the research will not be identifiable, and I have the right to withdraw from the project at any time without any obligation to explain my reasons for doing so.

I further understand that the data I provide may be used for analysis and subsequent publication, and provide my consent that this might occur.

Date

Print name

Sign Name

Student No.

Researcher: Lucy Irving

APPENDIX J

Study 3a. Debrief sheet

Dear Student

Thank you for taking part in this study. Your contribution assists in the validation of a new measure of imagery control, the Image Control and Recognition Task (ICRT). During this task, participants are asked to manipulate shapes using only their mental imagery, and then to try and name the resultant image before drawing it. The ICRT is being developed for use primarily in the field of mental imagery and creativity research.

The names you provided will enable further development of the tool, which is performance-based. The nature of mental imagery means that it is difficult to effectively measure individual differences in imagery control, and the ICRT aims to be a more objective tool. It is important that there is agreement about what the pictures depict.

If you have any questions relating to the study, or would like to know any further information please ask Lucy or email l.irving@mdx.ac.uk.

Thank you for taking the time to participate in this study.

APPENDIX K

The Vividness of Visual Imagery Questionnaire (VVIQ, Marks, 1973)

EYES OPEN VERSION

Vividness of Visual Imagery Questionnaire

Visual imagery refers to the ability to visualize, that is, the ability to form mental pictures, or to “see in the mind’s eye”. Marked individual differences have been found in the strength and clarity of reported visual imagery and these differences are of considerable psychological interest.

The aim of this test is to determine the vividness of your mental imagery. The items of the test will possibly bring certain images to your mind. You are asked to rate the vividness of each image by reference to the 5-point scale given below. For example, if your image is “vague and dim” then give it a rating of 4. Before you turn to the items on the next page, familiarize yourself with the different categories on the rating scale. Throughout the test, refer to the rating scale when judging the vividness of each image. Try to do each item separately, independent of how you have done other items. Complete all items for images with the eyes open.

Rating Scale

The image aroused by the item might be:

Perfectly clear and as vivid as normal vision	<u>1</u>	2	3	4	5
Clear and reasonably vivid	1	<u>2</u>	3	4	5
Moderately clear and vivid	1	2	<u>3</u>	4	5
Vague and dim	1	2	3	<u>4</u>	5
No image at all, you only “know” that you are thinking of an object	1	2	3	4	<u>5</u>

In answering items 1 to 4 think of some relative or friend whom you frequently see (but who is not with you at present) and consider carefully the picture that comes before your mind's eye.

Item –

1. The exact contour of face, head, shoulders and body.	1	2	3	4	5
2. Characteristic poses of head, attitudes of body, etc.	1	2	3	4	5
3. The precise carriage, length of step, etc. in walking	1	2	3	4	5
4. The different colours worn in some familiar clothes.	1	2	3	4	5

Visualise the rising sun. Consider carefully the picture that comes before your mind's eye.

Item –

5. The sun is rising above the horizon into a hazy sky	1	2	3	4	5
6. The sky clears and surrounds the sun with blueness	1	2	3	4	5
7. Clouds. A storm blows up, with flashes of lightening	1	2	3	4	5
8. A rainbow appears	1	2	3	4	5

Rating Scale

The image aroused by the item might be:

Perfectly clear and as vivid as normal vision	<u>1</u>	2	3	4	5
Clear and reasonably vivid	1	<u>2</u>	3	4	5
Moderately clear and vivid	1	2	<u>3</u>	4	5
Vague and dim	1	2	3	<u>4</u>	5
No image at all, you only "know" that you are thinking of an object	1	2	3	4	<u>5</u>

Think of the front of a shop you often go to. Consider the picture that comes before your mind's eye.

Item –

9. The overall appearance of the shop from the opposite side of the road	1	2	3	4	5
10. A window display including colours, shapes and details of individual items for sale	1	2	3	4	5
11. You are near the entrance. The colour, shape and details of the door	1	2	3	4	5
12. You enter the shop and go to the counter. The counter assistant serves you. Money changes hands.	1	2	3	4	5

Finally, think of a country scene which involves trees, mountains and a lake. Consider the picture that comes before your mind's eye.

Item –

13. The contours of the landscape	1	2	3	4	5
14. The colour and shape of the tree	1	2	3	4	5
15. The colour and shape of the lake	1	2	3	4	5
16. A strong wind blows on the trees and on the lake causing waves	1	2	3	4	5

Rating Scale

The image aroused by the item might be:

Perfectly clear and as vivid as normal vision	<u>1</u>	2	3	4	5
Clear and reasonably vivid	1	<u>2</u>	3	4	5
Moderately clear and vivid	1	2	<u>3</u>	4	5
Vague and dim	1	2	3	<u>4</u>	5
No image at all, you only "know" that you are thinking of an object	1	2	3	4	<u>5</u>

Same questions for eyes closed version

APPENDIX L

Study 3b. Information sheet

Department of Psychology, HSSc
Participant Information Sheet

Researcher: Lucy Irving

You are being invited to take part in a research study. Before you decide it is important for you to understand why the research is being done and what it will involve. Please take time to read the following information carefully. Ask if there is anything that is not clear or if you would like more information.

In this study, you will complete three imagery tasks and the session will take 45 minutes to an hour to complete. One is a self-report questionnaire, and the other two are performance-based tasks. Full instructions and practice trials will be provided.

Participation in this research is entirely voluntary. You may withdraw from the study at any time without giving a reason. If you are happy to take part, please sign the Informed Consent section at the bottom of this sheet.

The research data collected will be anonymous. Your questionnaires will be kept strictly confidential during the research and after the study has been completed. All information will only be seen by members of the research team and all proposals for research are reviewed by an Ethics Committee before they can proceed. Middlesex University's Psychology Ethics Committee has reviewed and approved this proposal.

If you have any concerns, questions or comments about this study please contact **Lucy Irving**. Department of Psychology, Middlesex University, Hendon, email l.irving@mdx.ac.uk

Thank you for reading this information. Please feel free to keep this sheet if you would like to.

APPENDIX M

Study 3b. Consent form

CONSENT FORM:

This study has been explained to me to my satisfaction, and I agree to take part.

I understand that I am free to withdraw at any time.

NAME: DATE:

MDX STUDENT NUMBER:

APPENDIX N

Study 3b. Debrief sheet

Thank you for taking part in this study. Your contribution assists us in our understanding of the relationship between different types of mental imagery task.

You completed three mental imagery tools:

The Image Control & Recognition Task (ICRT, Irving, 2011) required you to follow instructions and combine shapes and letters, and then try to name and draw the resultant image. This tool measures mental imagery control and this ability to manipulate mental images is something which many creative people say is utilised while engaging in creative pursuits.

You also completed a mental rotation task, which is a well-known tool developed by Shepard and Metzler (1971). The ways in which people manipulate mental images is of interest to those studying imagery and its use in creative domains.

You also completed the Vividness of Visual Imagery Questionnaire, (VVIQ, Marks, 1973), which measures how vivid you rate your images to be when introspecting on certain scenes and scenarios brought to mind.

These three tools will be analysed in relation to one another to ascertain whether the self-report tools bear any relation to the more objective measures, as the literature often reports that they do not (Burton, 2003).

If you have any questions relating to the study please ask Lucy or email l.irving@mdx.ac.uk.

Thank you for taking the time to participate in this study.

References

Burton, L.J. (2003). Examining the Relation Between Visual Imagery and Spatial Ability Tests. *International Journal of Testing*. Vol. 3(3), 277-291.

Daniels-McGhee, S. and Davis, G.A. (1994). The Imagery-Creativity Connection. *Journal of Creative Behaviour*. Vol.28(3), 151-177.

Irving, L., Barry, R., LeBoutillier, N., & Westley, D. (2011). The Image Control and Recognition Task: A Performance-Based Measure of Imagery Control. *Journal of Mental Imagery*, 35(3 & 4), 67-80.

Marks, D.F. (2003). Visual Imagery Differences in the Recall of Pictures. *British Journal of Psychology*. Vol. 64(1). 17-24.

Shepard, R. N., & Metzler, J. (1971). Mental rotation of three-dimensional objects. *Science*, 171, 701-703.

APPENDIX O

Adapted Test of Visual Imagery Control, (TVIC, Gordon, 1950)

THE GORDON TEST OF VISUAL IMAGERY CONTROL

NAME:

AGE:

MALE/FEMALE:

OCCUPATION/COURSE:

Read each question then close your eyes while you try to visualise the scene. Once you are happy with your image, please record how easily you are able to change and amend each image by circling one of the numbers below, with 1 being 'no control, and 5 being 'complete control'.

Your accurate and honest answer to these questions is most important for the validity of this study. Please ensure that you answer all 12 questions.

Please rate how easily you can control your internal image according to the following instructions.

- | | |
|---|---------------------------|
| 1. Visualise a car standing in the road in front of a house | 1.....2.....3.....4.....5 |
| 2. Visualise it in colour | 1.....2.....3.....4.....5 |
| 3. Visualise it in a different colour | 1.....2.....3.....4.....5 |
| 4. Visualise the same car lying upside down | 1.....2.....3.....4.....5 |
| 5. Visualise the same car back on its four wheels again | 1.....2.....3.....4.....5 |
| 6. Visualise the same car running along the road | 1.....2.....3.....4.....5 |
| 7. Visualise it climbing up a very steep hill | 1.....2.....3.....4.....5 |
| 8. Visualise it climbing over the top | 1.....2.....3.....4.....5 |
| 9. Visualise it getting out of control and | |
| 10. crashing through a house | 1.....2.....3.....4.....5 |

11. Visualise the same car running along the road with
a handsome couple inside 1.....2.....3.....4.....5
12. Visualise the car crossing a bridge and falling over
the side into a stream below 1.....2.....3.....4.....5
13. Visualise the car old and dismantled in a car cemetery 1.....2.....3.....4.....5

APPENDIX P

Study 4. Information sheet

School of Health and Social Sciences
Department of Psychology

Participant Information Sheet

Researcher: Lucy Irving

Supervisor: Dr Nicholas LeBoutillier

You are being invited to take part in a research study. Before you decide it is important for you to understand why the research is being done and what it will involve. Please take time to read the following information carefully. Ask us if there is anything that is not clear or if you would like more information. Take your time to decide whether you wish to take part.

