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# Attention Deficit Hyperactivity Disorder: Reframing "Deficit" as Creative Strength

by

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ABSTRACT

FACULTY OF SOCIAL AND HUMAN SCIENCES
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Creative ideas are those that are both novel and useful. Creativity is considered to be a valuable social resource, which has supported the development of society in myriad domains. It has been suggested that behavioural indicators of creativity overlap with symptoms of Attention Deficit Hyperactivity Disorder (ADHD). Indeed, there is some preliminary evidence to suggest that individuals with ADHD may be more creative than individuals without ADHD. The first chapter of this thesis outlines the relevant research and theory and presents the 'creative advantage hypothesis'. Specifically it is argued that defocused attention in individuals with ADHD increases the likelihood of unusual associations forming, thus increasing the likelihood of creative responses. The potential mediating roles of inhibition and delay aversion are also discussed.

The second chapter of this thesis describes a study designed to test predictions of the creative advantage hypothesis. Parents of pupils in Year 8 were asked to rate their child's level of inattentiveness and hyperactivity. Sixty six pupils completed a measure of figural creativity, inhibition and delay aversion in school. ADHD symptoms predicted creativity scores on one aspect of creativity, originality, and this effect was found in boys only. Inhibition and delay aversion were not found to mediate the relationship between ADHD symptomology and creativity in boys. Limitations and implications for Educational Psychologists and teachers are also discussed.

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**Declaration of Authorship**

I, Alexandra Marian Beaven, declare that this thesis entitled

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and the work presented in it is my own and has been generated by me as the result of my own original research. I confirm that:

1. This work was done wholly or mainly while in candidature for a research degree at this University;

2. Where any part of this thesis has previously been submitted for a degree or any other qualification at this University or any other institution, this has been clearly stated;

3. Where I have consulted the published work of others, this is always clearly attributed;

4. Where I have quoted from the work of others, the source is always given. With the exception of such quotations, this thesis is entirely my own work;

5. I have acknowledged all main sources of help;

6. Where the thesis is based on work done by myself jointly with others, I have made clear exactly what was done by others and what I have contributed myself;

7. None of this work has been published before submission.

Signed: ……

Date

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## Abbreviations

| | |
|---|---|
| α | Cronbach's alpha |
| β | standardised beta coefficient; test statistic in regression |
| ADHD | Attention Deficit Hyperactivity Disorder |
| APA | American Psychiatric Association |
| AUT | Alternative Uses Test |
| B | Unstandardised test statistic in regression |
| CACE | Creativity And Cultural Enrichment working group |
| CI | Confidence Interval |
| DCSF | Department for Children, Schools and Families |
| DfES | Department for Education and Skills |
| DSM-IV-TR | Diagnostic and Statistical Manual of Mental Disorders- 4th edition, Text Revision |
| DTAP | Dysregulation of Thought and Action Pathway |
| DV | Dependent Variable |
| EF | Executive Function |
| EYFS | Early Years Foundation Stage |
| F | test statistic for Analysis of Variance |
| IQ | Intelligence Quotient |
| IOR | Inhibition Of Return task |
| IV | Independent Variable |
| *M* | mean |
| Mdn | median |
| MIDA | Maudesley Index of Delay Aversion |
| MP | Member of Parliament |
| MPH | methylphenidate |
| MRI | Magnetic Resonance Imaging |
| MSP | Motivational Style Pathway |
| *N* | sample size |

| | |
|---|---|
| NACCCE | National Advisory Committee on Creative and Cultural Education |
| NICE | National Institute for health and Clinical Excellence |
| *p* | probability; significance of a test statistic |
| QCA | Qualifications and Curriculum Authority |
| r | effect size |
| $r_s$ | test statistic for Spearman's correlation |
| $R^2$ | test statistic for multiple regression |
| RAT | Remote Associates Test |
| SD | standard deviation |
| SE | standard error |
| SNAP-IV | Swanson's (1992) rating scale of ADHD symptomology |
| TTCT | Torrance Test of Creative Thinking |
| U | test statistic for Mann Whitney U test |
| UUT | Unusual Uses Test |
| W | Shapiro- Wilk test statistic |
| z | standardised test statistic |

Chapter 1: Is there a relationship between creativity and symptoms of Attention Deficit Hyperactivity Disorder?


## Abstract

Creativity supports the progression of knowledge in society. Within the burgeoning literature, a number of definitions of creativity have been suggested, although most specify a need for creative ideas to be both novel and functional. It has been suggested that behavioural traits associated with creativity overlap with aspects of Attention Deficit Hyperactivity Disorder (ADHD; Cramond, 1994). This paper critically reviews the relevant research surrounding creativity and ADHD in order to explore the validity of such claims. This review attempts to provide a coherent synthesis of the literature, in the form of the 'creative advantage' hypothesis. Specifically, it is argued that cognitive factors common to both creativity and ADHD, predispose individuals with ADHD towards creative thought. In seeking to reframe aspects of ADHD symptomology as sources of potential creative strength, this paper consciously adopts a positive psychology perspective (Seligman & Csikszentmihalyi, 2000).

**Overview**

This literature review will explore the putative relationship between creativity and ADHD symptomology. The paper will begin by defining creativity before considering the role of creativity in education. A number of explanatory models of creativity will then be presented, culminating in a discussion on the role of neuropsychological functions in creativity. The paper will then present a critical analysis of studies exploring the relationship between creativity and ADHD. A discussion of prominent theories of ADHD will then follow in an attempt to account for these findings and the "creative advantage hypothesis" of ADHD will then be presented. Specifically, it is suggested that individuals with ADHD may be predisposed to creative thought, given an overlap in cognitive mechanisms common to both ADHD symptomology and creative behaviour. In attempting to reframe aspects of ADHD (such as inattentiveness and inhibitory deficits) in terms of potential strength, the author consciously adopts a positive psychology perspective (Seligman & Csikszentmihalyi, 2000).

Although it is recognised that adopting a categorical perspective on ADHD has practical benefits for clinicians in terms of ensuring equitable access to scarce resources (e.g. medication), this paper adopts a dimensional view of ADHD, which places ADHD symptomology on a continuum. Within this ontological framework, individuals with ADHD are viewed as *quantitatively*, rather than *qualitatively* different to those without a diagnosis of ADHD. For this reason, the phrase "ADHD symptomology" will be used throughout this paper to refer to traits such as inattentiveness and hyperactivity/impulsivity. Therefore, studies utilising community selected samples will be considered in this review alongside studies where participants have a medical diagnosis of ADHD.

**1.0 What is creativity?**

The ability to be creative is believed to be the "cornerstone of what makes us human" (Dietrich & Kanso, 2010, p. 822) and is therefore of great social significance (Guildford, 1950). Indeed, the impact of creative thought has been implicated in myriad domains. For example, creativity is believed to be a vital component of scientific discovery (Simonton, 2003); a key driver in organisational productivity (Bharadwaj & Menon, 2000) and even a facet of sporting expertise (Memmert, 2007). In the words of Dietrich and Kanso (2010): "all progress and innovation depend on our ability to change existing thinking patterns, break with the present, and build something new" (p. 822).

On an intuitive level, the notion of creativity is somewhat nebulous. This may explain why the study of creativity was relatively neglected by researchers prior to Guilford's (1950) presidential address to the American Psychological Association. In his address, Guilford (1950) lamented the relative dearth of research into creativity at that time and emphasised the need to operationalise creativity in terms of a number of factors such as novelty, fluency and flexibility of thought. Guilford (1967) also distinguished between two forms of mental processes: convergent and divergent thinking, which have shaped the nature of subsequent creativity research. According to Hennesey and Amabile (2010) convergent thinking requires individuals to find a single 'correct' solution to a problem and involves "narrowing possibilities to a workable solution" (p.579). By contrast, divergent thinking requires individuals to consider multiple solutions to an open ended problem and "mak(e) unexpected combinations, recognizing links among remote associates, transforming information into unexpected forms" (Cropley, 2006, p. 391). It is thought that tests of divergent thinking can be a useful indicator of creative potential (Runco & Acar, 2010). Although divergent thinking is often used as synonym for creative thinking in the literature, it is important to recognise that creativity also involves convergent thinking. For example, it has been suggested that convergent thinking may be helpful in validating the usefulness of a novel idea and ensuring that it is fit for purpose (Cropley, 2006).

Researchers differ in their conceptualisations of creativity, although many definitions in the literature highlight the need for a creative product to be both novel and useful (Plucker, Beghetto & Dow, 2004). Finke (1996) calls such products examples of "creative realism"; outcomes which are innovative yet realistic. Such ideas show evidence of "imaginative divergence" (p. 391) in addition to "structural connectedness" to "established principles" and concepts (Finke, 1996 p. 391). Plucker et al. (2004) conclude that the following definition of creativity captures the general consensus within the literature: "Creativity is the interaction among aptitude, process, and environment by which an individual or group produces a perceptible product that is both novel and useful as determined within a social context" (p. 90).

This section began by highlighting the importance of creativity to society. It seems logical to suggest then that as the citizens of tomorrow, creativity should be nurtured in young people.

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### 1.1. Creativity in education

The importance of fostering creativity in schools has been recognized to some extent by previous UK governments. For example, in 1998 the National Advisory Committee on Creative and Cultural Education (NACCCE) was set up by the then Secretary of State for Education and Employment, David Blunkett MP and the Secretary of State for Culture, Media and Sport, Chris Smith MP with the view to: "make recommendations to the Secretaries of State on the creative and cultural development of young people through formal and informal education: to take stock of current provision and to make proposals for principles, policies and practice" (NACCCE, 1998, p. 1).

The NACCCE endorsed a "democratic definition" of creativity (p. 29) and suggested that all pupils should be given the opportunity to develop their creative skills. The NACCCE recommended the development of partnerships between schools and external organisations (such as museums, sporting organisations and performing arts organisations) in order to foster pupils' creativity and build links with the community. The NACCCE report also emphasised the role of teachers in fostering creativity in pupils as the following quote demonstrates:

> Creativity can be 'taught'. Teachers can be creative in their own teaching; they can also promote the creative abilities of their pupils. The roles of teachers are to recognise young people's creative capacities; and to provide the particular conditions in which they can be realised (NACCCE, 1998, p. 11).

In response to the NACCCE report, the Department for Education and Skills (DfES) created the Creativity And Cultural Enrichment working group (CACE) in 2001, which was succeeded by the Qualifications and Curriculum Authority (QCA) initiative *"Creativity: Find it, Promote it"* designed to increase schools' capacity to support creativity in educational settings (QCA, 2004). In addition, Creative Partnerships were set up nationally in 2002 to support projects between schools in disadvantaged areas and creative organisations. An independent review entitled: *"Nurturing creativity in young people"* (Roberts, 2006) reflected the previous Government's commitment to creativity and set out proposals to inform future policy. However, to my knowledge, no recent initiatives have been rolled out under current

coalition Government, and funding for the Creative Partnerships programme was withdrawn in 2011.

The current Early Years Foundation Stage curriculum (EYFS; DCSF, 2008) emphasises the need for youngsters to learn through play, and indeed one of the curriculum strands is entitled "Creative Development" which suggests creativity is a valued part of pupils' early educational experience. However, it seems plausible to suggest that creativity is less likely to be supported as the pupil moves through the school system, given the pressures teachers face to prepare pupils for high status public examinations.

It seems then, that the importance of fostering creativity in young people has been recognised to some extent at the governmental level. However, it is also important to explore the views of those who are able to directly influence creativity in young people, namely teachers.

There is some evidence to suggest that teachers' views on creative pupils are complex. For example, Kampylis, Berki, and Saariluoma (2009) presented Greek primary school teachers and teachers in-training with a self-report questionnaire in order to explore their implicit theories of creativity. The majority of participants endorsed the view that creativity can be developed in all individuals, but only half of participants expressed the view that creativity can be taught. The authors concluded that participants held "inconsistent implicit theories about creativity" (p. 25), which may inhibit their ability to foster creativity in the classroom. Furthermore, the majority of teachers and teachers in training indicated that they did not feel well qualified to support pupils' creativity in the classroom. However, given that this study was based on a sample of Greek teachers and teachers in training, such findings may not be generalizable to teachers in the UK.

In addition, there is evidence to suggest that some teachers perceive creative students as non-conformists (Chan & Chan, 1999) and potential trouble makers (Scott, 1999). Indeed, Sternberg (1985) found that teachers associated creative personalities with negative traits such as impulsivity and risk taking which, in the words of Westby and Dawson (1995), may impact on the teachers' "goals for maintaining order and attending to multiple children" (p. 2). Indeed, Kennedy (2005) observed that teachers often dismiss pupils' unexpected responses in classroom discussion, and note that while this may be legitimate in some circumstances, such practice could potentially limit opportunities for creative development.

Furthermore, Beghetto (2007) asked teachers in training to rate how useful they felt relevant or unique contributions were during class discussion. It was found that teachers in training generally valued relevance in the classroom over novel thought. Qualitative analysis of participants' responses revealed that novel contributions tended to be perceived as "potentially disruptive" or distracting (p. 7), although some participants suggested that novel contributions were "worth pursuing" and a welcome indicator of pupil participation in the lesson (p. 6).

The above research indicates that whilst teachers recognise the importance of supporting pupils' creativity in school on one level, their perceptions of creative students can be somewhat negative. Such a conflicted view of creativity suggests that there is a need to further explore theoretical models of creativity with school staff in order to raise their awareness of creativity as a construct. The following section will therefore focus on the key theoretical perspectives on creativity, drawing on relevant evidence in the literature.

## 1.2 Models of creativity

Consistent with a number of authors in the literature (e.g. Fishkin & Johnson, 1998; Runco, 2004), this paper distinguishes between four approaches to the study of creativity: the "creative person", "creative product", "creative press" and "creative process" (Rhodes, 1987, p. 218). This literature review therefore will briefly outline research surrounding the creative person, product and press before focusing in more detail on theories of creative processing, in particular looking at the role of associative and attentional processes in creativity.

**1.2.1 Creative person.** Some authors conceptualise creativity in terms of the creative personality. Indeed, the common stereotype of the creative individual as a socially awkward genius led Galang (2010) to coin the phrase "pro-social psychopaths", which captures the paradoxical nature of the creative personality. Typically, authors adopting this trait approach employ correlational designs in order to unpick the creative personality. In particular, two influential models of personality are commonly referred to in the literature: McCrae and Costa's (1987) Big Five model of personality (incorporating openness to experience; agreeableness; conscientiousness; extraversion and neuroticism) and Eysenck's (1967) Gigantic Three model of personality (incorporating extroversion; neuroticism and psychoticism).

In a recent review, Batey and Furnham (2006) claim that there is a lack of consensus in the literature regarding the creative personality. They attribute this to variations in the use of measures of creativity and personality. The authors tentatively conclude that when creativity is indexed by scores on tests of divergent thinking, extroversion appears to be correlated positively with creativity. They argue that the research findings implicating a relationship between creativity and psychoticism are more equivocal. In addition, the authors attempt to account for findings implicating the role of openness to experience and creativity by hypothesising that openness:

> Consists of two subfactors: one factor representing an attitudinal openness to new experiences and the second factor being, rather than a choice, an inability to inhibit irrelevant information, a perceptual openness. This suggests that to a certain extent, open people are more open to new ideas because they cannot effectively filter out irrelevant information (Batey & Furnham, 2006, p. 399).

Batey and Furnham (2006) emphasise that creativity in different fields such as the arts or science may require different combinations of personality traits. It seems therefore, that creativity can be associated with a constellation of broad personality traits.

In a similar vein, there has been some debate within the literature concerning the role of intelligence in creativity. Some authors have found a modest relationship between intelligence as measured by Intelligence Quotient (IQ) tests and creativity. For example, in their review of the literature, Batey and Furnham (2006) concluded that intelligence and creativity are correlated in the range of r = .20 to .40. Similarly, a recent study by Batey, Chamorro-Premuzic and Furnham (2009) found that intelligence accounted for 17% of the variance in participants' divergent thinking fluency scores. However, it must be acknowledged that their measure of creativity only took into account the *numbe*r of ideas produced rather than number of *original* and *useful* ideas produces so it is questionable whether these results apply to creativity per se.

It has been suggested that intelligence and creativity are correlated up to a point, but that this relationship disappears in individuals who are highly intelligent (Barron, 1969). Researchers often specify that an IQ of 120 marks this threshold (e.g. Preckel, Holing & Weise, 2006). However, there is inconsistent evidence for this notion within the literature. It has been suggested that methodological differences may account for

this lack of consensus, as researchers utilise different measures of academic ability and creativity (Preckel, et al. 2006). Preckel et al. (2006) found that correlations between divergent thinking scores and intelligence were of a comparable magnitude across a sample of pupils aged between 12 and 16 ranging in ability (including those deemed intellectually 'gifted'), which is inconsistent with predictions from the threshold hypothesis. Furthermore, a recent meta-analysis of the literature found that the mean correlation coefficient between creativity and intelligence was small (r=.17; Kim, 2005) and that when the potential moderating role of a threshold of IQ was explored, this variable "could not explain variance in the studies' correlation coefficients" (p.63). Kim (2005) also suggests that "when creativity tests are administered in a game like testing context, the creativity test scores have smaller relationships with IQ test scores" (p. 65) which implicates the influence of situational factors on pupils' performance. We will return to this idea later in the paper.