In this study, the relationships between particular thinking styles and mental imagery abilities will be investigated. You will be asked to complete a number of self-report questionnaires, relating to certain cognitive styles and traits, your imagery control and imagery vividness.

The questionnaires should take no more than 1 hour to complete.

Participation in this research is entirely voluntary. You do not have to take part if you do not want to. If you do decide to take part, you will be asked to sign a Written Informed Consent Form. You may withdraw from the study at any time without giving a reason.

The research data collected will be anonymous. Your questionnaires will be kept strictly confidential during the research and after the study has been completed. All information will only be seen by members of the research team and all proposals for research using human participants are reviewed by an Ethics Committee before they can

proceed. Middlesex University's Psychology Ethics Committee has reviewed and approved this proposal.

If you have any concerns, questions or comments about this study please contact **Lucy Irving**. Department of Psychology, Middlesex University, Hendon, room R109; email l.irving@mdx.ac.uk

Thank you for reading this information. Please feel free to keep this sheet.

APPENDIX Q

Study 4. Consent form

School of Health and Social Sciences Department of Psychology

Written Informed Consent

I have understood the details of the research as explained to me by the researcher, and confirm that I have consented to act as a participant.

I understand that my participation is entirely voluntary, the data collected during the research will not be identifiable, and I have the right to withdraw from the project at any time without any obligation to explain my reasons for doing so.

I further understand that the data I provide may be used for analysis and subsequent publication, and provide my consent that this might occur.

This sheet will be removed before data entry to ensure further confidentiality.

Print name: _____

Sign Name: _____

Date: _____

Student No: _____

Researcher: Lucy Irving

APPENDIX R

Study 4. Debrief sheet

Dear Student

Thank you for taking part in this study. Your contribution assists us in our understanding of the relationship between mental imagery and certain cognitive traits, or thinking styles.

You completed two imagery questionnaires (Test for Visual Imagery Control, TVIC, Richardson, 1969) and the Vividness of Visual Imagery Questionnaire, (VVIQ, Marks, 1973), and a measure relating to your feelings and experiences called the Oxford-Liverpool Inventory of Feelings and Experiences, (O-LIFE, Mason et al., 1995). In addition, you completed the Creative Visualisation Task, (CVT, Finke, 1990) and the Image Control and Task, (ICRT) which relates to both visual imagery and creativity. These measures are to be explored in relation to each other. Further information about these measures can be found in the reference list provided.

The traits which are measured by the questionnaire which asked about your thoughts and feelings are common. It is thought that these traits and characteristics are present among the 'normal' population, with all people falling somewhere on each scale.

The subscales are: unusual experiences, cognitive disorganisation, impulsive nonconformity and introverted anhedonia, yet the *unusual experiences* subscale (positive schizotypy) is of interest in the present study. This scale is characterised by magical or sometimes bizarre thoughts and ideas, visual and/or auditory hallucinations, and an 'over inclusive' thinking style, all of which are common among certain creative individuals. The relationship between these scales will be looked at in relation to the creativity task you completed, and the image control and recognition task in which you manipulated shapes as instructed. Imagery control has also been cited as being beneficial whilst engaging in creative activities.

If you have any questions relating to the study please ask Lucy or email l.irving@mdx.ac.uk.

References

- Finke, R. A. (1990). *Creative imagery: Discoveries and inventions in visualization*. Hillsdale, NJ: Erlbaum.
- Marks, D.F. (1973). Mental imagery and creativity: A meta-analytic review study. *British Journal of Psychology*. Vol. 94. 29-44

Mason, O., Claridge, G., & Jackson, M. (1995). New scales for the assessment of schizotypy. *Personality and Individual Differences*. Vol. 1, 7-13

Richardson, A. (1969). *Mental imagery*. Routledge and Kegan Paul: London.

APPENDIX S

Study 4. Correlations between creativity, imagery and schizotypy variables with age partialled out

Partial correlation results controlling for age:

The relationship between CVT and ICRT controlling for age was $pr = .52, p < .001$. This is a marginal increase from $r = .50, p < .001$.

When age was taken into account, the significant negative relationship between CVT & CogDis was removed, $pr = -.09, p = .414$. This coefficient represents a decrease from $r = -.22, p < .05$ when controlling for age.

The coefficient between CVT and VVIQ scores was $pr = .19, p = .073$, which is a decrease from $r = .22, p < .05$. The significant relationship between creativity and vividness was not found when age was accounted for.

There was no change in the relationships between TVIC and VVIQ ($pr = .38, p < .001$) and VVIQ and IntAn ($pr = -.21, p = .045$) when controlling for age, while the relationship between UnEx and ImpNon was $pr = .33, p = .002$, a marginal increase from $r = .31, p < .001$. The relationship between CogDis and ImpNon was $pr = .44, p < .001$, a marginal decrease from $r = .42, p < .001$.

APPENDIX T

Flyer for recruiting artists for Study 5

You are invited to take part in a research study

Are you an artist?

Are painting and drawing things you enjoy?

Have you ever published any of your work?

Are you creative?

USE YOUR IMAGINATION

... and be entered into a PRIZE-DRAW for

£150 Amazon vouchers

As part of my PhD research I am investigating the relationships between mental imagery abilities, thinking styles, and the techniques individuals use when engaging in creative endeavours.

If you take part you will undertake a range of short psychological questionnaires and tasks that measure your thinking styles and visual imagination.

I will prepare a *psychological profile* for you that explains which of your aptitudes and cognitive characteristics may be related to your creativity, and of course your name will be entered into the draw for the vouchers. The session will take no longer than 1.5 hours (less in most cases).

I can see people one-to-one or in small groups (up to 7 people) and can travel to a location convenient to you.

Please contact Lucy on lirving@mdx.ac.uk or call 07958 455 590

if you would like to take part or for more information.

Please pass these details on to anyone you know who may be interested.

~ Thank you ~

APPENDIX U

Complexities in scoring the Torrance Tests of Creative Thinking and subsequent scoring decisions

The following is an account of the challenges that arose during the coding and scoring of the Torrance Tests of Creative Thinking (TTCT), along with an explanation of the steps which were taken in an attempt to overcome these challenges. These obstacles are outlined along with illustrated examples.

PROBLEMS RELATING TO THE CIRCLES AND THE INCOMPLETE FIGURES TTCT TASKS

The titles which accompanied the incomplete figures and circles were problematic in terms of scoring. Originally the scorers were requested to insert the titles for each shape into the dataset as they had been written by the participants verbatim, so that the statistical infrequency (originality) of these titles could be calculated. However, once the data were returned for statistical analysis it was apparent that this was not straight-forward as most people had not provided a simple, one-word title, so comparison of the actual titles as they were written was not possible. The scoring was made more difficult because of a possible confound, namely, that the instructions explicitly requested participants to create stories with the stimulus images. Despite the judges studying the complete set of titles which were provided with the drawings, scoring these for 'abstractness' as a general quality was the titles did not lend always themselves to this type of scoring. Examples in Figure T1 and T2 illustrate this point.

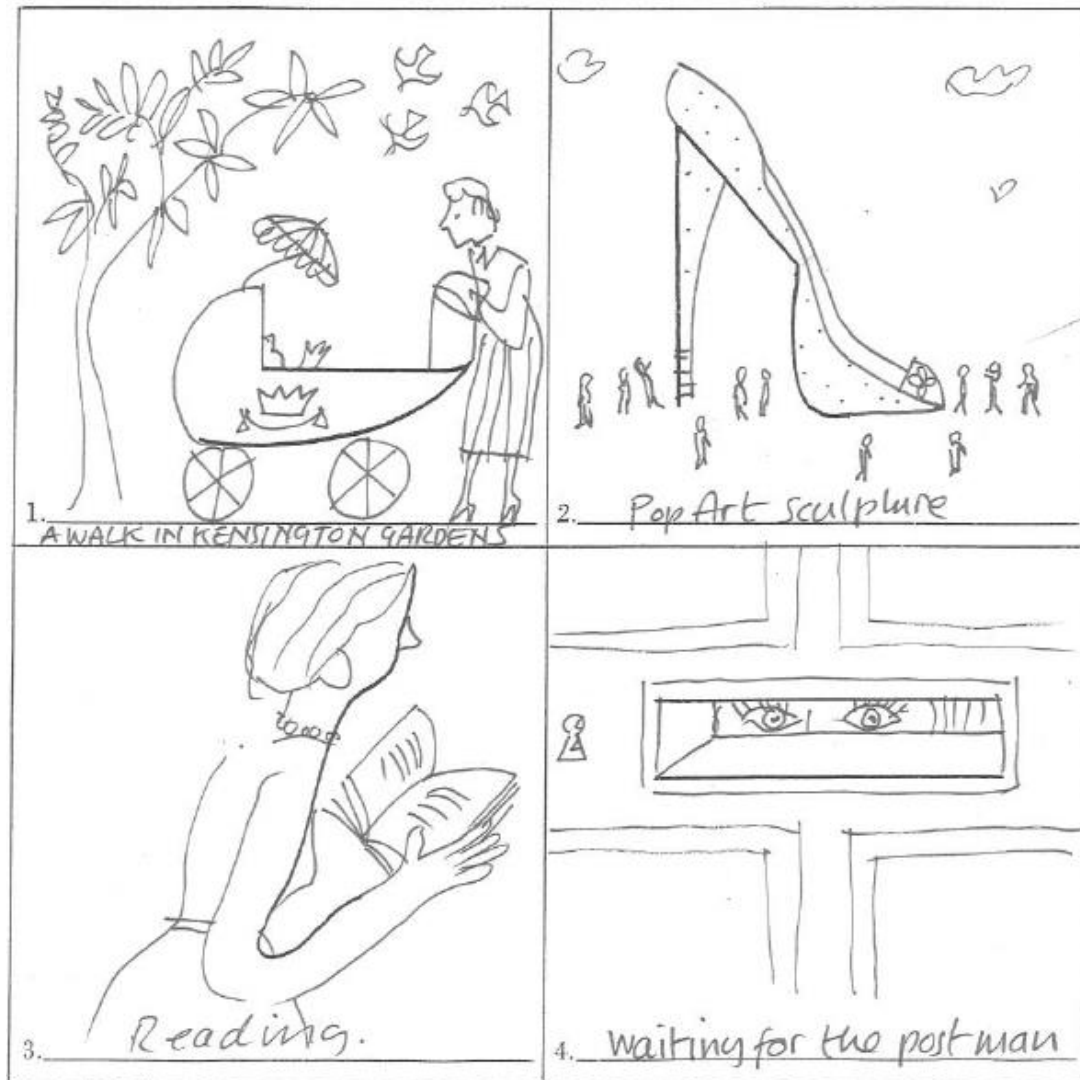


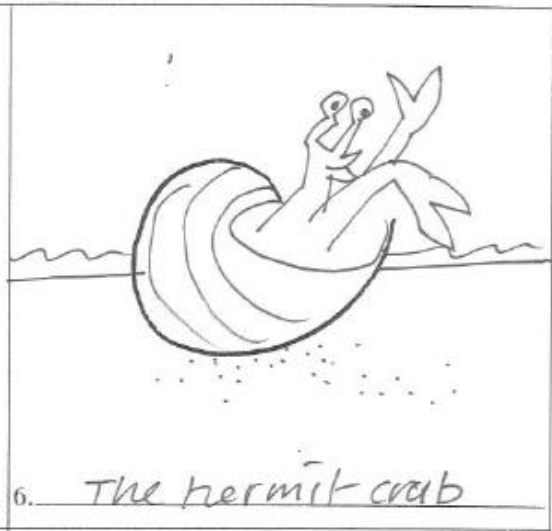
Figure T1

Drawings and accompanying titles provided in the Incomplete Figures Task

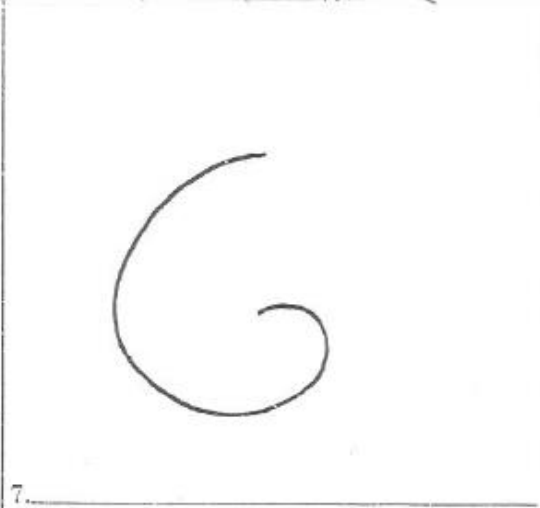
(Continued on the next page)



5. ENJOYING THE NEW HAT
DOWN UNDER



6. The hermit crab



7.



8. Feeding time.



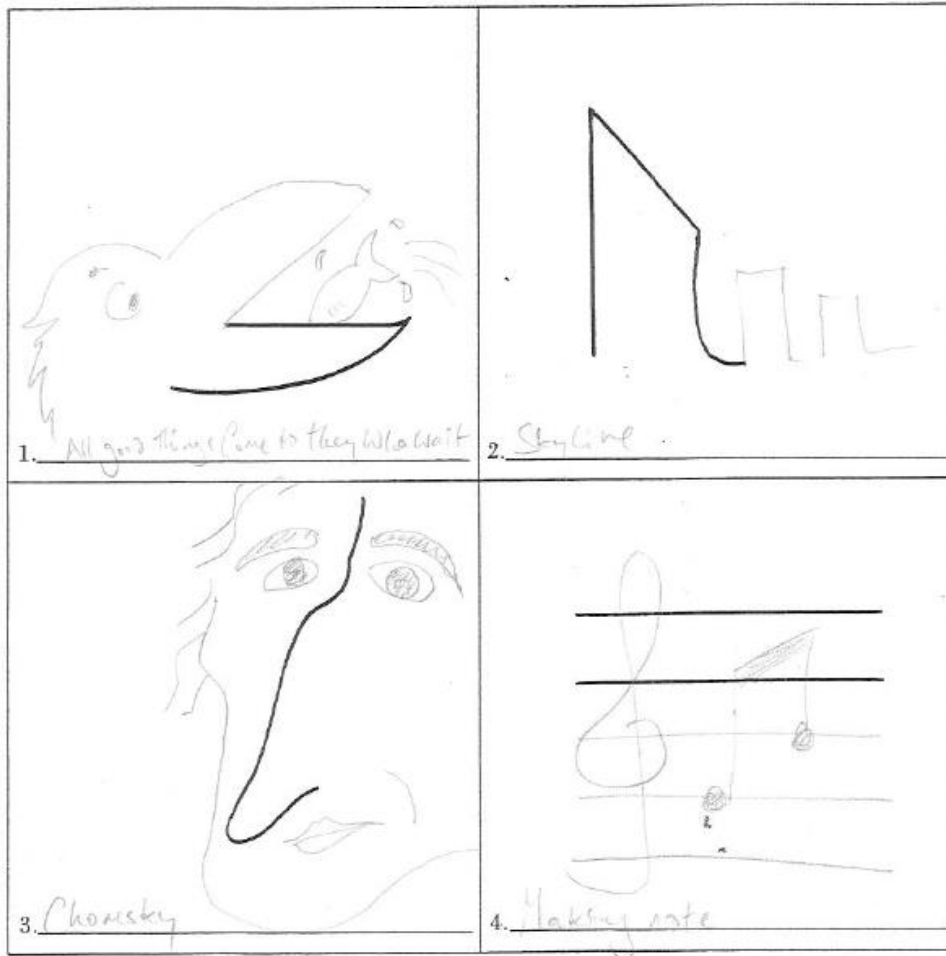
9. HONEY I SHRANK THE KIDS



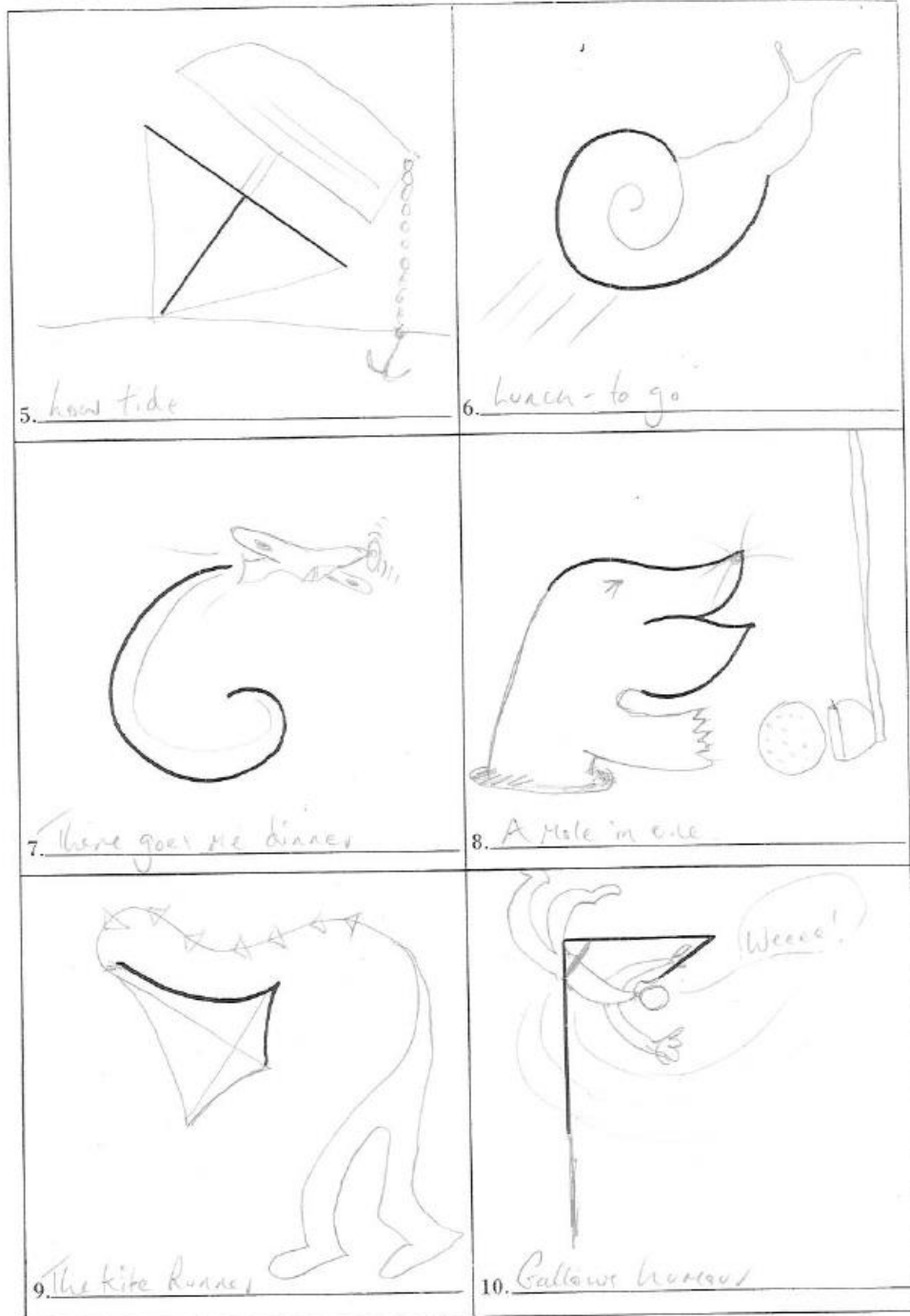
10. THE OLDEST PROFESSION

Figure T2

Examples of abstract titles provided in the Incomplete Figures task



(Continued on the next page)