This paper will now outline another approach to the study of creativity, where the focus is not on the creative person, rather the product of their creative thinking.

**1.2.2 Creative product.** Historically, the ability to produce a creative solution to a problem was considered to be the sole preserve of the 'genius'. Retrospective accounts of creative achievements by figures such as Einstein, Darwin and Beethoven reinforced the notion of "Big-C (eminent) creativity" (Beghetto & Kaufman, 2007, p. 73). However, contemporary theorists have suggested that this is a misconception and emphasised the notion of everyday or "little-c creativity" (Beghetto & Kaufman, 2007, p.73). Kaufman and Beghetto (2009) further refined this distinction in their "four C model of creativity". They assert that in addition to 'Big-C' and 'little-c' creativity, there exists two further categories of creativity: 'mini-c' and 'pro- c' creativity. Mini-c creativity refers to "novel and personally meaningful interpretation of experiences, actions, and events" and is conceptualised as part of the learning process (Beghetto & Kaufmann, 2007, p.73). It is argued that pro-c creativity encompasses the achievements of individuals who display creativity in their professions but have not yet reached eminent status (Kaufmann & Beghettto, 2009). Kaufmann and Beghetto (2009) provide the following vignette to illustrate the differences between these categories:

Consider Marcus, a (fictional) writer who has published four novels that have been reasonably well-received; perhaps one novel was given a regional prize. If we stick to little-c versus Big-C distinctions, where do we place Marcus? Sticking Marcus into the little-c category diminishes everything he has earned. Yet placing Marcus in the Big-C category is premature. Whether Marcus's work will be remembered, read, and enjoyed years after his death is beyond his control. Marcus has attained a level of creative acumen in a professional field, and should be compared with similar-stage writers. Comparing him with Hemingway, Poe, and Twain does him no favors; neither does placing him with those who have yet to prove themselves. The Pro-c category offers accomplished creative individuals their own category (p.5).

This conceptualisation of creativity offers researchers a means of categorising the products of creative behaviour, and may help teachers recognise the 'little c' and 'mini-c' forms of creativity that may be occurring in their classroom; however its usefulness as an explanatory framework is limited.

**1.2.3 Creative press.** Researchers who emphasise the pressures exerted by situational factors on creativity can be considered to work within the sphere of *creative press*. According to Rhodes (1987) the term "press" refers to "the relationship between human beings and their environment" (p. 220). In adopting a more interactionist point of view, such theorists move away from individualistic accounts of creativity. Amabile (1996) identified the following positive "social environmental influences on creativity": autonomy; sufficient resources; recognition and co-worker openness (p. 120). Potential inhibitors of creativity have been suggested to be surveillance, competition, and rigid organisational procedures (Amabile, 1996). Indeed, Witt and Beorkrem (1989) found a positive relationship between "climates of creative productivity" (p. 33) in the workplace and ratings of organisational effectiveness amongst employees in a military organisation. Furthermore, the role of the school environment on creativity has been demonstrated in a recent study by Besancon and Lubart (2008). The authors found that pupils aged between 7 and 12 years old schooled in alternative learning environments (such as Montessori[1] schools) performed better on tests of divergent thinking and

[1] Montessori schools encourage pupils to learn through a process of self-initiated discovery. Specially designed educational materials are used in these settings to support learning, and pupils are given more

creative writing or drawing tasks, than pupils schooled in more traditional learning environments. Such a perspective suggests the potentially important role of the environment in fostering creativity.

**1.2.4 Creative process.** Other researchers in the literature have focused on creative processing. Lubart (2001) defines the creative process as: "the sequence of thoughts and actions that leads to novel, adaptive production" (p. 295). Historically, the creative process has been conceptualised as a four stage process: (a) preparation, (b) incubation, (c) illumination, and (d) verification (Wallas, 1926). It is hypothesised that creativity requires a period of preparation, where the problem dimensions are explored fully, which is then is followed by incubation; a period of time spent not thinking about the problem directly. Unconscious processing of the problem is hypothesised to lead to a moment of insight or illumination and subsequent verification of the idea follows in order to ensure the solution is fit for purpose (Wallas, 1926). This places creativity as a form of unconscious processing (Weisberg, 2006). The notion of "illumination" resonates with the view of Gestalt theorists, who conceptualise creativity in terms of "leaps of insight" during unconscious processing (Weisberg, 2006, p. 94).

Although Wallas' (1926) theory was based on introspective accounts of the creative process, there has been some attempt to empirically validate this theory. For example, artists have been asked to compose a picture whilst verbalising their thoughts aloud (Patrick, 1937). Everything participants said during the task and the order in which they assembled their pictures, was recorded by the researcher. Patrick (1937) divided the sessions into quarters and found that for the first quarter, participants demonstrated numerous shifts in thought which was taken as evidence of preparation. It was also found that over two thirds of shapes drawn were drawn for the first time in the second and third quarter, which was taken as evidence of illumination. In the last quarter, Patrick (1937) claimed that participants made numerous revisions to their work, which was deemed evidence of verification. In the words of Patrick (1937): "the presence of incubation was shown if an idea occurred early in the report, recurred one or more times, the subject meanwhile talking of other things and at last appeared as the chief topic of the picture" ( p. 43). Participants were also interviewed about their normal

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freedom to follow their interests than in traditional pedagogical approaches (see Lillard, 2007 for further details).

working practice, and participants' responses appear consistent with Wallas' (1926) conceptualisation of creativity. However, upon closer inspection of the interview questions provided in Patrick's (1937) paper, some appear to be leading questions. For example participants were asked: "When you get ready to draw a picture do you incubate it a while first?" and "do you revise your picture much?" which may have influenced participants' responses (p.40). Indeed, Lubart (2001) notes that Patrick's (1937) study may be flawed by confirmative bias and questions the face validity of Patrick's (1937) operalisation of the four stages as outlined above. Furthermore, Lubart (2001) claims that Wallas' (1926) model is too vague to be useful, and that there is a need to specify sub-processes involved in creativity. To this end, this paper will now focus on two sub-processes which have been implicated in the creative process: associative processes and attentional processes.

***1.2.4.1 Associative processes in creativity.*** Mednick (1962) defined creativity as "the forming of associative elements into new combinations which either meet specified requirements or are in some way useful" (p. 221). According to Mednick (1962), the more "remote" two associations are, the more likely the solution will be creative (p.221). Mednick's (1962) associative theory assumes that there are three ways of forming remote associations, which may lead to a creative outcome. Firstly, it is suggested that ideas which are presented contiguously in the environment may lead to the "serendipitous" association of remote ideas (p. 221). Secondly, it is possible that an individual may notice the contiguity between two remote ideas by noticing points of "similarity" in disparate associations (p. 222). For example, Mednick (1962) described how certain aspects of creative writing (such as alliteration and use of rhyme) appear to exploit points of similarity in ideas. Thirdly, it is suggested that two remote associations may be linked by noticing contiguity between "mediating" factors common to both elements (p. 222).

Mednick (1962) proposed that when an individual is asked to consider the word "table" for example, this activates a number of associations. Conventional or common associations such as "chair" are hypothesised to occur first in the associative chain and more original ideas are considered later. An individual's pattern of associative responses is termed their "associative hierarchy" (p. 222). Individuals with a steep associative hierarchy tend to emit a number of conventional responses (e.g. chair, cloth) which are strongly associated with stimulus (i.e. table) but fewer remote associations. In

individuals with a flatter associative hierarchy, conventional responses are not thought to be "overly dominant" (p. 223). As a result, it is hypothesised that individuals with a flatter associative hierarchy will be better able to access remote associations than those with a steep associative hierarchy. Mednick's (1962) model predicts that creative thinkers are more likely to consider creative solutions to a problem because they have flatter associative hierarchies than non-creative individuals. Mednick proposed that creative people are better at finding remote associations and have more associations pertinent to the problem than non-creative people. Mednick (1962) developed the Remote Associates Test (RAT) of creativity on the basis of his theory. In this task, participants are presented with two seemingly remote ideas (e.g. *mines* and *lick)* and are asked to find the associative link between them (i.e. *salt*). Individuals with a flatter associative hierarchy are hypothesised to perform better on this task, as they are better able to access remote associations.

An early study by Mendelsohn (1976) used the RAT in order to explore associative processes in creativity. Participants were required to solve 30 anagrams organised into three categories (i.e. food, animals and miscellaneous). Participants in the informed condition were told that 10 of the anagrams fell into each category; in the uninformed condition participants were not told that the anagrams were categorical in nature. Those who scored highly on the RAT were found to make better use of contextual clues in the informed anagram condition than low scorers on the RAT, although this effect only held true for males. Mendelsohn (1976) argued that this indicates attentional processes are important in RAT performance, a point which we will return to later in the paper.

More recently, Rossman and Finke (2010) explored the relationship between associational information processing and creativity in a sample of German undergraduates. The authors used a number of measures to index creativity including the Alternative Uses Test (AUT; also referred to as the Unusual Uses Task; UUT) where participants are asked to think of as many uses as they can for an everyday object and subtests from the Torrance Test of Creative Thinking (TTCT; Torrance, 1966, 2006), where participants are required to extend incomplete line drawings in original ways. In addition, participants were presented with a modified version of the word pair list task. For the word pair list task, participants were presented with two words and asked to come up with a third word that could serve as a "connective associative link" (p. 893) between the two previously presented items. In this regard, the word pair task

could be seen as an analogous task to the RAT. Participants were also asked to judge the associative distance between word pairs on a 6-point rating scale (ranging from "strongly related" to "without any relation"). The authors found "a weak but significant correlation between the rated associative distance between the presented problem words and psychometrically determined creativity" and that "more original individuals estimate the associative distance between the unrelated word pairs as being lower than less original individuals do" (p. 895). The authors suggest that creative individuals benefit from a more "flexible associative network" than non-creative individuals (p. 895), in line with Mednick's (1962) predictions. The authors also found evidence of a link between participants' self-reported creative hobbies (such as painting, drawing and poetry) and associative information processing, which provides further support for the role of associative processing in creativity.

In addition, Eysenck (1995) hypothesised that creative associations are more likely to be formed in individuals who have reduced levels of inhibitory control. Indeed it seems plausible to suggest that individuals may be more successful in linking remote associations if they have reduced inhibition, as unusual "concepts and ideas are less likely to be inhibited" (White & Shah, 2006, p. 1123). Indeed, Carson, Higgins and Peterson (2003) found that creative undergraduates were seven times more likely to demonstrate deficits in latent inhibition than non-creative undergraduates. The authors speculate that creative individuals may be less able to "screen out" seemingly irrelevant stimuli (p.499) leading to more original responses. It is important to note however, that the participants in the studies included in the meta-analysis were young adults with high IQs and it is not clear how generalizable this may be to other populations.

The research outlined above indicates that associative processing may be important in creativity and in particular, the association between disparate concepts may give rise to creative solutions. There is also some preliminary evidence in the literature that reduced inhibition may be associated with creative processing.

***1.2.4.2 Attentional processes in creativity.*** Martindale (1995) suggests that Mednick's (1962) associative model can be understood cognitively in terms of conceptual attention, i.e. the ability to attend to a range of concepts at the same time. Individuals who have a steep associative hierarchy are hypothesised to have a narrow focus of conceptual attention, which limits their ability to link remote associates. By contrast, individuals who have flatter associative hierarchies are hypothesised to have a

broader range of conceptual attention (so called "defocused attention") and hence greater ability to form remote associates (Martindale, 1995, p. 245). According to Vartanian, Martindale and Kwiatkowski (2007) "defocused attention may be caused by reduced cognitive inhibition, where inhibition is understood as a mechanism that can restrict the flow of information into the focus of attention" (p. 1471).

In Friedman, Fishbach, Forster and Werth's (2003) study, participants were asked to complete a visual search task which encouraged them to adopt a narrow perceptual scope of attention or a broad perceptual scope of attention. They were then asked to complete creativity tasks (i.e. a picture caption task and the AUT). In line with their attentional priming hypothesis, participants who were primed to adopt a broad scope of perceptual attention generated more original responses to the creative task than those who were primed to adopt a narrow scope of perceptual attention.

In addition, other evidence in the literature indicates that individuals with a wide "breadth of attention" (Kasof, 1997, p. 303) perform better on creative tasks than those with a narrower scope of attention. Participants in Kasof's (1997) study completed a self-report measure of breadth of attention, in order to assess their ability to filter out extraneous stimuli such as noise and the feel of clothing on their skin. They were asked to write a poem around stimulus words *'joy'* and *'butterfly*' in the presence of noise stimuli (intelligible vs. unintelligible; predictable vs. unpredictable). Poems were subjectively rated for creativity and the language used by participants was coded for originality. The authors found that self-reported trait breadth of attention was positively correlated with creative performance on the poetry task. In addition, the authors reported that "exposure to attention narrowing environmental stimulation in the form of noise, hindered creative performance on the poetry task" (p. 310) and that this effect was greater in people who reported having a greater breadth of attention than those who had a narrow breadth of attention. Similarly, Memmert (2009) explored the role of "inattentional blindness" (p. 302) on creative responses and found that children who showed less inattentional blindness (i.e. those who noticed unexpected stimuli on a computer task) produced significantly more original ideas on a measure of divergent thinking.

Such research indicates that defocused attention is important in creativity. Indeed, in Ansburg and Hill's (2003) study, participants were required to memorise a list of 25 words, whilst ignoring another 25 words playing in the background. Participants were then asked to solve 30 written anagrams and to recall the list of words

previously presented. Ten of the words participants were asked to memorise were solutions to the anagrams and therefore became focal cues. A further 10 words which were played in the background were solutions to anagrams and therefore acted as peripheral cues. Participants were asked to complete the RAT and deductive reasoning problems in order to assess their creativity and analytical thinking respectively. Multiple regression analysis revealed that creative thinking predicted the ability to "diffuse attention and take advantage of peripherally presented cues" (p. 1146), whereas analytic thinking did not.

However, it has been suggested that whilst defocused attention may be important in the initial stages of creative thinking, individuals must be able to engage in focused attention in order to refine their creative solution to a problem and ensure its appropriateness (Ansburg & Hill, 2003). In the words of Vartanian et al. (2007) defocused attention may be a "variable state, rather than a stable trait" (p. 1471). Support for this notion has been demonstrated by Vartanian et al. (2007). The authors combined participants' scores on the RAT, AUT and Creative Personality Scale to give an index of "creative potential" (p. 1473) and found a positive correlation between creative potential and reaction times on tests which had an element of interference or ambiguity (e.g. Negative Priming Task and the Global Precedence task). The authors also found a negative correlation between creative potential and reaction times on tests that did not have an element of interference or ambiguity (e.g. Hick Task and the Concept Verification Task). The authors suggested that tasks which are more ambiguous require more defocused attention (and hence longer response latencies), than tasks which are less ambiguous (Vartanian et al. 2007).

In short, the literature discussed above indicates that creative processing may involve defocused attention and reduced inhibitory control. Such constructs also feature in the literature surrounding Attention Deficit Hyperactivity Disorder (ADHD). The following sections will therefore briefly outline the nature of ADHD before attempting to draw some parallels between aspects of creativity and ADHD.

### 1.3 What is Attention Deficit Hyperactivity Disorder (ADHD)?

According to the NICE (2008) guidelines "ADHD is a heterogeneous behavioural syndrome characterised by the core symptoms of hyperactivity, impulsivity and inattention" (p. 4). ADHD is a relatively common condition, which affects approximately 3 to 7% of school age pupils (APA, 2000). A recent meta-analysis of

studies reporting a point prevalence of ADHD in individuals under the age of 18, found that the world-wide pooled prevalence of ADHD was 5.29% (Polanzyck, de Lima, Horta, Biederman, Rohde, 2007). The DSM-IV-TR distinguishes between 3 subtypes of ADHD: combined type (if both inattention and hyperactivity are present); predominantly inattentive type, and predominantly hyperactive/impulsive type. As alluded to at the start of the paper, researchers differ in their ontological stance towards ADHD. The DSM-IV-TR criteria encourage a categorical definition of ADHD, although it is possible to conceptualise ADHD as lying at the extreme end of a continuum of dimensions. Support for the dimensional view of ADHD has been provided by genetic twin based studies exploring the aetiology of ADHD. ADHD is highly heritable although crucially, when heritability estimates of monozygotic and dizygotic twins are explored across different cut-offs in symptom severity, heritability estimate do not vary as a function of symptom severity (Levy, Hay, McStephen, Wood & Walderman, 1997) thus lending support to the dimensional view of ADHD.

The DSM-IV-TR (APA, 2000) criteria stipulate that in order to qualify for a diagnosis of ADHD, there must be evidence that the behavioural symptoms are pervasive, that is, occurring in at least two different settings. Individuals must also experience a degree of psychological, social or educational impairment as a result of their symptoms. Indeed, there is evidence to suggest that ADHD is associated with a range of long term negative outcomes such as academic underachievement (Ek, Westerlund, Holmberg & Fernell, 2011; Frazier, Youngstrom, Glutting & Watkins, 2007), social functioning difficulties (Rich, Loo, Yang, Dang & Smalley, 2009) and criminal delinquency (Pratt, Cullen, Blevins, Daigle, & Unnever, 2002).

In addition, the role of gender on ADHD symptom severity and prevalence has been explored in the literature. It has been estimated that ADHD symptoms are between 2 and 9 times more prevalent in males than females (APA, 2000). In addition, a large scale study found a significant main effect for gender on ADHD symptom severity, with ADHD girls being rated as "less symptomatic" than boys with ADHD by both parents and teachers (Newcorn et al, 2001, p.144), which may account for gender differences in diagnoses. Similarly, a meta-analysis by Gaub and Carlson (1997) found that girls with ADHD displayed lower levels of hyperactivity and externalising behaviour than boys with ADHD. Gaub and Carlson (1997) highlighted the fact that proportionally fewer girls are referred to ADHD clinics than boys and hypothesised that reduced rates of disruptive behaviour in girls with ADHD symptomology compared to

boys may account for this finding. The authors also emphasised the potentially confounding variable of referral source bias on gender differences in symptom severity. It was noted that non-referred populations of girls with ADHD symptomology showed "less impairment than boys with ADHD on inattention, internalizing behavior, peer aggression, and peer disliking" (Gaub & Carlson, 1997, p. 1041). By contrast, clinic referred boys and girls with ADHD symptomology were found to be similarly impaired on these measures (Gaub & Carlson, 1997, p. 1041).

It seems that ADHD symptomology is associated with a range of negative outcomes in the literature. However, in line with a positive psychology perspective (Seligman & Csikszentmihalyi, 2000), the current paper seeks to explore whether aspects of ADHD symptomology can be reframed in terms of potential strength. Indeed, given the evidence outlined earlier in this paper implicating the role of defocused attention and reduced inhibitory control in creativity, it is possible that ADHD symptoms may confer a creative benefit. The following sections therefore seek to explore the evidence base implicating a relationship between ADHD symptomology and creativity.

### 1.4 Is there any evidence of increased creativity in ADHD?

Within the literature, only a few papers have directly explored the relationship between creativity and ADHD (Abraham, Windermann, Siefen, Daum & Gunturkun, 2006). Indeed, the majority of the research appears to be theoretical speculation rather than empirical evidence (Healey & Rucklidge, 2008). For example, Cramond's (1994) notion of "overlapping syndromes" (p. 196) proposes that there is an overlap in behavioural indicators of creativity and ADHD. In defence of such an assertion, Cramond (1994) indicated that characteristics such as risk taking, emotionality, sensation seeking, impulsivity and day dreaming have been used to describe both creative and ADHD type personalities in the literature. However, the evidence cited in Cramond's (1994) paper suggests a reliance on primarily subjective, descriptive accounts of creative personalities, rather than objective empirical evidence. Similarly, Leroux and Levitt-Pervill (2000), assert that gifted ADHD individuals are often creative, yet they provide no evidence to support their claim.

Within the literature base, there has been some attempt to empirically investigate the relationship between ADHD and creativity. Shaw and Brown (1990) found that pupils with elevated levels of ADHD symptomology displayed evidence of greater

figural creativity than controls, as indexed by a subtest from the figural TTCT (a measure of divergent thinking). By contrast, no significant group differences were found on a verbal subtest of the TTCT. The authors acknowledge that a potential limiting factor in this study could have been the fact that their ADHD group was selected by teachers and school psychologists without the use of a standardised rating scale. In addition, they suggest that their teacher selected control group may have been biased towards the selection of "highly diligent" (p. 52) pupils, thus limiting the generalizability of their findings. The authors attempted to address some of these methodological limitations in a subsequent study (Shaw & Brown, 1991) and found that their initial findings were robust.

In a recent attempt to unpick the relationship between ADHD and creativity, Healey and Rucklige (2006) explored the prevalence of ADHD symptomology in a sample of creative children between 10 and 12 years old (who scored above the 90th percentile on the TTCT). Their results indicated that 40% creative children displayed elevated levels of ADHD symptomology, although none met the full diagnostic criteria for ADHD. The authors observed that:

> Given the cut-off used to identify children with ADHD symptomatology was 1.5 SD above the mean, one would expect approximately 9% of children within the general population to display clinically elevated levels of ADHD symptomatology. That this current study found a rate over four times expected suggests that ADHD symptomatology in a creative population is a relatively common occurrence (p. 433)

However, some authors have found no group differences between children with ADHD and controls on tests of creativity such as the figural TTCT and insight problems (Healey & Rucklidge, 2008).

It is important to note at this point that there is some evidence to suggest that stimulant medications (such as methylphenidate; MPH), which are commonly prescribed to help ADHD children sustain attention, may actually reduce "cognitive flexibility" in some ADHD children (Tannock & Schachar, 1992, p. 1218) therefore introducing a potential confound into studies exploring creativity in ADHD. Cognitive flexibility has been described in the literature as the ability to "shift freely from one concept to another or change a course of action or thought according to the demands of

a new situation" (Tannock, Schachar & Logan, 1995, p. 236) and is contrasted with "attentional over focusing and perservation" (Tannock & Schachar, 1992, p. 217). Tannock and Schachar (1992) found that MPH use temporarily increased the number of perseverative errors made by participants with ADHD, on the Wisconsin Card Sorting task, indicating a reduced ability to shift mental set (but see Tannock, Schachar & Logan, 1995). It seems plausible to assume that if ADHD medication leads to "cognitive overfocusing" (Swartwood, Swartwood & Farrell, 2003, p. 417), participants' performance on divergent thinking tasks would decrease, as these tasks require a degree of flexibility of thought. Swartwood et al.'s (2003) cross-sectional design explored the effects of MPH on the divergent thinking abilities of pupils with ADHD. Pupils were asked to complete a figural test of divergent thinking one hour after receiving medication and 12 hours after abstaining from medication. The authors found a significant effect of ADHD medication on participants' ability to elaborate on a creative idea, as indexed by a test of divergent thinking. The authors noted that "participants in this study provided more symmetrical, less complex embellishments while under the influence of MPH, indicating that creative thinking may be subtly influenced with stimulant treatment" (p. 419). This suggests that the effect of MPH on creativity may be specific to one dimension of creativity, that of elaboration, as other aspects of creativity (such as fluency, flexibility and originality) were not significantly different between conditions.

The above findings indicate that stimulant medication may be a potential confound in experimental studies exploring creativity in ADHD. In addition, given that stimulant medications are prescribed to pupils as a means of improving attentional focus, the fact that some researchers have noted a subsequent decrease in creative performance could be taken as further evidence of a putative link between the role of breadth of attention and creative performance.

Theories of creativity that emphasise the role of defocused attention in creativity, appear to be intuitively plausible explanations of increased creativity in ADHD, given that one of the key difficulties associated with ADHD is inattentiveness. However, as Vartanian et al. (2007) note, the ability to *shift* between defocused attention and sustained attention is important in the creative process. Indeed, Abraham et al. (2006) explored the performance of young adolescents with ADHD symptomology on a recently activated knowledge task and a creative imagery task. The former task required participants to produce a novel design for a toy, after being shown exemplars of toys,

which had three common elements (i.e. use of electronics, presence of a ball and high physical activity). The novelty of participants' designs was judged on how successful participants were in ignoring the "active contexts" of the exemplars (p. 120). For the creative imagery task, participants were required to put three objects together in a meaningful way to form a novel object that fell into a pre-determined category e.g. furniture, tools, toys, weapons or transportation. The authors found that participants with ADHD symptomology were better able to generate unique responses on the recently activated knowledge task but struggled to generate original and *functional* responses on the creative imagery task when compared to non–clinical controls. This suggests that whilst individuals with ADHD symptomology were able to generate original solutions, they were unable to refine their solution in order to generate functionally appropriate responses, and that this may be the result of their inability to shift from defocused to focused attention. However it should be noted that it is possible that the above findings may be contaminated with order effects (such as practice effects or fatigue), given that the tasks were not counterbalanced during the study.

In a similar vein, White and Shah (2006) compared the performance of adults with a diagnosis of ADHD on a measure of divergent thinking (UUT), convergent thinking (RAT), and a measure of executive inhibition (semantic Inhibition of Return task; IOR) to non-ADHD controls. The authors hypothesised that a high level of inhibition is necessary for solving convergent tasks in order to inhibit "partial solutions" (p. 1122) and arrive at the correct, single solution. In contrast, they hypothesised that low levels of inhibition may be beneficial for solving divergent thinking tasks, where it is important that low frequency ideas are not inhibited. White and Shah (2006) found that "ADHD individuals outperformed non-ADHD individuals on the Unusual Uses Task, but performed worse than non-ADHD on the Remote Associates Test and the semantic IOR task" (p. 1121). Inhibition was found to mediate the relationship between ADHD and performance on the convergent thinking task, which was in line with their predictions. However, inhibition was not found to mediate the relationship between ADHD and performance on the test of divergent thinking, which was not anticipated. The authors speculate that the test of inhibition used in their study, might not be sensitive to inhibitory deficits which are involved in divergent thinking skills.

In short, there appears to be some preliminary evidence in the literature indicating a relationship between ADHD symptomology and creativity. This paper will

now attempt to account for the evidence reviewed above through reference to psychological theories of ADHD.

## 1.5. Models of ADHD

**1.5.1. Evolutionary models of ADHD.** Evolutionary theories of ADHD assume that ADHD traits confer a selective advantage and hence have been selected for during human evolution. In essence, such theories are consistent with a positive psychology perspective on the human condition (Seligman & Czsentmihalyi, 2000), as they seek to account for ADHD in terms of evolutionary benefit. Evolutionary theories of ADHD emphasise the heritability and adaptive significance of ADHD to societies. For example, Hartmann (1999) reframed attention deficit in ADHD as superior vigilance to surroundings, and suggested that such a characteristic may have supported the development of early human hunter society. Although evolutionary theories are difficult to test empirically, there has been some attempt to explore the evolutionary significance of ADHD traits. For example, there is some preliminary evidence indicating that long dopamine receptor D4 alleles, which are associated with novelty seeking (Epstein et al, 1996) and ADHD (Faraaone, Doyle, Mick & Biederman, 2001), are more common in populations that have a history of migration than more sedentary populations (Chen, Burton, Greenberger, & Dmitrieva, 1999). The authors speculate that exploratory behaviour associated with the DRD4 long allele was selected for in the evolutionary history of migratory populations (Chen et al. 1999). Supporters of the evolutionary perspective on ADHD claim that behavioural traits associated with ADHD (such as visual scanning, impulsivity and hyperactivity) that confer "response readiness" in hostile environments (Jensen et al. 1997, p. 1677), may not be as adaptive in modern society, which has been described as the "anachronism" of ADHD (Arcos-Burcos & Acosta, 2007, p. 237).

Furthermore, in a computer simulation of the Changing Food group task, Williams and Taylor (2006) demonstrated that unpredictable, risky behaviour by a minority confers benefits to the whole group. The authors suggest that whilst risky behaviour may confer disadvantages for the individual, the rest of the group can benefit from learning from that individual's mistakes (Williams & Taylor, 2006). Although Williams and Taylor (2006) attempted to falsify their theory by presenting some testable predictions for future research, to my knowledge such research has yet to be

completed. Furthermore, as the authors recognise, their theory remains speculative, in the sense that they "cannot demonstrate that these tasks actually occurred sufficiently enough to have affected the course of evolution" (Williams & Taylor, p. 408).

**1.5.2 Cognitive deficit models of ADHD.** At a different conceptual level, theorists have proposed that ADHD is the result of underlying deficits in executive function (EF). According to Castellannos, Sonuga-Barke, Milham and Tannock (2006), the term EF refers to a range of higher order cognitive processes "that enable flexible, goal-directed behaviour"; such as inhibition of irrelevant stimuli, task switching and planning (p.118).

An influential EF deficit theory of ADHD was proposed by Barkley (1997). This model asserts that a central deficit in a domain of EF known as behavioural inhibition underlies ADHD symptomology. Behavioural inhibition is hypothesised to: allow inhibition of prepotent responses; stop an on-going response and engage in on-line interference control. It is argued that deficits in behavioural inhibition cause secondary deficits in four other areas of EF: "a) working memory; b) self-regulation of affect, motivation and arousal; c) internalisation of speech and d) reconstitution (behavioural analysis and synthesis)" (Barkley, 1997, p. 65). Such secondary deficits in EF in turn, are hypothesised to impact on an individual's ability to engage in "motor control, fluency and syntax" (p.73), which permit effective goal directed movement. Although this model is portrayed as an account of hyperactivity, that is, reduced motor control, Barkley (1997) claims that this model can also describe deficits in attention in ADHD. Barkley (1997) suggests that inattentiveness "represents an impairment in goal or task directed persistence arising from poor inhibition and the toll it takes on self-regulation" (p. 84). Consequently, this model conceptualises attention deficit as a "secondary" symptom in ADHD, resulting from "poor behavioural inhibition and interference control" (p. 84).

This influential model of ADHD has received some support from the literature. For example, Makris et al. (2007) utilised magnetic resonance imaging (MRI) technology in order to explore the cortical thickness of adults with ADHD symptomology. The authors found evidence of cortical thinning in "networks that subserve attention and EF" (p. 1364). There is also evidence to suggest that individuals with ADHD symptomology perform poorly on tasks measuring behavioural inhibition. Barkley, Grodzinsky and DuPaul's (1992) review of the literature indicated that of the

13 studies reviewed that employed the Wisconsin Card Sorting Task as a measure of behavioural inhibition, 8 studies found ADHD populations to be significantly more impaired than non-ADHD populations. However, Sergeant, Geurts and Oosterlan (2002) conclude that the Wisconsin Card Sorting Task may lack face validity as a test of behavioural inhibition as it is variously used in the literature as a measure of "set shifting and in others a measure of conceptual problem solving ability, use of feedback, the ability to modify incorrect strategies, flexibility, and inhibition of pre-potent but incorrect responses" (p. 22).

Similarly, there are conflicting reports in the literature about inhibition deficits in ADHD when the Stroop task is used to index inhibition. For example, Barkley et al. (1992) concluded that five of the six studies reviewed reported that participants high in ADHD symptomology performed significantly worse on the Stroop task than non-ADHD controls. However, a more recent meta-analysis concluded that no differences existed between the performance of individuals diagnosed with ADHD and non-ADHD controls on the Stroop task (Schwartz & Verhaeghen, 2008).

A recent meta-analysis found significant group differences in performance on EF tasks between those diagnosed with ADHD and non-ADHD controls in 65% of total comparisons. Studies utilising a measure of inhibition known as the Stop Signal Task were found to be the most consistent, yielding a weighted mean effect size of .61 across studies (Wilcutt, Doyle, Nigg, Faraone & Pennington, 2005). However, as Wilcutt et al. (2005) acknowledged, their interpretation of the literature may be compromised by the lack of reported reliability statistics for EF tasks. In addition, Nigg, Willcutt, Doyle and Sonuga-Barke (2005) emphasise that the modest effect size noted in the meta-analysis above indicates that the distribution of scores across individuals high in ADHD symptomology overlaps considerably with populations low in ADHD symptomology, with respect to performance on EF tasks. They then go on to note that from a sample of 887 participants across three research centres, at least half of the participants with ADHD symptomology showed "normal" performance on EF tasks, which threatens the validity of Barkley's (1997) single deficit theory.

It seems therefore, that whilst EF deficits may be associated with ADHD symptomology in some individuals, it does not seem likely that "EF deficits are the single necessary and sufficient cause of ADHD in all individuals with the disorder. Instead, EF difficulties appear to be one of several important weaknesses that comprise the overall neuropsychologic etiology of ADHD" (Wilcutt et al. 2005, p. 1342). This

paper will now discuss the dual pathway model of ADHD, which acknowledges the potential role of inhibition deficits in ADHD, as well as accounting for evidence indicating that individuals with ADHD may experience deficits in another area known as 'delay aversion'.