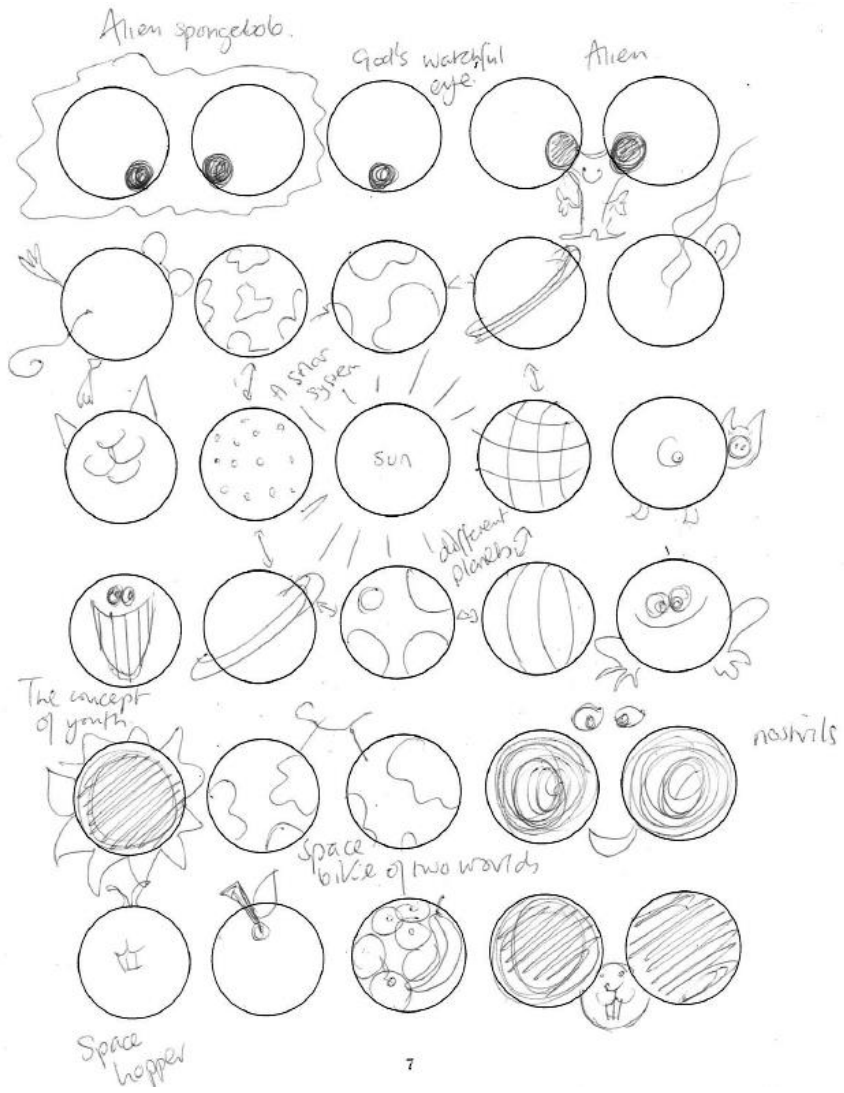


The problem of subjectivity was more pronounced for abstractness of titles than it was for the index of originality, which, owing to adoption of the Guilford scoring procedure, had a mathematical component to its calculation. The problems encountered when scoring the images for elaboration and abstractness of titles meant in order to obtain agreement discussion between the raters would likely have to take place for every instance of a potentially abstract title in order to agree on how to best award the points. This was problematic for a number of reasons. Firstly, it appeared to be at odds with the objectives of psychometric testing in general, that is, the intention of creating technical norms and scoring procedures is surely to avoid the need for discussion of this nature. Secondly, it seemed as though discussion about such a large set number responses would undermine the authenticity of subsequent calculations of inter-rater reliability. Lastly – a similar problem to the first – the need for discussion of each title seemed counter to an overarching aim of the study itself, which was to employ tools to measure creativity which avoided the problem of subjectivity as far as possible. The inter-rater reliability between the judges for the elaboration scores was not reliable ($r = .58$). The lack of agreement between raters may have been a result of the previously discussed issues. They could of course have resulted from raters' differing conceptualisations of the word 'abstract' and what constitutes an abstract title. That being said, these tasks were originally designed for use with children and so the abstractness of the responses, and indeed the overall level of detail provided may conceivably vary far less with younger participants, making it easier to award and agree upon ratings.

While this critique concerns the scoring of the TTCT, it is worth noting that scoring the other performance-based creativity tools in the battery was arguably less subjective and more numerical by comparison, indeed this was one of the reasons they were selected. The AUT scoring method included a correction for contamination of fluency and the responses were far easier to code due to the nature of the task instructions, while the scoring conventions for the CET were unambiguous and straightforward. The CET and the elaboration index of the TTCT both require judges to count instances of some feature. However, how well defined these ‘point criteria’ are varies depending on the tool. In the case of the CET, the criteria for awarding points are far more explicit, for example, if the creature lacks sensory organs then it receives a point on the ‘lacks sensory organs’ scale, while the TTCT criterion for elaboration is to award a point for each additional ‘idea’ included, a far less concrete instruction. Figure T3 below provides drawings which were provided by participants in the TTCT circles task.



(a)



(b)

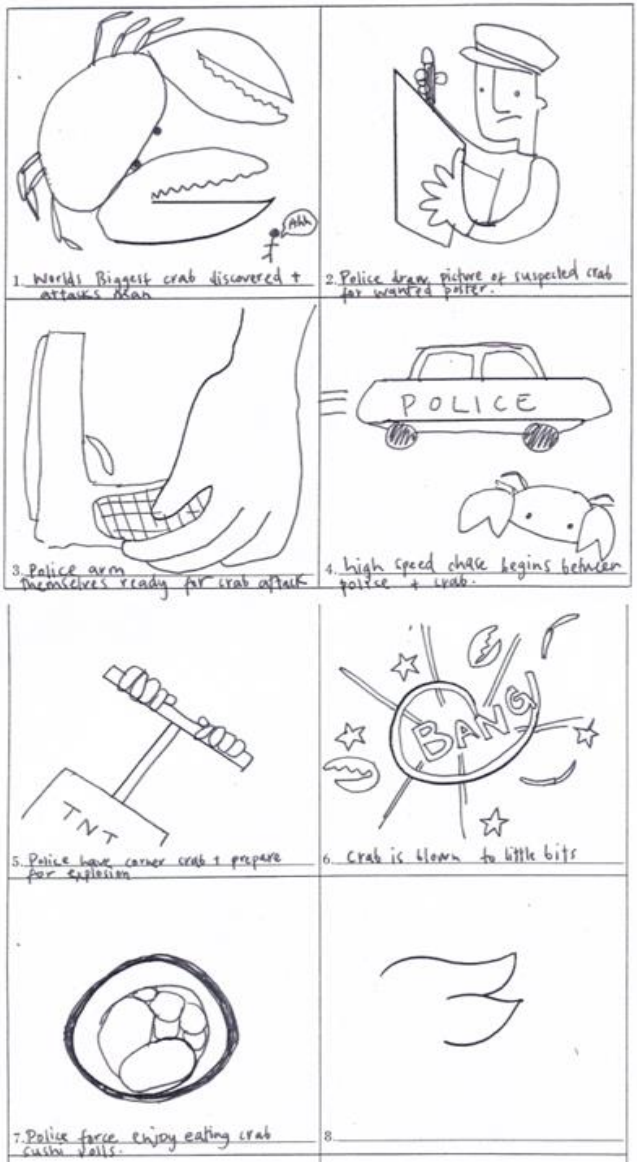
Figure T3

Examples generated by participants during the Circles task

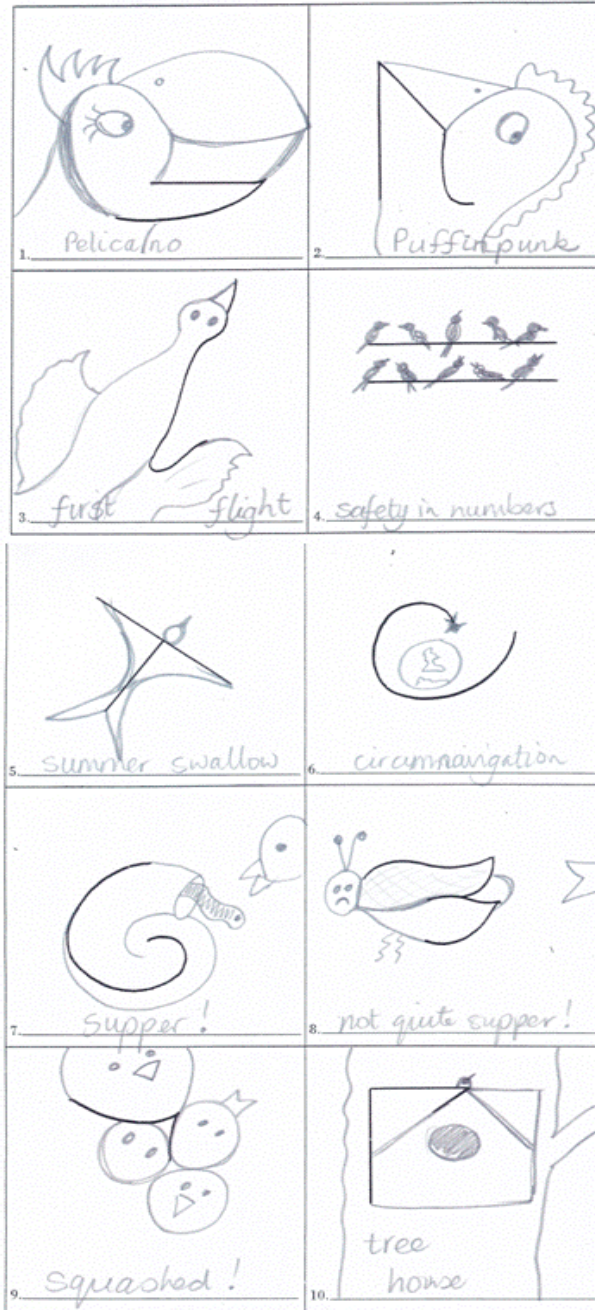
As the examples in Figure T5 indicate, for this activity there was no designated space provided for participants to record titles on the response sheet and the circles were close together. A sizeable number of participants did not provide titles for the images they made for the circles, or only titled a selection of them, and it is suggested that the lack of space may be part of the reason for this. Another probable reason may have resulted from the task instructions which explicitly specified that they tried to make the images tell a complete story, as was the case with the incomplete figures task. The example in Figure T3 (a), which does not tell a story, includes a lot of detail around the circles, which in turn takes up space, and the participant does not provide titles for any of the images drawn. However for the images in Figure T3 (b), although the response does not include a narrative, there is an apparent ‘space’ theme, so this participant has clearly tried to follow both the instruction to provide titles but to also make the images ‘fit together’ somehow, something seen in a number of participants’ responses¹⁹.

¹⁹ Some participants carried their theme through all of their images for all tasks. It is conceivable that the ‘space theme’ in Figure T5 (b) came about having completed the conceptual expansion task which required an imagined journey to a distant galaxy. This tendency was shown by a small number of the participants and was highlighted by the substantial number of ‘nautical’ themed drawings, possibly due to the similarity of the first TTCT incomplete figure to (half) a boat.

A complexity arose with the scoring the titles of the images generated by participants in the incomplete figures task. As was outlined in the Procedure section, instructions explicitly requested that participants tried to make the images *tell as complete and interesting a story* as they could, so a number of them intuitively wrote their narrative in the space below each figure. Not all of the participants provided what could be described as ‘titles’ and many instead followed the instruction to make up a story with the images. Additionally, when ‘titling’ their drawings, many assigned titles which did not lend themselves to the type of coding suggested by the originality scoring conventions. Some examples are presented at Figure T4 (a & b) to illustrate these points.



(a)



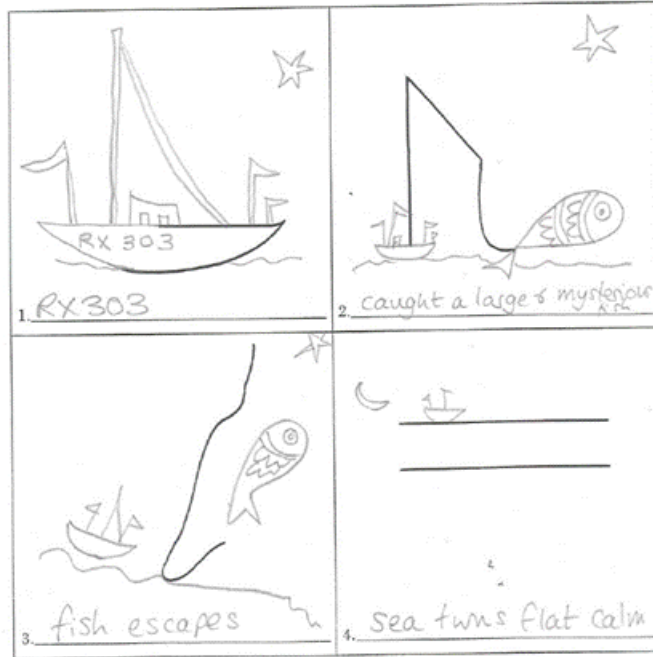
(b)

Figure T4

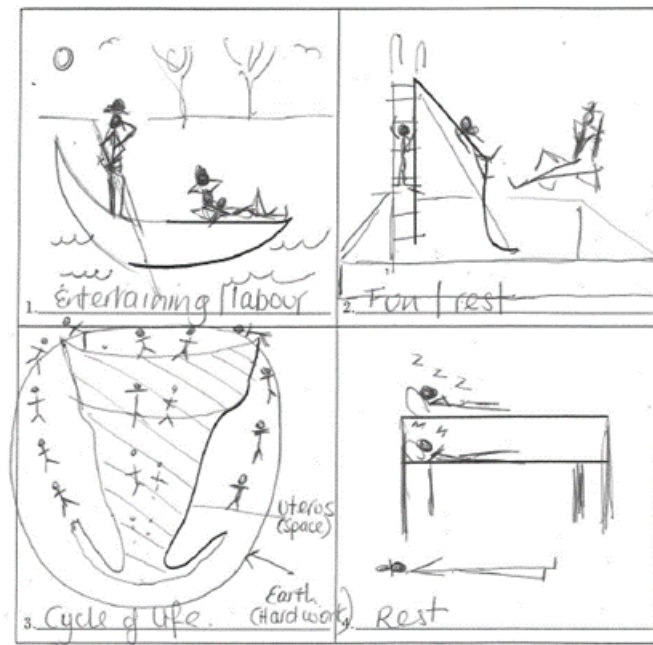
Examples of story-like titles generated in the Incomplete Figures task

Inspection of the responses provided for the incomplete figures task revealed that some common uses for the shapes frequently did emerge, so despite the lack of norms, this aspect of the scoring was attempted in order to ascertain originality scores. The judges were asked to re-score all images generated in the incomplete figures tasks but they were also asked to provide an indication of what the participant made the main shape into rather than to record the actual title. So, for example, it was apparent that the first incomplete figure was often made into a bowl or a mouth, so in these instances, despite the title provided possibly being something like 'breakfast', or 'yummy', the scorers were asked to provide a set of 'generic' titles for the images. They were asked to keep this as consistent as possible, so for example, for the drawings provided for incomplete figures number 1 in Figure T5, both images were entitled 'boat'²⁰.

²⁰ Figures T4 and T5 also highlight the tendency for some participants to continue a theme throughout their responses.



(a)



(b)

Figure T5

Examples of the same items being given different titles in the Incomplete Figures task

Another example is provided in Figure T6 on the next page (drawing 1) which illustrates complexities that arose when the stimulus shape was made into something that others also thought of, but when the title provided did not reflect this and instead focussed on some other element of the picture.

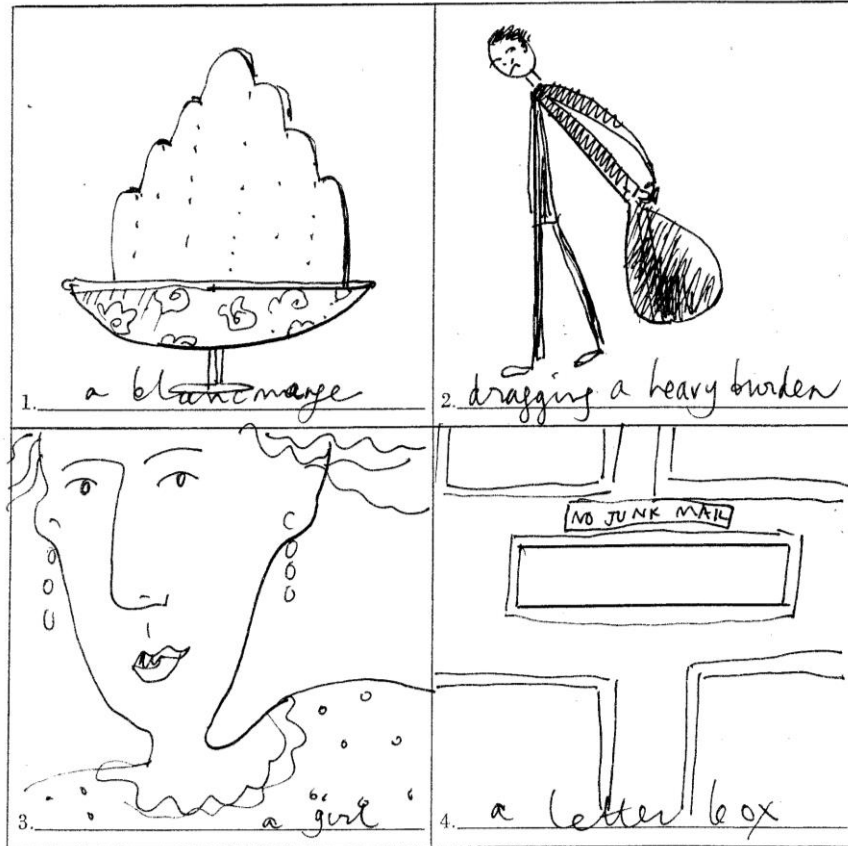


Figure T6

Example of a common response but an uncommon title in the Incomplete Figures task

The example in Figure T6 shows that the image 1 was made into a type of bowl, which is a common response, however, the image is entitled 'a blancmange'. Despite the steps taken to overcome these difficulties, it was found that an accurate analysis of the scorer assigned titles based on the descriptions provided in the space below each image was not possible. This was due to the substantial amount of guess work involved in scoring this

way and it was found that when judges assigned their own titles and subsequent originality ratings were compared the reliability was low ($r = .4$). The decision was therefore taken to discontinue the attempts to score for originality the titles accompanying the incomplete figures task drawings.

Torrance's (1974) scoring guide for the 10 separate incomplete figures also included the associated norms for each one. These provide examples for 'zero' and 'two' point common responses. Inspection of these however reveals the same problem which was discussed previously, that is, that these are primarily children's responses and the points awarded for originality would arguably be questionable if used with an adult sample. For example, 'creative' responses for the incomplete figures task image 4 (two horizontal parallel lines) include 'dog', 'bridge' and 'hammer'. According to the 1974 manual, these responses should each be awarded the maximum two points.