**1.5.3 Dual pathway model-the role of delay aversion in ADHD.** There is evidence in the literature that individuals with ADHD symptomology prefer immediate over delayed rewards (Luman, Oosterlan & Sergeant, 2005). There is evidence to suggest that this represents a motivation to avoid delay rather than an impulsive desire for immediate rewards or reward maximisation (Sonuga-Barke, Taylor, Sembi & Smith, 1992). Sonuga-Barke et al (1992) found that individuals with ADHD were more likely to prefer immediate rewards where doing so reduced the overall trial length (i.e. under experimental conditions which reduced the amount of delay they had to experience). The authors hypothesised that in situations where escape from delay is not possible, individuals who are delay averse may resort to hyperactive or inattentive behaviour in an attempt to reduce their perceived experience of delay (Sonuga–Barke et al. 1992). It follows then, that individuals who are delay averse may be better able to tolerate delay when presented with extra non-temporal stimulation. This notion has received some empirical support. For example, Antrop, Roeyers, Van Oost and Buysse (2000) found that when pupils were asked to wait in a room for 15 minutes and their behavioural responses monitored, those with a clinical diagnosis of ADHD symptomology showed evidence of more hyperactive behaviour than non-ADHD controls in the no-stimulation condition, but not in the stimulation condition (where a videotape was played in the waiting room).

In the dual pathway model of ADHD, delay aversion is described in terms of motivation, as it is hypothesised that pupils high in ADHD symptomology are not *unable* to tolerate delay but *choose* to avoid delay, which they experience as aversive (Solanto et al. 2001; Sonuga-Barke, 2002). Indeed, Sonuga-Barke, De Houwer, De Ruiter, Ajzenstzen and Holland's (2004) use of the dot probe conditioning paradigm, revealed that pupils high in ADHD symptomology showed an "attentional bias to cues for delay-related events" (p. 280) which supports the idea that such individuals perceive delay as a 'threat'. Sonuga-Barke's (2002) dual pathway model of ADHD (Figure 1) proposes that there are two pathways to ADHD, one mediated by executive function deficits (the dysregulation of thought and action pathway; DTAP), the other by delay

aversion (the motivational style pathway; MSP). The DTAP stipulates that inhibitory control deficit is a primary factor in the model, resulting in behavioural and cognitive dyresgulation. Behavioural dysregulation manifests itself in turn as behavioural symptoms of ADHD (inattentiveness, impulsivity or hyperactivity) and cognitive dysregulation leads to poor task engagement. Behavioural symptoms of ADHD and task engagement impact negatively on each other via a feedback loop. By contrast, the MSP suggests that individuals who have "altered reward mechanisms" (p. 32) may experience difficulty in waiting. This difficulty becomes delay aversion when failures to wait are punished by the social environment. Delay aversion is then hypothesised to lead to ADHD symptoms, as the individual attempts to reduce their feelings of delay either by attending to other stimuli or creating their own stimulation.

It seems intuitively plausible to suggest that two different pathways may mediate the symptoms of ADHD, given the heterogeneity in ADHD symptom presentation noted earlier in this paper (Wilcutt et al. 2005). Indeed, Solanto et al. (2001) found that participants' scores on the stop signal task (a measure of inhibition) and the choice delay task (a measure of delay aversion) did not correlate together, but when used together, possessed "excellent discriminant validity" to distinguish populations of individuals high in ADHD symptomology from those low in ADHD symptomology (p. 215). In support of the dual pathway model, a dissociation between performance on EF tasks and delay aversion tasks has also been found in pre-school children presenting with ADHD symptomology (Dalen, Sonuga-Barke, Hall & Remington, 2004).

Figure 1. The dual pathway model of ADHD

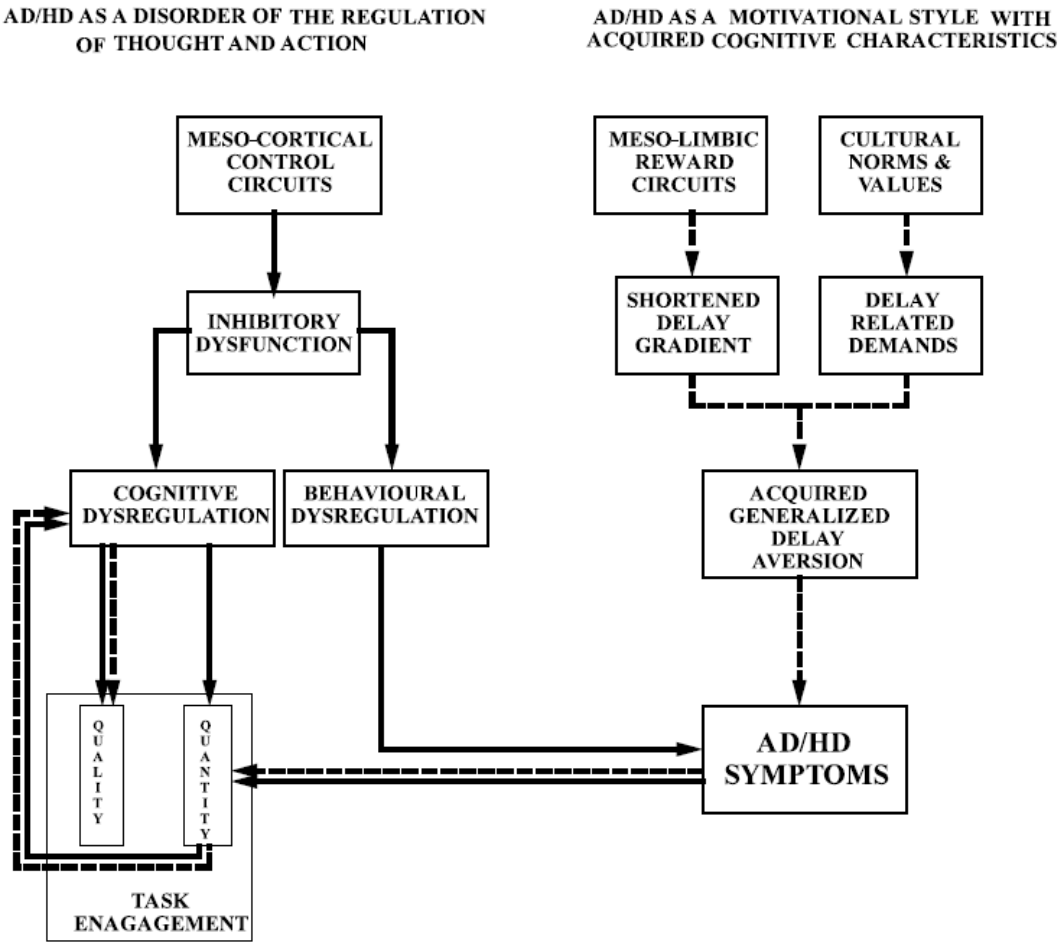


Figure 1. The dual pathway model. Solid arrows represent the Dysregulation of Thought and Action Pathway (DTAP); dashed arrows represent the Motivational Style Pathway (MSP). Both pathways lead to ADHD symptoms. Reproduced with permission from Sonuga-Barke, (2002). Psychological heterogeneity in AD/HD- a dual pathway model of behaviour and cognition. *Behavioural Brain Research, 130,* p. 32.

### 1.6 Towards a "creative advantage" hypothesis of ADHD

There seems to be some preliminary evidence in the literature indicating that theories of ADHD and creativity overlap, particularly in terms of the role of defocused attention and inhibition. There is also some evidence in the literature that individuals with ADHD symptomology show better performance on tests of divergent thinking than controls. In order to extend the observation in the literature of "overlapping syndromes" of creativity and ADHD (Cramond, 1994, p.196), the author proposes the "creative advantage" hypothesis of ADHD.

The creative advantage hypothesis predicts that ADHD symptomology may be an asset on certain creativity tasks, specifically, divergent thinking tasks. As described in previous sections of this paper, there is a suggestion in the literature that defocused attention is important in creativity, at least in the early stages of the creative process (Ansburg & Hill, 2003). Individuals with ADHD symptomology are likely to be more inattentive than control populations and it is assumed that such a tendency towards defocused attention increases the likelihood of remote associates (i.e. statistically infrequent ideas) being activated. Consequently, the probability of unique responses increases. In this way, the creative advantage hypothesis emphasises the role of inattentiveness on creativity in individuals with ADHD symptomology. No specific predictions are made regarding the *independent* contribution of hyperactivity on creativity.

Given the suggestion in the literature that inhibition deficits are important in creativity and ADHD symptom presentation, a secondary prediction of the creative advantage hypothesis is that individuals whose ADHD symptoms are a result of inhibition deficits will show a creative advantage. In line with White and Shah's (2006) hypothesis, it is assumed that reduced inhibitory control may be beneficial in divergent thinking tasks as original ideas would be less likely to be inhibited.

The dual pathway model of ADHD assumes that delay aversion can also lead to inattentiveness (defocused attention), and therefore the creative advantage hypothesis predicts that delay aversion may also mediate the relationship between ADHD symptomology and creativity. Although this notion has not been considered in the literature until now, perhaps individuals who are delay averse may be motivated to consider multiple solutions to problems, in order to reduce their experience of delay. Such an increase in fluency of ideas may increase the likelihood of original responses, and hence, creativity.

The study outlined in the following empirical paper builds on White and Shah's (2006) between-subjects experimental design. In White and Shah's (2006) study, adult ADHD status was the independent variable (ADHD diagnosis vs. no ADHD diagnosis); participants' scores on two measures of creativity (RAT and UUT) were the dependent variables and inhibitory control (as indexed by a semantic IOR task) was a mediator variable. Participants in the ADHD group had a clinical diagnosis of ADHD and met criteria for inclusion via a self-report measure of ADHD symptoms.

The study outlined in the following empirical paper adopts a correlational design in order to explore the association between ADHD and creativity across a *range* of ADHD symptoms. The present author also seeks to explore creativity in a school-age population, using different measures of creativity and inhibition to those presented in White and Shah's (2006) paper. In addition, the present author aims to discriminate between two potential mediators (inhibition deficit and delay aversion) of the relationship between ADHD symptoms and creativity.

Chapter 2: Attention Deficit Hyperactivity Disorder: reframing 'deficit' as creative strength


## Abstract

Attention Deficit Hyperactivity Disorder (ADHD) is a behavioural condition associated with inattentiveness, hyperactivity and impulsivity, which is estimated to affect between 3 and 9% of young people in the UK. Within the literature, ADHD has been associated with a range of long term negative outcomes such as academic underachievement and criminal delinquency. However, there is some preliminary evidence to suggest that in some circumstances, possessing ADHD symptoms may be beneficial in certain contexts. This paper seeks to explore the validity of the 'creative advantage hypothesis' of ADHD, which predicts that ADHD symptoms will be associated with increased creative performance. Furthermore, based on the notion that creativity may be specifically associated with certain cognitive styles linked to ADHD, it is predicted that this relationship would be mediated by differences in inhibition. The potential mediating role of delay aversion is also considered.

Sixty six school aged pupils (*M*=12.4, SD=3.00) whose parents had completed the SNAP-IV (Swanson, 1992) rating scale of ADHD symptoms, were presented with the Figural Torrance Test of Creative Thinking (Torrance, 1966, 2006), a measure of inhibition (Go No Go task; Bitsakou, Psychogiou, Thompson & Sonuga-Barke, 2008) and an adapted version of the Maudesley Index of Delay Aversion (MIDA; Kunsti, Stevenson & Oosterlaan 2001).

Multiple regression analysis revealed that levels of boys' ADHD symptomology significantly predicted one aspect of creativity. This relationship was not mediated by inhibition or delay aversion. The findings of this study provide some support for the creative advantage hypothesis, albeit restricted to boys only. Limitations and practical implications of this study are also discussed.

## 2.1 Introduction

Attention Deficit Hyperactivity Disorder (ADHD) is a behavioural condition characterised by inattentiveness, hyperactivity and impulsivity. According to the Diagnostic and Statistical Manual of Mental Disorders (DSM-IV-TR; APA, 2000) three subtypes of ADHD exist: predominately inattentive; predominately hyperactive and combined subtype. The DSM-IV-TR (APA, 2000) specifies that for a combined type diagnosis of ADHD, individuals must display six of the nine specified symptoms of inattentiveness and six of the nine specified symptoms of hyperactivity/ impulsivity. If an individual does not meet the criteria for a combined diagnosis then it is possible for them to receive a diagnosis of predominantly inattentive (ADHD-I) or predominately hyperactive (ADHD-H) subtypes. In order to receive a diagnosis of ADHD, symptoms must: be present for at least 6 months; confer significant functional impairment in at least two different contexts (e.g. home and school) and not be accounted for by any other mental disorder.

In specifying three subtypes of ADHD, the DSM-IV-TR adopts a categorical perspective on ADHD, the implicit assumption being that individuals with ADHD are qualitatively different to individuals without ADHD. However, it is possible to conceptualise ADHD in terms of a number of dimensions (such as inattentiveness, hyperactivity and impulsivity) that lie on a continuum from mild to severe within the normal population. Such a perspective assumes that individuals with ADHD are only *quantitatively* different to those who do not have a diagnosis of ADHD. In support of a dimensional view of ADHD, genetic twin based studies have found that ADHD is highly heritable, but that crucially, heritability estimates of ADHD are similar across subsamples of increasing symptom severity (Levy et al. 1997). This contrasts with predictions from a categorical view of ADHD, where significant differences in estimates of heritability would be expected as a function of symptom severity.

Given that ADHD, by definition, specifies a degree of functional impairment, it is unsurprising that researchers have identified a range of negative outcomes associated with ADHD in the literature. For example, a relatively robust finding in the literature implicates the role of ADHD symptomology in academic underachievement (Ek, Westerlund, Holmberg & Fernell, 2011; Frazier, Youngstrom, Glutting & Watkins, 2007; see Loe & Feldman, 2007 for a review). In addition, a recent meta-analysis concluded that "childhood ADHD is associated with a substantially higher risk of a

lifetime history of nicotine and illicit substance use, in addition to nicotine dependence, alcohol, marijuana, cocaine, and illicit drug abuse/dependence" (Lee, Humphreys, Flory, Liu & Glass, 2011, p. 338). Furthermore, longitudinal studies have revealed that having a diagnosis of childhood ADHD is a risk factor for psychiatric disorders in early adulthood (notably mood disorders, addictive disorders and antisocial disorders) in boys (Biederman et al. 2006) and girls (Biederman et al. 2010). There is also evidence to suggest that boys with a diagnosis of ADHD and those with co-morbid Oppositional Defiant Disorder (ADHD + ODD) possess an elevated risk for delinquency in adulthood, when compared to a non-clinical control group (Sibley et al. 2011). The authors noted that: "These two groups were more likely to offend earlier, commit a greater variety of crimes, and initiate severe delinquency than comparison participants" (Sibley et al. 2011, p. 28). Research suggests that adolescent females with a diagnosis of ADHD experience more interpersonal difficulties (such as maternal conflict and fewer romantic relationships) than non-ADHD controls (Babinski et al. 2011). However, it is important to note that Babinski et al.'s (2011) findings were exploratory and hence the authors did not correct for multiple testing; further research is therefore necessary to validate these claims.

It could be argued that such an emphasis on negative outcomes pathologises individuals high in ADHD symptomology and that a paradigm shift in research focus towards areas of potential strength may ultimately increase our understanding of ADHD. One promising avenue for exploration that has been identified in the literature concerns the role of ADHD symptoms in creativity. Although myriad definitions of creativity exist in the literature the majority emphasise the need for a creative product to be both novel and useful (Plucker et al. 2004). The following definition of creativity captures the general consensus: "Creativity is the interaction among aptitude, process, and environment by which an individual or group produces a perceptible product that is both novel and useful as determined within a social context" (Plucker et al. 2004, p. 90).

In addition, researchers have distinguished between convergent and divergent thinking in the creativity literature. Convergent thinking involves "narrowing possibilities" in order to find a single, correct solution (Hennesey & Amabile, 2010, p.579). By contrast, divergent thinking involves the consideration of multiple solutions to open-ended problems. Although divergent thinking is often considered to be synonymous with creativity in the literature, Cropley (2006) suggests that convergent thinking is also important in creativity, in order to ensure a novel idea is fit for purpose.