The reliability coefficients reported in the manual between trained and untrained scorers are particularly high (fluency, $r = .96$; flexibility; $r = .94$, originality; $r = .86$ and elaboration, $r = .91$). Despite the efforts of the scorers and a complete re-score of all responses as previously described, reliabilities obtained in this study were nowhere near those reported in Torrance (1974), (ranging from $r = .27$ for resistance to premature closure to $r = .67$ for abstractness of titles). It is possible that the coding and scoring of the images in early samples upon which the norms were based was far simpler due to the

fact that children had generated them, however, even when streamlined and thorough categorical coding was undertaken using the manual as a guide for the categories, the subjective nature of these specific elements of scoring the TTCT remained problematic.

SUBSEQUENT SCORING DECISIONS

Further to the complexities encountered by judges when scoring the tasks according to the original (1974) scoring of the TTCT, it was decided to discontinue the attempts to streamline this procedure in order to obtain acceptable agreements. The decision was taken to use only the Checklist of Creative Strengths scores as the creativity index for the TTCT (TTCT-CS). This was for a number of reasons. As has already been described, conventional scoring for originality was not possible for the drawings in either the incomplete figures task or the circles task for the reasons discussed above. In addition to this, as was outlined in the Materials section, the creativity checklist has a clear scoring procedure which is designed in a way which appears to acknowledge at least some of the obstacles encountered when scoring for originality and abstractness of titles. There is a maximum score of 26 using this checklist, with far simpler methods of point allocation. Should a participant exhibit more than three instances of the specified criteria across either of the creative thinking activities, they receive a maximum of two points. Although there remains some element of subjectivity, this appears to be an improvement to the early methods of scoring this tool. Literature has been published which supports the addition of this element to the TTCT scoring (Kim, 2006), and it was therefore felt

that using this index alone would capture the creative characteristics exhibited by participants in the tasks. Additionally, measures of fluency and originality were obtained for the Alternative Uses Task (AUT), and it was felt that none of the other measures employed in the present study captured the aspects of creativity that are tapped by the creative strengths checklist. Factor analytic studies of the TTCT have suggested that Torrance's index of creative strengths may represent a separate factor to the other indices scored in the TTCT (Kim, 2006). This subscale has stricter scoring criteria to the others and so it was decided that this would be the index of creativity for the TTCT drawings.

Lastly, in case further justification should be sought in support of the decision to omit some of Torrance's indices, a final point concerns the scoring manual that was available (Torrance, 1974). This edition did not contain the 're-normed' figures for the creative indices published in 2008, (Torrance, 2008, cited in Kim, 2011), and were in fact calculated on American college students and younger children whose maximum age only went up to nineteen. It is argued that comparing the results from my sample of adult university students and visual artists to these figures would not be appropriate, regardless of the problems described afore. Indeed, as was noted by Kim (2006) "Data that were collected from two elementary schools and a high school provide the major body of longitudinal research on the TTCT" (p. 6). These norms were also produced during the 1960s and 1970s, and it is conceivable that norms calculated from respondents completing the tasks during 2014 would differ substantially from these.

Torrance (1974) stated that “slight modifications will always have to be made in administration procedures depending upon the purposes and conditions of the testing” (p. 6). Due to the fact my sample was considerably different to Torrance’s in terms of demographic composition, that is, my participants were well-educated adults, and it is likely that their responses and even the categories of their responses may be more sophisticated than those described in the TTCT scoring manual which was available to me. To take one obvious example, the amount of elaboration provided by children is unlikely to be comparable to that of adults. One last point is that the purposes and conditions of my investigation differed substantially from the more ‘traditional’ administration protocols which can include categorising children in order to make decisions about whether they should join programmes for so-called ‘gifted and talented’ pupils.

APPENDIX V

Study 5. Information sheet and consent form

Department of Psychology, HSSc Participant Information Sheet

Researcher: Lucy Irving

You are being invited to take part in a research study which will take around one hour. Before you decide it is important for you to understand why the research is being done and what it will involve. Please take time to read the following information carefully. Ask if there is anything that is not clear or if you would like more information.

In this study, the relationships between thinking styles and mental imagery will be investigated. You will be asked to complete some questionnaires relating to thinking styles and experiences, some divergent thinking tasks, and some measures relating to your mental imagery control. Full instructions and practice trials will be provided.

Participation in this research is entirely voluntary. You may withdraw from the study at any time without giving a reason. If you are happy to take part, please sign the Informed Consent section at the bottom of this sheet.

The research data collected will be anonymous. Your questionnaires will be kept strictly confidential during the research and after the study has been completed. Responses will only be seen by the researcher and all proposals for research are reviewed by an Ethics Committee before they can proceed. Middlesex University's Psychology Ethics Committee has reviewed and approved this proposal.

If you have any concerns, questions or comments about this study please contact **Lucy Irving**. Department of Psychology, Middlesex University, Hendon, email l.irding@mdx.ac.uk

Thank you for reading this information. Please feel free to keep this sheet if you would like to.

CONSENT FORM:

This study has been explained to me to my satisfaction, and I agree to take part.

I understand that I am free to withdraw at any time.

NAME: DATE:

JOB TITLE:

(this slip will be removed from responses to maintain confidentiality)

APPENDIX W

Study 5. Debrief sheet

Thank you for taking part in this study. Your contribution assists in our understanding of the relationships between mental imagery control, thinking styles and creativity.

The Image Control & Recognition Task (ICRT, Irving, 2011) required you to follow instructions and manipulate shapes, and then try to name and draw the resultant image. This tool measures mental imagery control and is often cited that mental imagery is important to creative people in their work. This is indeed reported by many famous creative individuals such as Albert Einstein, Salvador Dali and numerous others (Akiskal & Akiskal, 2007). It is suggested that creative individuals are able to engage in ‘combinatory play’ of mental images, often leading to solutions to problems or unique works of art.

The Torrance Tests of Creative Thinking (TTCT, Torrance, 1965) is a widely used measure which looks at ‘figural’ creativity and was the task in which you made pictures from circles and random lines. Ward’s (1994) Alien Drawing Task is a conceptual expansion task and the Alternative Uses Task is a measure of divergent thinking and verbal fluency. The responses you generated in these tasks will be rated for creativity by trained judges who are blind to the aims of the study.

The Oxford-Liverpool Inventory of Feelings and Experiences, (O-LIFE, Mason et al., 1995) is a measure relating to your thoughts, feelings and experiences. The traits which are measured by the questionnaire are common throughout the population. The following subscales are measured: *unusual experiences*, *cognitive disorganisation*, *impulsive nonconformity* and *introvertive anhedonia*. Many of these characteristics are reported amongst creative individuals (Nettle, 2005). Particularly common are ‘unusual experiences’, characterised by magical or sometimes bizarre thoughts and ideas, visual and/or auditory hallucinations, and an ‘over inclusive’ thinking style which appears to lends itself to unique creative output. The relationships between these subscales will be looked at in relation to the creativity tasks you completed, and the imagery control task (ICRT).

If you have any questions relating to the study please ask Lucy or email l.irving@mdx.ac.uk. You will receive your psychological profile as soon as possible²¹.

²¹ This latter note was added to artists’ debriefs only.

Thank you for taking the time to participate in this study.

Lucy Irving

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APPENDIX X

Study 5 partial correlations controlling for age

Unusual experiences with creative expansion, $pr = .219, p = .037$

Unusual experiences with cognitive disorganisation, $pr = .407, p < .001$

Unusual experiences with impulsive nonconformity, $pr = .250, p = .017$

Unusual experiences with creative achievement, $pr = .276, p = .008$

ICRT with TTCT-CS – no relationship

ICRT with impulsive nonconformity, $pr = .247, p = .018$

AUT with ICRT, $pr = .356, p = .001$

Creative expansion with ICRT, $pr = .203, p = .053$

Creative achievement with ICRT, $pr = .224, p = .033$

Publication arising from the thesis

Irving, L., Barry, R., LeBoutillier, N., & Westley, D. (2011). The Image Control and Recognition Task: A Performance-Based Measure of Imagery Control. *Journal of Mental Imagery*, 35(3 & 4), 67-80. ²²

Journal of Mental Imagery, 2011, 35(3 & 4) 67-80

The Image Control & Recognition Task: A Performance-Based Measure of Imagery Control

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MIDDLESEX UNIVERSITY, LONDON, UNITED KINGDOM

An objective, performance-based indicator of imagery control may offer new insights into the field of mental imagery research, since the current tools may not accurately reveal individual differences in this attribute. The Image Control and Recognition Task (ICRT) is comprised of increasingly difficult tasks requiring the combination and manipulation of geometric shapes and letters. An initial study ($n = 29$) provided a sound rationale for further development of the ICRT, with a trend analysis confirming that the items increased in difficulty. In a subsequent study ($n = 31$), a trend analysis indicated that the ICRT induced a good range of scores. The ICRT may be helpful in elucidating the frequently reported finding that self-report and performance-based imagery tools have little relationship (Burton, 2003; Burton & Fogarty, 2003; McAvinue & Robertson, 2006-2007).

Keywords: Mental Imagery; Imagery Control; Rotation; Transformation; Objective; Self-report

A review of the literature reveals that a number of imagery tools are available for assessing mental imagery, ranging from questionnaires to measures of accuracy and reaction time. Richardson's (1969) revised version of Gordon's Test of Visual Imagery Control (TVIC) is a commonly used questionnaire that requires participants to state whether they can visualize images of a car in various scenarios. Investigation of the TVIC's psychometric properties has produced mixed results (Ashton and White, 1974; Kihlstrom, Glisky, Peterson, Harvey, & Rose, 1991; LeBoutillier & Marks, 2001-2002). LeBoutillier and Marks (2001-2002) found a pervasive response leniency in this tool and suggest that it fails to satisfy univariate assumptions of psychometric testing. Nevertheless, the TVIC enjoys acceptable test-retest and split-half reliabilities,

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²² size reduced on this page only

although there is disagreement regarding its internal factorial structure (Campos, 2009-2010; LeBoutillier & Marks, 2000-2001). Moreover, while the TVIC purports to measure a single ability, it may tap at least three latent variables (Kihlstrom et al., 1991; LeBoutillier & Marks, 2001-2002). Another frequently used self-report measure is the Vividness of Visual Imagery Questionnaire (VVIQ; Marks, 1973), which has been found to have acceptable reliability and validity (Kihlstrom et al., 1991; McAvinue and Robertson, 2006-2007); however, only a small number of the VVIQ items pertain to the control of mental imagery and there is no precise way to determine whether participants are accurately depicting the intended images. Some theorists claim that these questionnaires do not measure mental imagery vividness and control but rather tap abilities such as spatial memory, memory for experiences, or memory for visual stimuli (Ernest, 1977; Hiscock, 1978; Slee, 1988). These critiques, when considered alongside other purported problems such as social desirability, demand characteristics, and experimenter expectancy (Lequerica, Rapport, Axelrod, Telmet, & Whitman, 2002; Neisser, 1972; Sheehan & Neisser, 1969), suggest that new methods should be developed to measure imagery control.

Many performance-based measures for assessing spatial imagery abilities focus on the visualization and rotation of stimuli (McAvinue & Robertson, 2006-2007). In Shepard and Metzler's (1971) mental rotation task, response times are usually found to have a linear relationship with the angle or degree of rotation (known as the "symbolic distance effect"; Moyer & Bayer, 1976), demonstrating that participants form an image of the shape and mentally rotate it until it matches the orientation of the other shape (Shepard & Cooper, 1982). An alternate measure is Paivio's (1978) mental clocks task, which assesses the participant's ability to internally compare two images of clock faces. These and other spatial tasks, such as the Flags Test (Thurstone & Jeffrey, 1956, as cited in McAvinue & Robertson, 2006-2007), the Space Relations Test (Bennett, Seashore, & Wesman, 1974, as cited in McAvinue & Robertson, 2006-2007), and the Paper Folding Test (Kyllonen, Lohman, & Snow, 1984) are acceptable measures of spatial ability (McAvinue & Robertson, 2006-2007).

Carroll (1993) found that several factors underlie spatial ability pertaining to visualization, including the manipulation of visual patterns and the spatial relations between imaged objects. These findings support the claim that mental imagery is multidimensional (Kosslyn, 1983; Kosslyn et al., 2004). Blajenkova, Kozhevnikov, and Motes (2006) as well as Farah, Hammond, Levine, and Calvanio (1998), Kosslyn (1994), and Kosslyn and Koenig (1992) have identified at least two distinct subsystems in visual imagery for encoding and processing spatial information: *object imagery* (the form, size, color, shape,

and other aspects pertaining to the imaged objects' literal appearance) and *spatial imagery* (the spatial relations between imaged objects).

Spatial ability tasks undoubtedly require the controlled mental manipulation of visual images and generally have good psychometric properties (Blajenkova, Kozhevnikov, & Motes, 2006), making them invaluable for investigating spatial imagery and assessing concurrent reliability of performance-based imagery questionnaires. Nevertheless, scores on spatial ability tests are frequently found to be independent of subjective reports of mental imagery ability (Burton, 2003; Blajenkova et al., 2006; Campos, 2009-2010; McAvinue & Robertson, 2006-2007). Burton (2003) investigated both performance-based and self-report methodologies in relation to visualization and speed of rotation and found little relationship between these factors. Purportedly, this was due to the imaginal stimuli of scenes and objects being different than the usual stimuli of geometric shapes and capital letters. According to Burton (2003), the type of stimuli involved in imagery tasks influences this relationship in that self-report ratings of images of shape are more likely to relate to conventional spatial tasks such as mental rotation or mental comparison than are self-report ratings of images retrieved from long-term memory. Indeed, it has been found that if the stimuli are similar in type, such as geometric or alphanumeric shapes, the relationship is stronger than when the stimuli are of scenery or relatives (McAvinue & Robertson, 2006-2007). Further, although self-report questionnaires and spatial tasks may measure entirely different abilities, they are often treated as though they are comparable (Blajenkova et al., 2006; Burton, 2003; Campos, 2009-2010); that is, they may each tap individual aspects of imagery ability (McAvinue & Robertson, 2006-2007). Notwithstanding these inconsistencies, tests of spatial performance have traditionally been accepted as an objective measure of imagery control due to the requirement that participants manipulate internal images in order to complete the task (Burton, 2003).

In the past 20 years, an alternative imagery protocol known as *image generation* has emerged in the cognitive literature. Image generation looks primarily at the emergence of creativity through visualization and the mental synthesis of imagined forms (Finke, 1996; Finke & Slayton, 1988; Finke, Ward & Slayton, 1992). The tasks utilized in this approach tap into processes of controlled mental imagery and mental rotation that are particularly relevant for understanding individual differences in mental imagery. Finke, Pinker and Farah's (1989) guided image manipulation task, although not explicitly designed to measure imagery control, seeks to understand whether participants can assign new meanings to imagined combinations of shapes and letters and

asks them to detect any number of “emergent forms” (new shapes or objects) from their internal representation. It is likely that success on this task would not be possible without controlled mental imagery, and it is interesting to note Burton and Fogarty’s (2003) finding that these convergent and divergent problem-solving tasks were located next to objective tests of imagery on their “continuum of self-report imagery and objective spatial tasks” (p. 515).

While the instruments described thus far are sufficient measures of spatial ability, mental rotation capacity, or imagery vividness, most were not designed to measure mental imagery control. Accordingly, the Image Control and Recognition Task (ICRT) was developed as an easy-to-administer, performance-based, objective measure to assess individual differences in imagery control. Based on Finke, Pinker and Farah’s (1989) image task, originally designed to investigate whether new patterns can emerge from manipulated mental images, the ICRT involves increasing numbers of imagery transformations that combine to form familiar objects or ambiguous shapes. Unlike Farah et al’s protocol, which involves a series of 3- and 4-stage tasks in which participants mentally join and rotate shapes to form familiar objects, the ICRT requires a higher level of image control during the image manipulations. That is, more steps are involved than were provided in the original tool, thereby creating levels of difficulty in the task. The ICRT is also comprised of a larger number of standardized problems to yield a range of scores that can then be employed as an individual differences measure of mental imagery control. In a pilot study, approximately 80% of the participants correctly solved 3-stage tasks, suggesting that 1- or 2-stage tasks are unlikely to contribute any distinguishing information about mental imagery control. Accordingly, 3-stage tasks were developed to decipher the individual’s substantive ability for and levels of mental imagery control.

Study 1

Image Control and Recognition Task (ICRT)

Method

Participants


Twenty-nine students (3 males, 26 females; mean age = 23.11; $SD = 6.51$) from Middlesex University participated as part of their undergraduate psychology course requirements. Further demographic details were not recorded.

Materials

Tasks consisted of 3 to 9 image manipulations, or stages, resulting in a series

of 22 ICRTs. Each ICRT required participants to combine and manipulate geometric shapes and/or letters, and then to draw the resultant mental image. Upon correct completion of the task, it was expected that either a familiar object or a nondescript shape would spontaneously present itself. The longer the task, the greater the challenge to those lacking strong mental imagery control as more manipulation is required. A score of 1 was given for correct depiction of the shape, and a score of 0 was given for any other depiction. Table 1 provides a sample ICRT with instructions for a 4-stage task; the correct image depiction is shown beside the instruction.

Table 1
Sample ICRT with Depiction of Correct Response

Instruction (4-stage task)	Depiction
Imagine a plus sign Add a circle to the bottom of the vertical line Add a capital V to the top of the vertical line Rotate the entire shape 180°	

Procedure

Participants read an introduction to the experiment, gave their informed consent, and completed all measures in individual sessions. They were instructed on how to complete the Image Control and Recognition Tasks and were reassured that the ICRTs were not tests of drawing ability. They were also informed not to memorize the stages of the instructions but, rather, to try and create a clear mental image as they focused on what the experimenter was saying.

Participants were not permitted to take notes or make sketches during the image transformation phase, or to turn the page during the drawing phase. The researcher read the ICRT instructions aloud to the participants, who were allowed to do the task with their eyes open or closed. While hearing the instructions, the participants were required to visually manipulate the mental images and indicate to the experimenter when they felt happy with their image. An instruction could be repeated only if the participant had not moved to the next stage. In the last stage, the participants were requested to draw whatever new image they now saw. While they were completing the tasks, the experimenter noted any obvious problems with wording or order of instruction and scored each completed image response as 1 or 0. Upon completion of all tasks, the participants were debriefed about the aims of the study and the experimenter answered any questions. Participants were given the opportunity to ask questions before and after completion of the task.

Results and Discussion

The Image Control and Recognition Task was piloted to investigate whether the tasks became more difficult as the number of instruction stages increased.

Item Analysis

Preliminary analysis on the suitability of test items was based on verbal feedback from the participants, along with investigation into the wording and face validity of the tool that was informed by researcher observations and retrospective reports. It highlighted six problematic items, described below.

Lack of clarity. Two items were removed because participants asked questions concerning the manipulations on each administration. The instructions were not written in clear, unambiguous language.

Additional stages required. Three items were removed because suitable additions would have increased the length of the task.

Inconsistent task requirements. One item was removed because it required participants to think of and manipulate two separate images simultaneously and then to combine them.

Data relating to the above items were omitted from further analysis. Analysis of the remaining 16 items revealed a normal distribution of the ICRT scores with a mean score slightly lower than a to-be-expected middle score ($M = 5.86$, $SD = 4.93$, $Minimum = 0$, $Maximum = 16$) with a 0-16 potential range of scores. Nonsignificant z -score transformation values were calculated for both skew ($z = 1.01$, $p > 0.05$) and kurtosis ($z = -1.44$, $p > 0.05$).

Following this analysis, it was necessary to investigate whether the items increased in difficulty as the number of stages increased. Solvability percentages were generated for the 16 ICRTs. A significant negative Pearson's correlation of $-.65$ was found ($r < .01$) between the number of steps and task difficulty. It is argued that since only those with a high degree of mental imagery control can successfully complete the longer ICRTs, a negative correlation would be expected because less steps should indicate an easier task.