It has been suggested that traits such as risk taking, emotionality, sensation seeking, impulsivity and day dreaming describe creative individuals as well as those with ADHD, and that creativity and ADHD may be "overlapping syndromes" (Cramond, 1994, p.196). It follows then that if behavioural traits of ADHD overlap with those of creativity, individuals high in ADHD symptomology may show superior performance on creative tasks than controls. There has been some attempt to empirically investigate this notion within the literature. For example, Shaw and Brown (1990) found that pupils aged between 10 and 13 years who were identified by teachers as being high in inattentiveness and hyperactivity, performed significantly better on a subtest of figural creativity taken from the Torrance Test of Creative Thinking (TTCT; Torrance, 1966, 2006) than controls. However, no significant differences were found between the two groups in terms of verbal creativity. The authors acknowledge a potential selection bias in their teacher selected control group towards pupils displaying "strong conformity and extreme diligence" (p. 52). It is possible therefore, that the control group in this study was not representative of the normal population. In addition, participants high in ADHD symptomology were not identified using standardised rating scale, instead subjective teacher, Head teacher or school psychologist judgements were used. When the authors selected participants based on a standardised rating scale of ADHD symptomology (Connor's rating scale) in a subsequent study, individuals high in ADHD symptomology performed significantly better on tests of figural creativity than controls (Shaw & Brown, 1991). More recently, Healey and Rucklige (2006) found that in a sample of 10-12 year olds, 40% of children identified as being creative displayed elevated levels of ADHD symptomology, which is consistent with the notion that creativity and ADHD symptoms may overlap.

In addition, White and Shah (2006) compared the performance of adults with a diagnosis of ADHD on two measures of creativity: the Unusual Uses Test (UUT; a measure of divergent thinking) and the Remote Associates Test (RAT; a measure of convergent thinking). The authors found that individuals with a diagnosis of ADHD performed better on the test of divergent thinking but worse on the test of convergent thinking than non–ADHD controls, which suggests that the benefits associated with ADHD symptomology may be limited to particular kinds of creativity tests, namely those requiring open ended responses. However, some researchers have found no group differences between children high in ADHD symptomology and those low in ADHD

symptomology on tests of creativity such as the TTCT and insight problems (Healey & Rucklidge, 2008), which suggests the need for further research in this area.

In short, there appears to be some preliminary evidence supporting a putative link between ADHD and symptomology, and the following section highlights some key points of overlap between theoretical models of creativity and ADHD which may account for these findings.

### 2.1.1. Theoretical considerations- the role of defocused attention and inhibition deficits

Why should creativity and ADHD be associated? It seems plausible to suggest that creative individuals and those high in ADHD symptomology may by united by common cognitive factors. The case for defocused attention and inhibition deficits in creativity and ADHD will now be presented.

Inattentiveness is a core feature of ADHD and attentional processes have also been implicated in the creativity literature. For example, Martindale (1995) reconceptualised Mednick's (1962) associative model of creativity in terms of conceptual attention. Mednick (1962) initially hypothesised that creative responses involve the juxtaposition of remotely associated ideas. It has been suggested that creative individuals are more successful in producing original ideas because they have a "flat associative hierarchy"; unusual combinations of ideas are just as likely to be activated as more conventional ideas (Mednick, 1962, p. 223). Martindale (1995) suggested that individuals who have a broad focus of conceptual attention (so called "defocused attention"; p. 245), would be more successful in uniting remote associates than individuals who are less able to attend to a broad range of concepts simultaneously. According to Martindale (1995) "defocused attention versus flat associative hierarchies are cognitive and behaviouristic ways of describing exactly the same phenomenon" (p. 247). There has been some support for the role of defocused attention in creativity. For example, when participants were primed to adopt a broad scope of perceptual attention they were able to generate more novel responses on a measure of divergent thinking than those who were primed to adopt a narrow scope of perceptual attention (Friedman et al. 2003). However, it has been claimed that whilst defocused attention is important in the initial stages of the creative process, individuals must also be able to focus their attention in the latter stages in order to refine their creative product and ensure that it is fit for purpose (Ansburg & Hill, 2003). Given that individuals high in ADHD

symptomology experience difficulties in sustaining attention, it seems plausible suggest that such individuals may struggle with this aspect of creative thinking. Indeed, Abraham et al. (2006) found that individuals with a diagnosis of ADHD were less able to generate a novel yet *functional* invention on a creative imagery task than controls (Abraham et al. 2006). In short, there appears to be some evidence implicating the role of defocused attention in creativity, which parallels the notion of "inattentiveness" in the ADHD literature.

In addition to the role of defocused attention, it seems that creative individuals and those high in ADHD symptomology may share deficits in inhibitory control. Indeed, Eynseck (1995) hypothesised that individuals who have reduced levels of cognitive inhibition, would be more likely to form creative associations. There is some empirical support for the role of inhibition in creativity as Carson et al. (2003) found that high lifetime creative achievers were significantly more likely to demonstrate deficits in inhibition than low lifetime creative achievers. In addition, Carson et al. (2003) found that individuals who demonstrated reduced levels of inhibition produced significantly more original responses on a test of divergent thinking than individuals who demonstrated higher levels of inhibition.

Deficits in inhibitory control have also been associated with ADHD in the literature (see Willcutt et al. 2005, for a review) and form the basis of Barkley's (1997) executive function deficit theory of ADHD. According to Barkley (1992), deficits in behavioural inhibition (i.e. the ability to halt a pre-potent response) cause secondary deficits in four other areas of EF: "a) working memory; b) self-regulation of affect motivation and arousal; c) internalisation of speech and d) reconstitution (behavioural analysis and synthesis)" (p. 65). These secondary deficits in EF in turn are hypothesised to impact on an individual's ability to engage in appropriate goal directed behaviour, thus increasing the likelihood of inattentiveness or hyperactivity.

It seems plausible to suggest that inhibitory deficits may be a common factor in creativity and ADHD. Indeed, White and Shah (2006) investigated the role of inhibition on two aspects of creativity: divergent and convergent thinking in a sample of adults with a diagnosis of ADHD. They hypothesised that low inhibitory control would facilitate performance on divergent thinking tasks as "concepts and ideas are less likely to be inhibited" (p. 1123). By contrast, White and Shah (2006) hypothesised that high inhibitory control would facilitate performance on convergent thinking, given the need

to inhibit incorrect "partial solutions" (p. 1122). Results indicated that individuals with a diagnosis of ADHD performed better than controls on the measure of divergent thinking, but worse than controls on the measure of convergent thinking. In addition, the authors found that differences in inhibition (as measured by the semantic inhibition of return task) statistically mediated the relationship between ADHD symptomology and performance on the convergent thinking task. However, an unexpected finding emerged with respect to divergent thinking: differences in inhibition did not mediate the relationship between ADHD symptomology and divergent thinking. The authors suggest that this latter finding may be related to the type of inhibition task used in the study and hypothesise that "ADHD-related inhibitory deficits not assessed in the present study, and/or characteristics of ADHD unrelated to inhibition, may contribute to better divergent thinking ability in individuals with ADHD" (p. 1128). Indeed, it is possible that replicating White and Shah's (2006) study with a different measure of inhibition may give different findings with respect to the mediating role of inhibition in divergent thinking.

Such a formulation however, may be overly simplistic given the heterogeneity of ADHD symptom presentation. Inhibition deficits alone are neither sufficient nor necessary to lead to ADHD (Wilcutt et al. 2005). Some individuals who show high levels of ADHD symptomology have been found to show a preference for smaller sooner rewards, over larger later rewards (Luman et al. 2005), a phenomenon known as delay aversion. Sonuga-Barke's (2002) dual pathway model of ADHD attempts to reconcile these apparently divergent findings. His model describes two potential pathways in ADHD: the dysregulation of thought and action pathway (DTAP) and the motivational style pathway (MSP). The DTAP places deficits in inhibitory control as a primary symptom of ADHD, which leads to behavioural dyresgulation and the manifestation of behavioural symptoms such as inattentiveness, impulsivity and hyperactivity. Inhibition deficits are also hypothesised to lead to cognitive dysregulation, which in turn leads to poor task engagement. Behavioural symptoms of ADHD and task engagement are thought to interact via a feedback loop. The MSP specifies that delay aversion is a product of the motivation pathway. It is suggested that individuals may become delay averse if they have biologically "altered reward mechanisms" regarding the perceived value of delayed rewards, in combination with negative experiences of delay (such as being subjected to unreasonably high expectations to tolerate delay in their early years). Delay aversion is then hypothesised

to lead to ADHD symptoms, as the individual attempts to reduce their experience of delay either by attending to other stimuli (inattentiveness) or creating their own motor stimulation (hyperactivity).

### 2.1.2. The creative advantage hypothesis

The creative advantage hypothesis predicts that ADHD symptomology may lead to superior creative performance, specifically on tests of divergent thinking. It is predicted that defocused attention may increase the likelihood of an individual associating two conceptually remote ideas together, thus predisposing those with ADHD symptomology to perform better on tasks that require novel responses. Although this hypothesis clearly implicates the role of inattentiveness on creativity, no prediction is made regarding the *independent* contribution of hyperactivity on creativity.

In addition, the creative advantage hypothesis sets up secondary predictions regarding potential mediators of the relationship between ADHD symptomology and creativity:

1) Given the suggestion in the literature implicating the role of inhibition deficits in both creativity and ADHD, it is assumed that any benefits ADHD populations experience in terms of creativity may be mediated by cognitive deficits in inhibitory control. It is suggested that individuals with inhibition deficits are more likely to be creative because unusual ideas are less likely to be screened from consciousness.

2) It is possible that delay aversion may also mediate the relationship between ADHD symptomology and divergent thinking, given that delay aversion has been hypothesised to lead to inattentiveness in ADHD. Although this aspect of the creative advantage hypothesis remains speculative at present, perhaps individuals with delay aversion may be more creative than those who are not delay averse, as the former may be motivated to produce multiple ideas (thus increasing the chances of original responses) in order to reduce their experience of delay.

The creative advantage hypothesis assumes that as inhibition deficits and delay aversion independently lead to inattentiveness (defocused attention) in ADHD, they may have similar effects on divergent thinking. The current study seeks to discriminate between these two potential mediators, although it is acknowledged that the case for inhibition deficits is somewhat stronger than the case for delay aversion, given previous evidence implicating the role of inhibition deficits in both ADHD and creativity.

### 2.1.3. Aims and hypotheses

The current study seeks to test the "creative advantage hypothesis", in order to contribute to the growing literature base. In particular, the current study seeks to build on the findings of White and Shah (2006) with a younger sample of participants and explore whether their results can be extended using a figural measure of creativity, a computerised test of motor response inhibition and a delay aversion task.

There is a relative lack of research exploring creativity in young adolescent populations. Given evidence indicating that creativity tends to increase with age (Torrance, 1968, Besancon & Lubart, 2008), but dips during transition to the first year of secondary school (Lau & Cheung, 2010), the current study explores the creative abilities of pupils in the second year of their secondary education (i.e. Year 8 in the UK educational system).

There is evidence to suggest that ADHD is more prevalent in boys than girls (APA, 2000) and girls are generally rated as "less symptomatic" than boys by both parents and teachers (Newcorn et al. 2001, p. 144). If an association does indeed exist between creativity and ADHD symptoms, it would be harder to find in girls than boys, because of the restricted range of ADHD symptoms in girls. The responses of boys and girls will therefore be analysed together and separately in this study. The creative advantage hypothesis can be falsified though exploration of six testable predictions which will become the focus of this study:

*Hypothesis 1:* Inattentiveness should correlate positively with pupils' scores on a test of divergent thinking.

*Hypothesis 2:* Inhibition deficits should correlate positively with ADHD symptomology and divergent thinking.

*Hypothesis 3:* Delay aversion should correlate positively with ADHD symptomology and may correlate with divergent thinking.

*Hypothesis 4:* ADHD symptomology should significantly predict pupils' scores on a test of divergent thinking.

*Hypothesis 5:* The relationship between ADHD symptomology and divergent thinking should be independently mediated by differences in inhibition

*Hypothesis 6:* The relationship between ADHD symptomology and divergent thinking may alternatively be mediated by delay aversion.

In addition, the impact of gender on ADHD symptoms will also be considered:

*Hypothesis 7:* Boys should show higher levels of ADHD symptomology than girls.

## 2.2 Method

### 2.2.1 Design

A correlational design was used to explore the relationship between parental ratings of inattentiveness and hyperactivity/impulsivity on the SNAP-IV (predictor variables) and creativity subscale scores on the TTCT (outcome variables). Inhibition deficits (number of commission errors on the Go No Go task) and delay aversion (percentage of short delay reward choices on a delay aversion task) acted as mediator variables. Participants within the same year group (Year 8) were recruited from three secondary schools on the basis of opt-in parental consent and parental completion of the SNAP-IV rating scale. Participants completed the TTCT, Go No Go task and a delay aversion task in groups of three, during a one hour testing session in school.

### 2.2.2 Participants

Participants were recruited from three secondary schools, in three different geographical regions[2]. The parents of pupils in Year 8 (N=608) were approached and

[2] Due to difficulties in recruiting participants, it was necessary to extend the geographical range of the study to include schools in three different Local Authorities. Local Authorities were approached where

14.4% (N=87) agreed for their child to take part in the study. Parents were advised that if their child was currently taking medication for ADHD, they would not be eligible to participate in the study[3]. Parents who indicated their consent were subsequently sent an ADHD rating scale. Sixty nine parents completed and returned the rating scale giving a 79.3% response uptake. Pupils whose parents had completed the rating scale were then invited to participate in the second phase of the study. One pupil did not attempt the test battery due to a diagnosis of epilepsy[4] and a further two pupils were absent on the day of testing. Sixty six pupils in total made up the final sample. Participants were therefore recruited on the basis of parental consent to take part in the study and parental completion of an ADHD rating scale. Pupils who participated in the study ranged in age between 12 years 4 months and 13 years 4 months (*M*= 12 years 9 months, SD= 3.00 months). There was an even gender split in the sample (male N=33; female N=33).

### 2.2.3 Measures

**2.2.3.1 SNAP-IV.** The SNAP-IV (Swanson, 1992) is a 90 item measure of inattentiveness and hyperactivity which can be completed by teachers or parents. Items 1-18 reflect the DSM-IV criteria for ADHD; items 19-39 measure activity and attention levels as well as Oppositional Defiant Disorder. Items 39-90 set out exclusion criteria for a diagnosis of ADHD, tapping behaviours associated with non-ADHD conditions

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the author had prior employment experience. Participants were therefore recruited from one school in Bracknell Forest (N=27), one school in North Hampshire (N=17) and one school in South Wales (N=22).

[3] There is some evidence to suggest that stimulant medications (e.g. methylphenidate), which are commonly prescribed to help ADHD children sustain attention, may actually reduce "cognitive flexibility" in some individuals (Tannock & Schachar, 1992; Swartwood et al 2003 but see Tannock, Schachar & Logan, 1995), which may have implications for creative thinking. As a precautionary measure, pupils who were taking medication for ADHD were excluded from the study in order to avoid introducing a potential confound into the study.

[4] Given that the fast presentation of the stimuli in the Go No Go task could be perceived as a "flashing" stimulus, participants were asked at the start of the study if they had a diagnosis or epilepsy or were sensitive to flashing lights. Pupils who indicated that they were sensitive to flashing lights were asked to return to lessons without completing the study as a precautionary measure.

such as Tourette's Disorder and Obsessive Compulsive Disorder among others. For the purposes of this study, only items 1 to 18 were used as a measure of inattentiveness and hyperactivity (Appendix A). The response format of the SNAP-IV is a 4 point Likert scale (Not at All = 0, Just A Little = 1, Quite A Bit = 2, and Very Much = 3), where parents indicate the extent to which their child displays the behaviour in question. Subscale scores for inattentiveness and hyperactivity are expressed as an average rating-per-item. Bussing, Mason, Bell, Porter and Garvan (2008) explored the reliability of parents and teacher ratings on a shortened version of the SNAP-IV, which consisted of 26 items (18 DSM-IV descriptors of inattentiveness and hyperactivity, and 8 items relating to ODD). They found that overall, this measure possessed excellent reliability both in terms of parent (r=.94) and teacher (r=.97) ratings. Solanto and Alvir (2009) also found that the 39 item measure possesses slightly higher internal reliability than Connor's Revised Questionnaire for ADHD diagnosis[5].

**2.2.3.2 Torrance Test of Creative Thinking (TTCT).** The TTCT comes in two forms: the figural and verbal, where participants are asked to respond to a number of open ended tasks incorporating figural or verbal stimuli respectively. Only the figural version of the TTCT will be discussed here. The Figural TTCT is a measure of divergent thinking, which was initially published in 1966 and has been subsequently re-normed in 1974, 1984, 1990, 1998 and 2007. Participants are asked to complete three drawing based tasks lasting 10 minutes each and are encouraged to "think of ideas that no-one else will think of" (Torrance, 2008a, p.2). During the first activity, *"Picture Construction"*, participants are required to draw a picture incorporating an 'egg' shaped stimulus. This is followed by "*Picture Completion",* where participants are presented with ten incomplete figures and asked to transform as many of these as they can into interesting pictures. Finally, participants are presented with the "*Lines*" activity, where they are required to make as many interesting objects or pictures as they can from 30 pairs of parallel lines. For each activity, participants are also asked to label each of their drawings with an imaginative title. Responses are scored for:

[5] In line with dimensional view of ADHD adopted in this paper, the SNAP-IV scale encourages raters to indicate where on the continuum of symptom severity the participant lies.

- *Fluency,* which translates as the number of legitimate responses (i.e. appropriate use of stimulus material) given per activity. Only *Picture Completion* and *Lines* are scored for fluency as *Picture Construction* consists of a single item.
- *Originality,* which reflects the number of statistically rare ideas given. The scoring manual provides a list of common responses which are given a score of zero; all other legitimate responses are given a score of one.
- *Elaboration,* which reflects the extent to which ideas have been developed. Responses are scored in terms of the number of additions to each drawing which go beyond the essential elements. The number of additions is converted to a score through reference to a table in the scoring manual.
- *Abstractness of Titles,* which captures the use of abstract or metaphorical language in titles given to drawings. Responses are given a score of between 0 and 3 depending on how far the title moves beyond a concrete description of the drawing.
- *Resistance to Premature Closure,* which refers to the ability to be psychologically open-minded when considering ways to complete tasks. It reflects the ability to withhold the temptation to 'close' incomplete figural stimuli prematurely in Activities 2 and 3 with a direct line or simple curve.

Raw scores are converted into standard scores (*M*=100, SD=20) with reference to age appropriate tables provided in the Norms Technical Manual (Torrance, 2008b). In addition to the basic scoring procedures outlined above, participants responses can also be scored in term of 13 creative strengths: emotional expressiveness; storytelling articulateness; movement or action; expressiveness of titles; synthesis of incomplete figures; synthesis of lines or circles; unusual visualization; internal visualization; extending or breaking boundaries; humour; richness of imagery; colourfulness of imagery, and fantasy (Torrance, 2008a). According to the manual, creative strengths can be added to the average of participants' standard score in order to give a value known as the "Creative Index". Due to time constraints, only the norm referenced scoring procedure for the subtests and the average standard score was used in this study.

The TTCT is one of the most widely used measure of creativity in the literature (Davis, 1997). The measure has been most recently normed in 2007, and Kuder

Richardson 21 reliability estimates for average creativity scores range from .85 to .93 across the 5 to 16 year age range (Torrance, 2008b).

**2.2.3.3 Go No Go task.** Bitsakou et al.'s (2008) Go No Go task was used to index inhibition deficits. The programme was made compatible with Windows 7 Operating System, but the content remained unchanged. In this computer based task, participants are presented with left or right pointing arrows and asked to press the corresponding left or right button on the computer keyboard. "Go trials" make up 75% of trials and require individuals to press the appropriate key when presented with either left or right pointing green arrows. For 25% of trials, individuals are presented with the "No Go" stimulus: a green double-headed arrow, and must inhibit their motor response and refrain from pressing any key on the computer keyboard. In the current study, the number of trials where the participants erroneously responded to a No Go trial (i.e. commission errors) was used as an index of inhibition deficit. Participants completed 100 trials, and for all stimuli the inter-stimulus interval was 1500 ms (100ms stimulus duration, followed by a blank screen for 1400ms). According to Bistakou et al. (2008) the test-retest reliability of this task is "moderate (intra-class correlation= 0.61; Bitsakou, 2007, unpublished data)" (p. 264).

**2.2.3.4 Delay aversion task.** Maudsley's Index of Childhood Delay Aversion (MIDA; Kuntsi, Stevenson, Oosterlaan & Sonuga-Barke, 2001), was adapted in order to make it compatible with Windows 7 Operating System. This game-like computer task requires pupils to 'shoot' target spaceships which move slowly across the screen. Pupils are given a choice of when to shoot spaceships over a course of 20 trials, where waiting for a short delay before shooting scores one point and waiting for a long delay before shooting scores two points. In Kunsti et al's (2001) original task, participants were required to wait for 2 seconds in order to gain one point, and 30 seconds in order to gain two points. In the current study, for practical reasons the interval of the long delay option was reduced. Consequently, the period of time pupils were required to wait in order to gain two points was reduced to a 10 seconds[6]. In order to gain one point, pupils

[6] It was felt that the cumulative effect of multiple 30 second delays would have a negative effect on pupils' interest and engagement levels and hence overestimate the number of pupils identified as being delay averse. In addition, reducing the period of long delay was appropriate for pragmatic reasons, given pressures on the researcher to ensure that the test battery could be completed comfortably within one

were required to wait 2 seconds. Prior to the onset of 20 trials, participants were exposed to two practice trials. The percentage of short delay reward choices was used as an indicator of delay aversion.

Kunsti et al's (2001) original measure has been found to have a satisfactory test-retest reliability based on partial correlations (.69) (Kunsti, Stevenson, Oosterlan & Sonuga-Barke, 2001) and good discriminant validity (Kunsti et al. 2001). However, it has been found that intelligence may be a moderating factor on performance on the MIDA (Bitsakou, Psychogiou, Thompson & Sonuga-Barke, 2009).

### 2.2.4 Procedure

Ethical approval was granted by the University of Southampton Ethics Committee (Study ID=844, Appendix B1, B2). Head teachers of six secondary schools in Bracknell Forest Local Authority, 11 secondary schools in Hampshire and one secondary school in Wales were approached by telephone and email and invited to participate in the study. One school from each region agreed to take part, and opt in consent forms (Appendix C) and information sheets (Appendix D) were sent to the parents of all pupils in Year 8 (N=603). Parents were given at least a fortnight to return consent slips to school. School staff were then given a range of pass numbers to allocate to each pupil whose parents consented for their participation. In order to ensure linked anonymity, schools were instructed to keep a list of pupil names and pass numbers; the researcher only had access to the list of pass numbers. The researcher ensured that the appropriate pass number was written on the SNAP-IV before sending to parents via school staff. Parents were provided with a deadline to return the questionnaire in the stamped addressed envelope provided. During the second phase of data collection, pupils whose parents had completed the SNAP-IV were invited to a one hour testing session in their school. Pupils were tested in groups of three, with up to nine pupils

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lesson. Delay aversion tasks specify different lengths of long delay, and values range from 10 seconds (Bitsakou, Antrop, Wieserman & Sonuga-Barke, 2006) to 30 seconds (Kunsti et al. 2001) within the literature; the more conservative estimate of delay aversion (10 seconds) was therefore chosen for this exploratory study. The researcher checked the distribution of pupils' scores on the delay aversion task after the first two days testing (N=18), and noted the range of scores collected. The distribution of pupils' scores was judged to be approaching normality and so a decision was made to continue using this task in the adapted format.

being tested per day. At the beginning of each testing session the researcher outlined the purpose of the study and pupils' written assent was sought (Appendix E). Pupils who reported that they were sensitive to flashing lights and/or had a diagnosis of epilepsy were asked to return to lessons. Pupils then completed three tasks, the Figural TTCT for 30 minutes, and two computer based tasks: the delay aversion task for 10 minutes and Go No Go task for approximately 5 minutes. Across the sample, tasks were counter balanced in order to reduce order effects. Participants were asked to record their pass number manually on the TTCT form and the researcher logged pupils' pass numbers when prompted by the computerised Go No Go and the delay aversion tasks. Pupils' participation on the delay aversion task was rewarded with small stationery items. Participants were provided with a written debrief form to take home and thanked for their participation (Appendix F).

### 2.2.5 Analysis

Parental ratings of inattentiveness and hyperactivity on the SNAP-IV were linked to participants' performance on the computer tasks and the TTCT standard scores via the pass number system. All data was entered into SPSS for analysis. The raw data was screened for univariate outliers through conversion to z-scores ($M$=0, SD=1) and visual inspection of box plots for each variable. One data point had a z-score of above 3.29 and was classed as a significant outlier as recommended by Field (2009). This data point was replaced with a value corresponding to 3 SD above the mean. Missing data on the SNAP-IV (N=2) was dealt with by calculating an average rating per item for items answered. The distribution of the data set was then checked for normality both visually (using histograms and p-plots) and quantitatively, using the Shapiro-Wilk test.

Participants' median scores were then calculated for all the variables across the whole sample and split by gender. A one tailed non-parametric Mann-Whitney U test was used to explore the significance of gender on participants' SNAP-IV scores and a two tailed Mann Whitney U Test was used to explore the significance of gender on the remaining variables. Effect sizes for Mann-Whitney estimates were also calculated. The reliability of the SNAP-IV was also calculated.

A one-tailed Spearman's correlation was carried out between: inattentiveness and creativity; delay aversion and creativity, and inhibition and creativity, across the whole sample and split by gender. A two-tailed Spearman's correlation was carried out between: ADHD combined scores and creativity; hyperactivity and creativity; creativity subtests, and subscale scores on the SNAP-IV, across the whole sample and split by gender[7]. In order to correct for multiple correlations and Mann Whitney U comparisons a False Discovery Rate correction was applied for both forms of analysis[8].

Hierarchical multiple regression was then conducted to explore the role of ADHD symptomology on relevant creativity subtests. Parental ratings of inattentiveness and hyperactivity were both entered into subsequent regression models as potential predictors, as jointly they can be considered a proxy for ADHD. However, given that the creativity advantage hypothesis emphasises the role of defocused attention in creativity, participants' inattentiveness scores were entered first into the regression equation, followed by hyperactivity. In order to avoid violating the assumption of singularity, only subscale scores for inattentiveness and hyperactivity were entered into the regression equation (and not total scores on SNAP-IV). This also allowed the researcher scope to explore the relative contributions of inattentiveness and

[7] As recommended by Field (2009) effect sizes were calculated for Mann Whitney U Tests using the formula:

r= Z/ √N (where Z= z-score and N= sample size).

[8] When conducting multiple comparisons, the likelihood of making Type 1 errors increases. A Bonferroni correction is often applied in such circumstances in order to reduce the familywise error rate. Some authors have argued that the Bonferroni correction can be too conservative (e.g. Bland & Altman, 1995), and increase the likelihood of making Type 2 errors. Indeed in this study, applying a Bonferroni correction for multiple correlations (0.05/165) and would specify a corrected p value of =.0003. A less conservative method of multiple correction involving sequential Bonferroni type calculations was used in the current paper in order to control for the number of falsely rejected null hypotheses: the False Discovery Rate (Benjamini & Hochberg, 1995). In this procedure, observed p values for all comparisons are ranked ( with lower numbers indicating smaller p values) and entered into the following equation:

$$P_{(i)} \leq \frac{i}{m} q^*$$ (where $P$= uncorrected p value, $i$=rank, $m$=total number of comparisons, and $q$*= 0.05)

The highest p value to satisfy the constraint becomes the corrected p value for the sample.

hyperactivity on creativity[9]. Post hoc power calculations were conducted for significant regression models using an on-line multiple regression power calculator, (retrieved from: http://www.danielsoper.com/statcalc3/calc.aspx?id=9).

Mediational analysis was then attempted as outlined by Baron and Kenny (1986). Baron and Kenny (1986) stipulate 4 conditions that must be fulfilled during mediational analysis: 1) The independent variable(s) (IV) must predict the proposed mediator, 2) The IV(s) must predict the dependent variable (DV), 3) the mediator must predict the DV whilst controlling for the IV(s), 4) the effect of the IV(s) on the DV in regression 3 must either non-significant or smaller than in regression 2.

## 2.3. Results

### 2.3.1 Descriptive statistics

Visual inspection of histograms indicated that the majority of variables were non-normally distributed across the whole sample. The Shapiro–Wilk test confirmed that the distribution of following variables was significantly non-normal: mean rating per item on the inattentiveness subscale of the SNAP-IV ($W_{60}$=.925, p=.001); mean rating per item on the hyperactivity subscale of the SNAP-IV ($W_{60}$=.893, p<.001); mean total rating per item on the SNAP-IV ($W_{60}$=. 916, p=.001); percentage short delay reward choices on delay aversion task ($W_{60}$=.753, p<.001); elaboration scores on the TTCT ($W_{60}$=.853, p<.001), abstractness of titles scores on the TTCT ($W_{60}$=.941, p=.006) and number of commission errors on Go No Go task ($W_{60}$=.947, p=.011). By contrast, fluency ($W_{60}$=.986, p=.741); originality ($W_{60}$=.976, p=.398); resistance to premature closure ($W_{60}$=.981, p=.489), and mean creativity standard scores on the TTCT ($W_{60}$= .984, p=.612) did not differ significantly from normal.

[9] According to Green (1991), the minimum sample size necessary to test the overall model can be estimated using the formula 50 + 8k (where k is the number of predictors). The minimum sample size required to test the contribution of individual predictors can be estimated using the formula 104 + k (where k is the number of predictors). As the current study will attempt to test both the overall model and the contribution of the individual predictors Green (1991) recommends that both formulas be calculated, and the largest minimum sample size used. The sample size of this study does not meet the minimum sample size (N=106) required and so the results of subsequent multiple regression analysis should be interpreted with caution.

In boys, visual inspection of histograms indicated that the majority of variables were non-normally distributed. The Shapiro-Wilk test confirmed that the following variables were significantly non-normally distributed: mean rating per item on the inattentiveness subscale of the SNAP-IV ($W_{(33)}$ =.919, p=.017); mean rating per item on the hyperactivity subscale of the SNAP-IV ($W_{(33)}$= .932, p=.040); mean total rating per item on the SNAP-IV ($W_{(33)}$= .900, p=.005); percentage short delay reward choice ($W_{(33)}$=.743, p<.001); elaboration scores on the TTCT ($W_{(33)}$=.754, p<.001); abstractedness of titles score on TTCT ($W_{(33)}$=.905, p=.007) and number of commission errors on Go No Go task ($W_{(33)}$= .926, p=.026). By contrast, fluency ($W_{(33)}$ =.984, p=.892); originality ($W_{(33)}$=.975, p=.638); resistance to premature closure ($W_{(33)}$= .970, p=.481) and mean creativity scores on the TTCT ($W_{(33)}$=.981, p=.827) did not differ significantly from normal.

In girls, visual inspection of histograms indicated that the majority of variables were non-normally distributed. The Shapiro-Wilk test confirmed that the following variables were significantly non-normally distributed: mean rating per item on the inattentiveness subscale of the SNAP-IV ($W_{(33)}$ =.878, p=.001); mean rating per item on the hyperactivity subscale of the SNAP-IV ($W_{(33)}$= .789, p<.001); mean total rating per item on the SNAP-IV ($W_{(33)}$= .847, p<.001); percentage short delay reward choice ($W_{(33)}$=.810, p<.001); elaboration scores on the TTCT ($W_{(33)}$=.883, p=.002); abstractedness of titles score on TTCT ($W_{(33)}$=.934, p=.044) and number of commission errors on Go No Go task ($W_{(33)}$= .935, p=.049). By contrast, fluency ($W_{(33)}$=.990, p=.984); originality ($W_{(33)}$=.968, p=.429); resistance to premature closure ($W_{(33)}$= .974, p=.613) and mean creativity scores on the TTCT ($W_{(33)}$=.985, p=.927) did not differ significantly from normal.

Participants' median scores on the SNAP-IV questionnaire, delay aversion task, TTCT and Go No Go task across the whole sample are presented in Table 1. Participants' median scores on the same measures split by gender are presented in Table 2.

Table 1

*Median scores on SNAP-IV questionnaire, delay aversion task, TTCT, and Go No Go task (whole sample)*

| | Mdn. | Range |
|---|---|---|
| SNAP-IV | | |
| Inattentiveness | 0.78 | 2.67 |
| Hyperactivity | 0.44 | 2.26 |
| Combined | 0.64 | 2.22 |
| | | |
| Neuropsychological tests | | |
| % Short delay reward choice on delay aversion task | 10.0 | 85.0 |
| Number commission errors on Go No Go task | 7.5 | 23.0 |
| | | |
| TTCT standard scores | | |
| Fluency | 99.50 | 82.00 |
| Originality | 98.00 | 79.00 |
| Elaboration | 73.00 | 46.00 |
| Abstractness of titles | 82.00 | 76.00 |
| Resistance to premature closure | 84.00 | 81.00 |
| Mean creativity score | 87.60 | 43.00 |

*Note.* Inattentiveness= mean rating per item on SNAP-IV inattentiveness subscale, Hyperactivity= mean rating per item on SNAP-IV subscale, Combined= total mean rating per item on SNAP-IV; TTCT= Torrance Test of Creative Thinking (Figural).