Table 2 shows the solvability figures for Study 1. It is possible to group these figures together, representing individual stages, suggesting that the number of stages does have a direct relationship with how easy the task is to complete. However, 7- and 9-stage tasks were apparently too easy to solve, as they appear above all 6-stage tasks and two 8-stage tasks in the table. This highlighted that the ICRTs constituting each set were not appropriately difficult: the tasks solved by the fewest participants had 6 stages, although some participants solved the 7-, 8-, and 9-stage tasks despite their failure to solve the 6-stage tasks. This finding warrants further investigation.

Table 2
Solvability Percentages for Image Control and Recognition Tasks in Study 1

Number of Stages	Name of ICRT	% Solved
3	Shape 1	58.6
3	Shape 2	58.6
4	TV	51.7
4	Heart	48.3
5	Clock Tower	48.3
4	Walkie Talkie	34.5
4	Candle	34.5
7	Stickman	34.5
5	Cottage	31.0
5	Sailing Boat	31.0
9	Star	31.0
8	Bowtie face	27.6
8	Shape 3	27.6
6	Cat	24.1
6	Christmas Tree	20.7
6	Snowman	20.7

$n = 29$.

To test whether the number of ICRTs correctly solved was linearly related to the number of instruction stages, a trend analysis was conducted. Analysis of variance (ANOVA) indicated that the number of steps significantly affected the percentage of ICRTs solved by the participants, $F(3, 115) = 4.83$, $MSE = 1400.25$, $p < .05$, $\eta^2 = .11$). Bonferroni tests indicated that ICRTs with fewer stages were associated with significantly higher solvability percentages than ICRTs requiring more steps to solve them (Table 3). The trend analysis indicated that the data fitted well with a linear model, with the linear component accounting for a substantial proportion (11%) of the variance in solvability.

Table 3
ICRT Solvability Percentages As a Function of Number of Stages in Study 1

Stages	<i>M</i>	<i>SD</i>
3	58.6 ^a	44.45
4	42.2 ^{ab}	34.78
5	36.6 ^{ab}	39.18
6	21.6 ^b	29.71

$n = 29$.

Note. Means with the same letter in their superscripts do not differ significantly from one another according to a Bonferroni test with a .05 limit on familywise error rate.

The results of the pilot study suggest that it is possible to use the ICRT as a performance-based measure of mental imagery control that distinguishes between different competencies in this attribute. The scores decreased according to how many stages were involved in each problem, suggesting that participants found the longer ICRTs harder to complete. Some participants attempted to memorize the instructions rather than concurrently amending their mental images. For this reason, a working verbal memory task (the digit span, DS) was introduced in Study 2 to establish whether this was a confounding variable. It was expected that looking at DS scores in relation to total ICRT scores would help distinguish between those relying on working memory to solve the tasks and those simply using their capacity to control their mental imagery. Participants may have been able to guess the resultant images in two of the items, so these were re-ordered to prevent guessing. In summary, this study, designed to pilot and develop the ICRT, provided a sound rationale for Study 2, which aimed to evaluate its reliability and validity. A practice test was also introduced in Study 2.

Study 2

Development of the Image Control and Recognition Task

Method

Participants

Thirty-one psychology students (2 males, 29 females; mean age = 21.84; $SD = 6.23$) from Middlesex University participated as a component of their undergraduate research methods course. Further demographic details were not recorded.

Materials

The amended ICRT (16 items) and a forward digit span (DS) were administered to participants. In the DS, 14 number strings of increasing length (3-8 digits) were read aloud to the participant, who then repeated them in order. Scores were calculated out 14, and the experiment was discontinued if the participant failed to repeat two consecutive strings of the same length.

Procedure

The procedure for Study 2 was the same as for Study 1, except for the following modifications: The participants underwent two 3-stage practice trials; the experimenter explained that some of the tasks may involve 90° and 180°

Solvability percentages were selected and mean solvability figures for each number of stages were calculated. These mean solvability percentages are given in Table 6.

Table 5
Solvability Percentages for Image Transformation Tasks in Study 2

Number of Stages	Name of Desired Image	% Solved
3	Shape 1	87.1
3	Shape 2	71.2
5	Clock Tower	61.3
4	TV	58.1
4	Heart	58.1
4	Candle	58.1
9	Star	45.2
7	Stickman	41.9
5	Cottage	41.9
5	Sailing Boat	38.7
8	Bowtie	38.7
4	Walkie Talkie	35.5
6	Cat	32.3
6	Christmas Tree	32.3
8	Shape 3	22.6
6	Snowman	19.4

$n = 31$

Table 6
ICRT Solvability Percentages As a Function of Number of Stages in Study 2

Stages	<i>M</i>	<i>SD</i>
3	79.0 ^a	28.20
4	52.4 ^b	34.97
5	46.9 ^b	30.63
6	27.7 ^c	30.99

$n = 31$

Note. Means with the same letter in their superscripts do not differ significantly from one another according to a Bonferroni test with a .05 limit on familywise error rate.

To test the hypothesis that the number of ICRTs correctly solved was linearly related to the number of instruction stages required to complete them, a trend analysis was conducted. Analysis of variance (ANOVA) indicated that the number of steps significantly affected the percentage of ICRTs solved by participants, $F(3, 120) = 14.18$, $MSE = 979.29$, $p < .001$, $\eta^2 = .26$). As shown in

Table 6, Bonferroni tests indicated that ICRTs with fewer stages were associated with significantly higher solvability percentages than were longer ICRTs. The data fitted well to a linear model with the linear component accounting for a significant proportion (26%) of the variance in solvability as indicated by the trend analysis.

General Discussion

The aim of the research presented here was to introduce and test a new, objective measure of mental imagery control. The ICRT revealed individual differences in controllability, and the task induced a good range of scores. It appears that it is possible to distinguish between different levels of visual imagery control aptitude, at least for 3- to 6-stage tasks. How much extra discrimination is revealed through the longer ICRT problems, however, is unclear and will continue to be investigated. The trend analyses on the solvability figures of Studies 1 and 2 indicated that the ICRTs with more stages are more difficult and require more aptitude in mental imagery control to correctly solve. Some people simply do not have the ability to control their mental imagery, although at least one 3-stage task was completed correctly by all participants in Study 2. It is possible that different cognitive processes may be necessary to solve different items; for example, holding a triangle in memory requires the person to pay attention to its rotation, the direction it is pointing, whether it is equilateral, etc. Moreover, any number of these processes could be crucial to solving of the task.

Verbal working memory (as measured by digit span) was not found to be related to ICRT scores. Whether working memory influences the ICRT remains an issue, however, as the correlation between scores on the digit span and the ICRT, although not statistically significant, approached significance. The manipulation of geometric and alphanumeric shapes is related to spatial imagery, yet it is possible that elements of object imagery come into play upon successful completion of an image transformation task when form, size, and shape of individual parts are appraised as a whole image. Future validation of the ICRT will, therefore, include a visual memory task because visual memory aptitudes, more than working memory, may influence the ability to complete the ICRTs. People may use imagery recalled from memory to identify the new form. Future research will also include the Test of Visual Imagery Control (TVIC; Gordon, 1969) in order to assess concurrent validity.

The tools available to measure mental imagery and spatial ability may soon be complemented by this response-based measure, which entails elements of visualization, mental rotation, manipulation, and spatial imagery aptitude, all of which are important components for mental imagery control. The shapes to be imagined in the ICRT are not perceptually-sourced (i.e., there are no images in

front of participants during the experiment); thus, visualization and mental imagery control alone are utilized. It is not possible to turn or manipulate the shapes in any way other than controlling one's mental imagery. If administered alongside self-report imagery measures, the ICRT could also provide researchers with more information regarding the finding that self-report imagery control scores do not correlate with measures of spatial ability (Burton, 2003). Since self-report measures of imagery are also verbally-sourced, future research could investigate the possible crossover between verbally-sourced and pictorial self-report tools and perceptually-sourced spatial ability tasks, which are usually visually-sourced and movement/kinetic-based in nature. There is a potential for further elucidating the lack of relationship between these types of tools, and administration of a mental rotation task alongside other self-report imagery control tools would allow for this. There is, however, the possibility that multiple cognitive processes are involved in tasks with increasing stages, for example, in terms of imagined locations and manipulations of imagined objects. This possibility means that some tasks may be more cognitively taxing than others of the same length, and this is also something that will be explored in future studies.

As an additional measure of individual differences, future studies could record response times, as it was noted during the experimental sessions that, for high scorers especially, the process of accurately completing these tasks appeared effortless, as they moved through the stages quickly, without asking for repetition or clarification. It was observed during the experiment that those reportedly using strategies other than imagery control alone took longer to begin drawing and to complete each stage of the task. Gathering details regarding response times in both the transformation and drawing phases would enable investigation of whether participants attempt to memorize and go back to previous stages. Presenting the ICRT instructions in equally spaced timed periods may also prevent rehearsal of instructions, thus revealing more accurate accounts of imagery controllability; responses should indicate whether the demands of the imagery task grow and whether response times increase as a function of the number of stages. Because participants were neither timed nor allowed to ask for clarification during the task, they may have rehearsed the instructions as they had been committed to memory, leading to inflated scores.

The problems found in some introspective imagery measures (e.g., response leniency, social desirability, and demand characteristics; DiVesta, Ingersoll & Sunshine, 1971; LeBoutillier & Marks, 2000-2001; Sheehan & Neisser, 1969) are less likely to influence the ICRT due to the test format and the nature of the task. It would be difficult, if not impossible, to achieve high scores on the ICRT simply due to the participant's wish to do well on the test or appear favorably to the experimenter.

Conclusion

To conclude, the aim of this paper was to introduce a new measure of control and manipulation of mental imagery, the Image Control and Recognition Task (ICRT). The ICRT yielded a good range of scores that varied across individuals and mapped a theorized relationship between number of stages and level of task difficulty. It appears to measure general spatial imagery aptitude objectively, a characteristic offered by few measures, and also highlights individual levels of imagery control, tapping elements of spatial and object imagery.

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