Table 2

*Median scores on SNAP-IV questionnaire, delay aversion task, TTCT, and Go No Go task (by gender)*

| | Gender | Mdn. | Range |
|---|---|---|---|
| SNAP-IV | | | |
| Inattentiveness | Male | 0.89 | 2.56 |
| | Female | 0.44 | 2.44 |
| Hyperactivity | Male | 0.56 | 1.78 |
| | Female | 0.22 | 2.26 |
| Combined | Male | 0.78 | 1.89 |
| | Female | 0.39 | 2.22 |
| Neuropsychological tasks | | | |
| % Short delay reward choice on | Male | 10.0 | 85.0 |
| delay aversion task | Female | 10.0 | 60.0 |
| Number of commission errors on | Male | 8.0 | 23.0 |
| Go No Go task | Female | 7.0 | 17.0 |
| TTCT standard scores | | | |
| Fluency | Male | 104.00 | 74.00 |
| | Female | 96.00 | 74.00 |
| Originality | Male | 98.00 | 79.00 |
| | Female | 98.00 | 79.00 |
| Elaboration | Male | 73.00 | 46.00 |
| | Female | 73.00 | 36.00 |
| Abstractness of titles | Male | 82.00 | 76.00 |
| | Female | 82.00 | 67.00 |
| Resistance to premature closure | Male | 79.00 | 81.00 |
| | Female | 88.00 | 75.00 |
| Mean creativity standard score | Male | 86.00 | 41.40 |
| | Female | 87.60 | 41.00 |

*Note.* Inattentiveness= mean rating per item on SNAP-IV inattentiveness subscale, Hyperactivity= mean rating per item on SNAP-IV subscale, Combined= total mean rating per item on SNAP-IV; TTCT= Torrance Test of Creative Thinking (Figural).

Males were rated as being significantly more inattentive (U= 353.50, z=-2.453, p=.007, r = -.30) and hyperactive than females (U= 328.00, z= -2.791, p=.002, r = -.34) on the SNAP-IV. Males' combined inattentive/hyperactivity score on the SNAP-IV was also higher than females' (U=295, z= -3.204, p=.001, r =.-.39). These findings remained significant at the p≤.007 level, when multiple comparisons were corrected using False Discovery Rate procedure. Percentage of short delay reward choices in males did not differ significantly from females (U= 542.5, z= -.026, p=.982, r= -.003) on the delay aversion task. Number of commission errors on the Go No Go task did not differ significantly between males and females (U=523, z= -.270, p=.791, r= -.03). Levels of fluency (U=463.00, z= -1.046, p=.299, r= -.13) ; originality (U=525.50, z= -.244, p=.811, r= -.03), elaboration (U=396.50, z= -1.953, p=.051, r= -.24), abstractedness of titles (U=508.5, z= -.465, p=.647, r= -. 05); resistance to premature closure scores (U=412.00 z= -1.704, p=.089, r= -.20) and mean creativity scores (U=481, z= -.814, p=.420, r= - .10) on the TTCT did not differ significantly between males and females.

### 2.3.2 Reliability of the SNAP-IV

Cronbach's alpha for the entire measure (18 items, α = .920) and the inattentiveness subscale (9 items α =.920) were both found to be excellent. The Cronbach's alpha for the hyperactivity scale (9 items, α =.863) indicated that the internal reliability of this subscale was good.

### 2.3.3. Correlational analysis

After correcting for multiple correlations the adjusted significance value was set at p<.004. No significant correlations were observed between ADHD symptomology (inattentiveness, hyperactivity) and creativity scores across the whole sample (Table 3).

Table 3

*Spearman's rank correlations between SNAP-IV scores, percentage short delay choices and creativity subtests across whole sample.*

| | Inattentiveness | Hyperactivity | Combined | % Short delay choices | Commission errors | Fluency | Originality | Elaboration | Abstractedness of titles | Resistance to premature closure | *M* creativity |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Inattentiveness | - | - | - | - | - | - | - | - | - | - | - |
| Hyperactivity | .494† | - | - | - | - | - | - | - | - | - | - |
| Combined | .827† | .725† | - | - | - | - | - | - | - | - | - |
| % Short delay choices | .091 | .098 | .113 | - | - | - | - | - | - | - | - |
| Commission errors | .061 | .027 | .013 | -.229 | - | - | - | - | - | - | - |
| Fluency | .243 | .031 | .094 | -.138 | .134 | - | - | - | - | - | - |
| Originality | .157 | -.020 | .029 | .076 | .070 | .797† | - | - | - | - | - |
| Elaboration | -.118 | -.125 | -.153 | -.274 | -.143 | -.091 | -.158 | - | - | - | - |
| Abstractedness of titles | -.136 | .054 | -.048 | .135 | -.007 | -.031 | .017 | -.159 | - | - | - |
| Resistance to premature closure | .075 | -.129 | -.045 | -.222 | .060 | .542† | .472† | .000 | .047 | - | - |
| *M* creativity | .120 | .009 | .016 | -.095 | .038 | .771† | .729† | .177 | .447† | .697† | - |

*Note:* Inattentiveness = mean rating per item on SNAP-IV; Hyperactivity= mean rating per item on SNAP-IV, Combined= total mean rating per item on SNAP-IV. *M*= mean

*p <.004, one tailed. † p<.004 two tailed (False Discovery Rate correction applied)

Table 4

*Spearman's rank correlations between SNAP-IV scores, percentage short delay choices and creativity subtests split by gender*

| | | Inattentiveness | Hyperactivity | Combined | % Short delay | Commission errors | Fluency | Originality | Elaboration | Abstractedness of titles | Resistance to premature closure | *M* creativity score |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Inattentiveness | Male | - | - | - | - | - | - | - | - | - | - | - |
| | Female | - | - | - | - | - | - | - | - | - | - | - |
| Hyperactivity | Male | .241 | - | - | - | - | - | - | - | - | - | - |
| | Female | .528† | - | - | - | - | - | - | - | - | - | - |
| Combined | Male | .816† | .694† | - | - | - | - | - | - | - | - | - |
| | Female | .761† | .666† | - | - | - | - | - | - | - | - | - |
| % Short delay choices | Male | .108 | .203 | .192 | - | - | - | - | - | - | - | - |
| | Female | .007 | .015 | .012 | - | - | - | - | - | - | - | - |
| Commission errors | Male | -.042 | -.142 | -.077 | -.346 | - | - | - | - | - | - | - |
| | Female | .104 | .026 | .030 | -.071 | - | - | - | - | - | - | - |
| Fluency | Male | .327 | .142 | .283 | -.207 | .210 | - | - | - | - | - | - |
| | Female | .198 | -.194 | -.141 | -.055 | .018 | - | - | - | - | - | - |
| Originality | Male | .449* | .186 | .402 | -.012 | .168 | .901† | - | - | - | - | - |
| | Female | -.097 | -.212 | -.349 | .161 | -.075 | .695† | - | - | - | - | - |
| Elaboration | Male | -.024 | -.106 | -.076 | -.305 | -.050 | .109 | .025 | - | - | - | - |
| | Female | -.042 | -.018 | -.023 | -.236 | -.258 | -.200 | -.371 | - | - | - | - |
| Abstractedness of titles | Male | -.285 | .097 | -.115 | .360 | -.138 | .020 | .024 | -.083 | - | - | - |
| | Female | -.043 | .022 | .004 | -.126 | .150 | -.100 | -.009 | .379 | - | - | - |
| Resistance to premature closure | Male | .211 | .198 | .233 | -.170 | .087 | .529† | .531† | .003 | -.024 | - | - |
| | Female | .129 | -.244 | -.093 | -.267 | .031 | .708† | .439 | -.070 | .069 | - | - |
| *M* creativity standard score | Male | .269 | .222 | .297 | .025 | .044 | .863† | .863† | .177 | .369 | .664† | - |
| | Female | .068 | -.130 | -.162 | -.173 | .009 | .705† | .580† | .130 | .517† | .748† | - |

*Note:* Inattentiveness = mean rating per item on SNAP-IV; Hyperactivity= mean rating per item on SNAP-IV, Combined= total mean rating per item on SNAP-IV

*p <.004, one tailed. † p<.004 two tailed (False Discovery Rate correction applied)

Participants' originality scores were significantly correlated with fluency scores ($r_s$=.797, p<.001) and resistance to premature closure ($r_s$=.472, p<.001). Participants' fluency scores were significantly correlated with resistance to premature closure ($r_s$=.542, p<.001). Correlations between creativity subtests and mean creativity score ranged from $r_s$= .177 to .771. No significant correlations were observed between commission errors and ADHD symptomology or creativity subtest scores. No significant correlations were observed between percentage delayed reward choice and ADHD symptomology or creativity subtest scores.

The correlational analysis was then conducted for boys and girls separately (Table 4). In boys, a significant positive correlation was found between inattentiveness and originality ($r_s$=.449, p=.004); fluency and originality ($r_s$=.901, p<.001); fluency and resistance to premature closure ($r_s$= .529, p<.001) and originality and resistance to premature closure ($r_s$=.531, p=.001). Correlations between subtest scores and mean creativity score ranged from r=.177 to .863 in boys. In girls, a significant correlation was found between fluency and originality ($r_s$=.695, p<.001), and fluency and resistance to premature closure ($r_s$=.708, p<.001). Correlations between subtest scores and mean creativity score ranged from r=.130 to .748 in girls.

For both genders, no significant correlations were found between commission errors and ADHD symptomology or creativity subtests. For both genders, no significant correlations were found between delay aversion and ADHD symptomology or creativity subtests.

### 2.3.4. Multiple regression analysis

Given the significant correlation observed between originality and inattentiveness in boys, a hierarchical multiple regression was conducted to explore the predictive value of ADHD symptomology (inattentiveness and hyperactivity) on originality in boys only. Inattentiveness and hyperactivity jointly predicted originality scores in boys (Table 5), although inattentiveness was the only predictor to make a significant contribution to this model. Indeed, when inattentiveness was considered in isolation at the first step of the model, the regression model was more significant. No multivariate outliers were detected through reference to estimates of Cooks D and leverage. Multicollinearity was not found to

be problematic in this model, indicating that the regression model provided a good fit to the data. Inspection of histograms and normal P-P plots indicate that whilst the assumption of normality of residuals was supported, the assumption of homoscedasticity was violated, indicating that this model may not generalise beyond the sample. In addition, when Stein's formula[10] was used to cross validate the model, the adjusted $R^2$ value (=.005) was found to be considerably different to the observed value of $R^2$ (=.189). This suggests that the regression model possesses poor cross validity. Similarly, post hoc power calculations revealed that this model was underpowered (=.67).

Table 5

*Hierarchical Multiple Regression for ADHD Symptomology on Originality in Boys.*

| | B | SE B | β | 95% CI for B | |
|---|---|---|---|---|---|
| | | | | Lower bound | Upper bound |
| Step 1 | | | | | |
| Inattentiveness | 13.748 | 5.119 | .434* | 3.308 | 24.118 |
| Step 2 | | | | | |
| Inattentiveness | 13.544 | 5.664 | .428* | 1.977 | 25.110 |
| Hyperactivity | .708 | 7.764 | .016 | -15.148 | 16.564 |

*Note:* Inattentiveness = mean rating per item on Inattentiveness subscale of the SNAP-IV; Hyperactivity = mean rating per item on Hyperactivity subscale of SNAP-IV; B= unstandardized b coefficient; SE= standard error of b coefficients; β= standardised beta values; CI= confidence interval. $R^2$ = .189, $F_{(1,31)}$= 7.213, p=.012* for Step 1; $R^2$ Change= .000 $F_{(2,30)}$= 3.495, p=.043* for Step 2.*p= <.05

[10] Stein's formula ( as cited in Field, 2009):

$$adjusted\ R^2 = 1 - \left[\left(\frac{n-1}{n-k-1}\right)\left(\frac{n-2}{n-k-2}\right)\left(\frac{n+1}{n}\right)\right](1-R^2)$$

where n= number of participants and k= number of predictors

### 2.3.5 Mediational analysis

Inattentiveness ($R^2$= .005, F $(_{1,31})$=.160, p=.692) and hyperactivity ($R^2$=.042, F $(_{1, 31})$ = 1.373, p=.250 ) did not significantly predict inhibition separately or together ($R^2$=.043, F $(_{2, 30})$ =.666, p=.521) in boys. Inattentiveness ($R^2$=.023, F $(_{1,31})$=.732, p=.399) and hyperactivity ($R^2$=.052, F$(_{1,31})$= 1.699, p=202) did not significantly predict delay aversion separately or together ($R^2$=.050, F $(_{2, 30})$ =.898, p=.418) in boys.

Together, these findings violate the first condition of mediational analysis as outlined by Baron and Kenny (1986). No further mediational analyses were therefore attempted to account for the observed relationship between ADHD symptomology (inattentiveness and hyperactivity) and originality in boys.

## 2.4. Discussion

The aim of this paper was to explore the putative relationship between ADHD symptomology and creativity, using a school age sample. In particular, this study aimed to test aspects of the "creative advantage hypothesis", which set up predictions regarding the role of inhibition and delay aversion on creative performance. Specifically, it was hypothesised that ADHD symptomology would predict performance on a test of divergent thinking and that this would be mediated by differences in inhibition and delay aversion.

Correlational analysis revealed that when the sample was considered as a whole, inattentiveness was not significantly related to any aspect of creativity, which is inconsistent with the creative advantage hypothesis and previous research (e.g. White & Shah, 2006). Given that gender differences were found on parental ratings of symptom severity on the SNAP-IV, it is possible that the above findings may be masking differential outcomes for boys and girls. Indeed, when male and females responses were analysed separately, boys' level of inattentiveness was found to be correlated with originality. Perhaps the lack of comparable findings in girls could be attributed to the fact that in general, girls were rated as being less inattentive than boys, hence making it harder to 'detect' any association between ADHD symptomology and divergent thinking.

ADHD symptomology was found to predict originality in boys. Inattentiveness and hyperactivity accounted for 18.9% of variance in boys' levels of originality on the TTCT, although inattentiveness was the only predictor which made a significant contribution to this model. As boys' levels of inattentiveness increased, levels of originality increased, which is consistent with predictions from the creative advantage hypothesis. It is interesting to note that significant findings were limited to one subtest of the TTCT in boys: originality. Although the importance of originality in creativity is clear, definitions of creativity often go beyond the production of novel ideas in emphasising the need for original yet *functional* ideas (Plucker et al. 2004; Sternberg & Lubart, 1991). Whilst the TTCT does not explicitly convey to participants the importance of functionality in creativity, the Elaboration and Abstractedness of Titles subtests may index participants' ability to *develop* their creative ideas. Presumably, the ability to refine a creative idea and ensure it remains fit for purpose requires the focusing of attention. Therefore, the benefits associated with inattentiveness may be limited to one aspect of creativity, originality, at least for boys in this sample. Indeed, such a notion is consistent with previous research by Abraham et al. (2006), who found that individuals with ADHD were less able to generate functional responses on a creative imagery task, but more able to generate original responses on a recently activated knowledge task when compared to non-ADHD controls.

This study also sought to discriminate between two potential mediators of the relationship between ADHD symptoms and creativity: inhibition deficits and delay aversion. Inhibition was not found to correlate with, or mediate the relationship between, ADHD symptomology and originality in boys. This contrasts with predictions made by the creative advantage hypothesis and previous research emphasising the role of inhibition deficits in creativity (Carson et al. 2003). However, this lack of an effect for inhibition may be because participants in the current study did not show significantly elevated levels of inhibition deficits. Indeed on average, participants in the current study successfully inhibited a Go response to No Go trails on 70% of trials, which is comparable to the performance of non-ADHD controls on the same task in Bitsakou et al.'s (2008) study.

Similarly, delay aversion was not found to correlate with, or mediate the relationship between, ADHD symptoms and originality in boys. This finding is inconsistent with the tentative prediction put forward in the creative advantage hypothesis. However, it

is possible that the adapted delay aversion task was not a reliable measure of delay aversion. Indeed, the majority of participants appeared to perform near ceiling level on this task, indicating that the task was not sensitive enough to tap delay aversion. Given these limitations, such findings remain inconclusive at present.

In short, the results of this study lend some support for the creative advantage hypothesis as ADHD symptomology was found to predict originality in boys only. In contrast to the predictions made by the creative advantage hypothesis; no evidence was found of the mediating role of inhibition or delay aversion in creativity. However, such findings would need to be replicated in future research before any firm conclusions were drawn.

Indeed, these conclusions need to be considered in light of the limitations inherent in this study. Firstly, the small sample size used in this study meant that the regression analysis conducted was underpowered. In addition, the significant regression model for originality in boys was found to possess poor cross validity. Consequently, the findings of this study are unlikely to generalise to the wider population of inattentive boys.

Secondly, as already indicated the majority of participants demonstrated that they were able to tolerate the 10 second delay in the delay aversion task. Most measures of delay aversion specify a delay of between 20 and 30 seconds (Bitsakou et al. 2009), although some measures specify a delay of 10 seconds (e.g. Delay Frustration Task, Bitsakou et al. 2006). Future research may benefit from manipulating the length of long delay both within this range and outside it, in order to establish an agreed estimate of delay likely to balance the trade-off between Type I and Type II errors in delay aversion.

Thirdly, practical difficulties in recruiting participants meant that participants had to be sampled from three different geographical areas. Although participants were recruited from the same year group, it was not possible to match pupils on other variables (e.g. socioeconomic status, ethnicity, intelligence) across schools which may have influenced results.

Due to evidence in the literature indicating that ADHD medication may be a potential methodological confound, parents were advised that if their child was taking medication for ADHD then they were not eligible to take part. This exclusion criterion may have limited the number of individuals in the sample with ADHD symptomology at the

more severe end of the continuum. Given the restricted range of ADHD symptomology in the sample, it is possible that the results of the study represent a 'snapshot' of the wider picture. Perhaps the relationship between ADHD symptomology and divergent thinking is not linear but instead follows a reverse U-shaped curve, where inattentiveness confers a creative advantage until a threshold of symptom severity is reached. Beyond this point, further increases in symptom severity might not be associated with gains in creativity.

Despite these limitations, the results of this study provide some support for the creative advantage hypothesis and suggest some interesting avenues for further research. For example, given the finding of gender effects on the relationship between ADHD symptomology and aspects of creativity, there is a need to tease out whether this is a genuine effect, or limited to the current sample. In addition, it may be interesting to explore the generalizability of the current findings to other tests of divergent thinking (such as the verbal TTCT) and real world examples of creative achievement in participants.

Future research would benefit from recruiting individuals across the entire range of ADHD symptomology, including those with a clinical diagnosis of ADHD, in order to explore whether the relationship between ADHD symptomology and creativity is linear or nonlinear. Future studies should also aim to recruit enough participants in order to ensure that regression analyses have enough power to detect significant effects.

Furthermore, given the debate in the literature about the potential moderating role of intelligence in creativity (Barron, 1969) and delay aversion as measured by the MIDA (Bitsakou et al. 2009), it may be helpful to control for intelligence in subsequent studies in order to assess the influence of this variable on creativity in participants with ADHD symptomology.

In short, the findings of this study lend some preliminary support to the creative advantage hypothesis, although it is acknowledged that the role of ADHD symptomology on creativity was limited to boys only. Such findings have a number of implications for teachers and Educational Psychologists. As professionals who work with schools on a systemic level, Educational Psychologists are well placed to advise school staff on theories of creativity and potentially support the establishment of a whole school ethos where pupils' creativity is valued and nurtured. This appears to be particularly important given

evidence indicating that teachers do not feel qualified to support pupils' creativity in the classroom.

Furthermore, the findings of the current study suggest that some pupils with ADHD symptomology may experience a degree of success on divergent thinking tasks. Given research indicating that pupils high in ADHD symptomology often struggle in the classroom (Ek et al. 2011), adapting tasks in order to build on their strengths may boost pupils' intrinsic motivation to complete tasks. The role of teacher expectations on pupils' performance has been explored in the literature (Brophy & Good, 1970), and it seems plausible to suggest that reframing aspects of ADHD symptomology in terms of areas of potential strength may lead to positive change for these pupils.

There may also be a role for Educational Psychologists in encouraging teachers to incorporate opportunities for creativity in the classroom. One way of doing this could be through asking pupils questions such as "how else could we solve this problem?" and "how can we make this idea even better?" during class discussion. Other recommendations could include ensuring a balance between closed and open-ended tasks in lessons in order to develop pupils' convergent and divergent thinking skills respectively. Techniques such as 'thought showers' and 'mind maps' may help pupils organise their ideas when faced with open-ended tasks. Teachers may also wish to incorporate a degree of flexibility in their lessons plans in order to provide pupils with opportunities to meet learning objectives in myriad ways e.g. through role play, diary entries or other forms of creative expression. It is possible that such practice may ultimately increase pupils' sense of ownership over the learning process and engagement in learning. Indeed, in supporting the development of pupils' creativity in school, educational professionals are likely to play a vital role in nurturing the creative minds of the future.

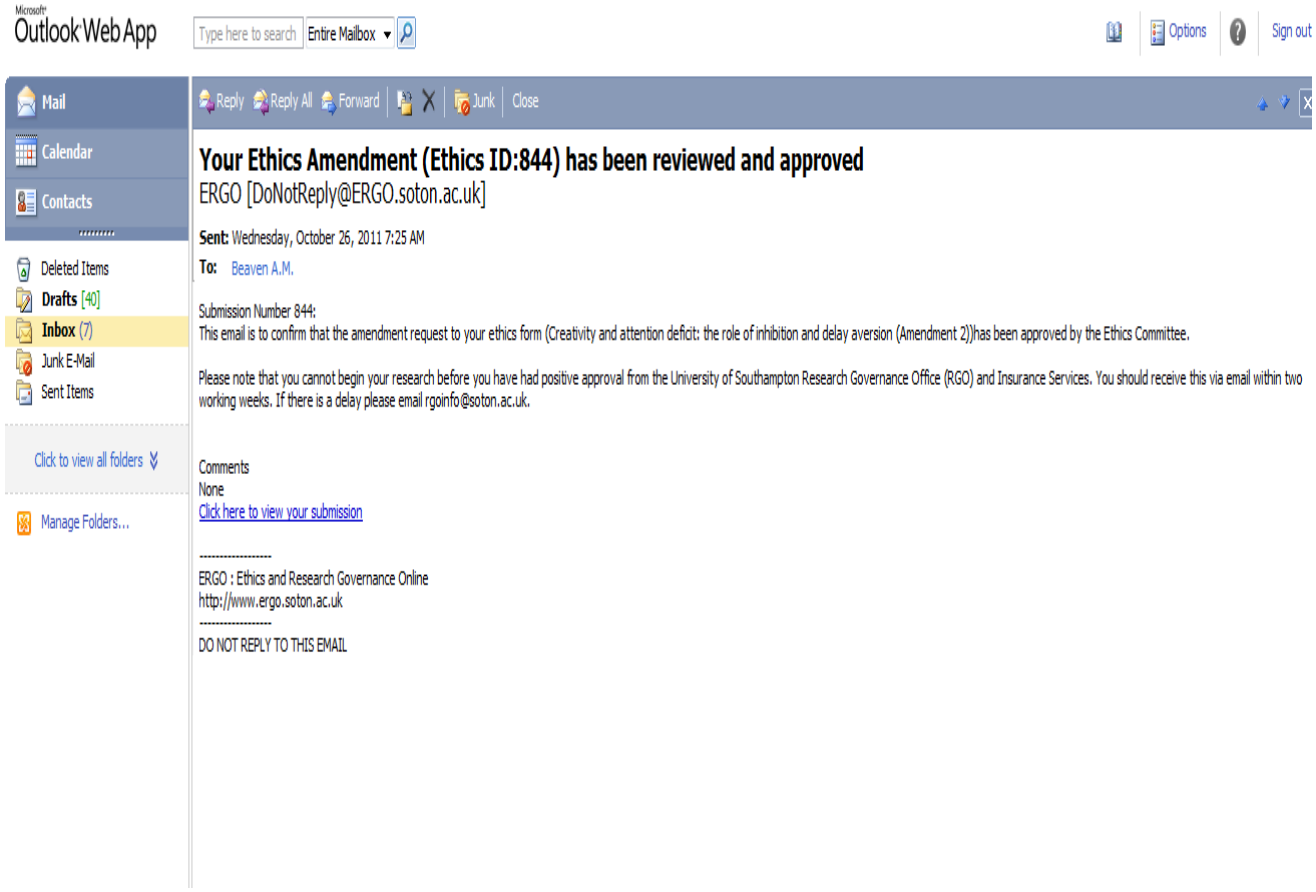
**Appendix A**

## The SNAP-IV Rating Scale (Adapted from Swanson, 1992)

*Please provide the following information about your child:*
Pupils' gender: M / F
Pupils' date of birth:
Nationality:
For each item, select the box that best describes this child. Put only one tick per item:

| | Not at all | Just a little | Quite a bit | Very much |
|---|---|---|---|---|
| 1. Often fails to give close attention to details or makes careless mistakes in schoolwork or tasks | | | | |
| 2. Often has difficulty sustaining attention in tasks or play activities | | | | |
| 3. Often does not seem to listen when spoken to directly | | | | |
| 4. Often does not follow through on instructions and fails to finish schoolwork, chores, or duties | | | | |
| 5. Often has difficulty organizing tasks and activities | | | | |
| 6. Often avoids, dislikes, or reluctantly engages in tasks requiring sustained mental effort | | | | |
| 7. Often loses things necessary for activities (e.g., toys, school assignments, pencils, or books) | | | | |
| 8. Often is distracted by extraneous (external ) stimuli | | | | |
| 9. Often is forgetful in daily activities | | | | |
| 10. Often fidgets with hands or feet or squirms in seat | | | | |
| 11. Often leaves seat in classroom or in other situations in which remaining seated is expected | | | | |
| 12. Often runs about or climbs excessively in situations in which it is inappropriate | | | | |
| 13. Often has difficulty playing or engaging in leisure activities quietly | | | | |
| 14. Often is "on the go" or often acts as if "driven by a motor" | | | | |
| 15. Often talks excessively | | | | |
| 16. Often blurts out answers before questions have been completed | | | | |
| 17. Often has difficulty awaiting turn | | | | |
| 18. Often interrupts or intrudes on others (e.g., butts into conversations/games) | | | | |

## Appendix B1


Microsoft Outlook Web App
Type here to search
Entire Mailbox
Options
Sign out
Mail
Calendar
Contacts
Deleted Items
Drafts [40]
Inbox (7)
Junk E-Mail
Sent Items
Click to view all folders
Manage Folders...
Reply
Reply All
Forward
Junk
Close
Your Ethics Amendment (Ethics ID:844) has been reviewed and approved
ERGO [DoNotReply@ERGO.soton.ac.uk]
Sent: Wednesday, October 26, 2011 7:25 AM
To: Beaven A.M.
Submission Number 844:
This email is to confirm that the amendment request to your ethics form (Creativity and attention deficit: the role of inhibition and delay aversion (Amendment 2))has been approved by the Ethics Committee.
Please note that you cannot begin your research before you have had positive approval from the University of Southampton Research Governance Office (RGO) and Insurance Services. You should receive this via email within two working weeks. If there is a delay please email rgoinfo@soton.ac.uk.
Comments
None
Click here to view your submission
ERGO : Ethics and Research Governance Online
http://www.ergo.soton.ac.uk
DO NOT REPLY TO THIS EMAIL

## Appendix B2

UNIVERSITY OF Southampton

Miss Alexandra Beaven
School of Psychology
University of Southampton
University Road
Highfield
Southampton
SO17 1BJ

RGO Ref: 8134

17 June 2011

Dear Miss Beaven

**Project Title Creativity and Attention Deficit: The Role of Inhibition and Delay Aversion**

This is to confirm the University of Southampton is prepared to act as Research Sponsor for this study, and the work detailed in the protocol/study outline will be covered by the University of Southampton insurance programme.

As the sponsor's representative for the University this office is tasked with:

1. Ensuring the researcher has obtained the necessary approvals for the study
2. Monitoring the conduct of the study
3. Registering and resolving any complaints arising from the study

As the researcher you are responsible for the conduct of the study and you are expected to:

1. Ensure the study is conducted as described in the protocol/study outline approved by this office
2. Advise this office of any change to the protocol, methodology, study documents, research team, participant numbers or start/end date of the study
3. Report to this office as soon as possible any concern, complaint or adverse event arising from the study

Failure to do any of the above may invalidate the insurance agreement and/or affect sponsorship of your study i.e. suspension or even withdrawal.

**On receipt of this letter you may commence your research but please be aware other approvals may be required by the host organisation if your research takes place outside the University. It is your responsibility to check with the host organisation and obtain the appropriate approvals before recruitment is underway in that location.**

May I take this opportunity to wish you every success for your research.

Yours sincerely

Dr Martina Prude
Head of Research Governance

Tel: 023 8059 5058
email: rgoinfo@soton.ac.uk

**Appendix C**

UNIVERSITY OF Southampton

## PARENT OPT-IN CONSENT FORM (Version 2 9/9/11)

Study title: Creativity and attention deficit: the role of inhibition and delay aversion

Researcher name: Alexandra Beaven
Ethics reference:844

Dear Parent/Guardian,

I would like to introduce myself as a 3rd Year Trainee Educational Psychology student from the University of Southampton. I am conducting a project exploring creativity and attention in your child's school as part of my doctoral dissertation and would welcome your child's participation.

Please read the attached information sheet for more information on the aims of the study and if you are happy for your child to participate in the study, please complete and return the consent form to [name of school] by [date].

Yours faithfully,

Alexandra Beaven
Trainee Educational Psychologist
University of Southampton

## CONSENT FORM (*Version 2, 9/9/11*)

**Study title**: Creativity and attention deficit: the role of inhibition and delay aversion

**Researcher name**: Alexandra Beaven
**Ethics reference**: 844

*Please initial the box(es) if you agree with the statement(s):*

| | |
|---|---|
| I have read and understood the information sheet (Version2, 9/9/11) | ☐ |
| I agree to complete a questionnaire about my child's ability to sustain attention | ☐ |
| I agree for my child to participate in this study | ☐ |
| I agree that my child's Cognitive Ability Test (CAT) score can be released to the researcher if the school possesses such information | ☐ |
| I understand that my participation is voluntary and I may withdraw at any time without my legal rights being affected | ☐ |
| I understand that my child's participation is voluntary and they may withdraw at any time without their legal rights being affected | ☐ |

***Data Protection***
*I understand that information collected about me during my participation in this study will be stored on a password protected computer and that this information will only be used for the purpose of this study. All files containing any personal data will be made anonymous.*

Name of pupil (print name)……Class……..

School……
Signature of parent/guardian……..Date……

**Appendix D**

# Participant Information Sheet for parents/guardians (Version 2. 9/9/11)

**Study Title**: Creativity and attention deficit: the role of inhibition and delay aversion

**Researcher**: Alexandra Beaven **Ethics number**: 844

**Please read this information carefully before deciding whether or not to allow your child to participate in this research. If after reading this information sheet, you are happy for your child to participate please initial, sign and return the consent form to [child's school] by [date].**

**What is the research about?**
As a third year trainee Educational Psychologist, this research is part of my doctoral dissertation at the University of Southampton. I am interested in looking at the role of attention on creativity, as there is a suggestion in the literature that those who find it difficult to stay focused may show higher scores on some tests of creativity. I am also interested in the role of inhibition and delay aversion on this relationship. Inhibition is our ability to filter out irrelevant information, and delay aversion represents our tolerance for delay. All individuals differ in their ability to pay attention, filter out irrelevant information and tolerate delay and I am interested in sampling a range of pupils to get a better understanding of how these factors interrelate. If schools have data on pupils' Cognitive Ability Test (CAT) scores, I will request access to this information in order to see if this influences my results.

**Why has my child been chosen?**
Your child has been chosen because the Headteacher of your child's school has agreed for the research to be conducted on their school site. All parents of pupils in Year 8 have been contacted inviting their child to participate in this project.

Unfortunately, if your child is currently receiving medication to help improve their attention (such as Ritalin), they will not be able to take part in the study.

**What will happen to my child if they take part?**
If you are happy for your child to take part, once you have returned your consent slip you will be sent a short questionnaire asking you questions about your child's ability to sustain attention and their activity levels. The purpose of this exercise is not to 'diagnose' attention deficit disorders, rather to get a sample of children who range in their abilities to stay focused on tasks.

Pupils will then be invited to participate in a one-off testing session, to take place during the school day. Prior to each testing session, I will seek pupils' written assent, and they will be told that they can have a break if they need to. I will invite the pupils to complete a range of drawing tasks to assess their levels of figural creativity, followed by 2 game-like computer based tasks, which tap inhibition and delay aversion. Each session will last no more than 60 minutes in total and I anticipate being able to test up to 3 pupils at the same time. After the sessions, pupils will be debriefed about the purpose of the study and provided with a written information sheet to take home.

**Are there any benefits for my child taking part?**

Your child's responses will contribute to our growing knowledge of creativity in children, and may provide avenues for schools to support those children who struggle to remain focused in some lessons.

**Are there any risks involved?**
In the unlikely event that your child becomes distressed/ tired, they will be not be required to complete the study if they do not want to. As a trainee Educational Psychologist I am CRB checked and will follow the appropriate action as dictated by school policy in case of emergency.

**Will my child's participation be confidential?**
You will not be asked to provide your name or your child's name when completing the questionnaire. Your child's name won't be used to identify their responses on the experimental tasks. Instead, your child will be assigned a numerical passnumber which will be used to link information you provide, your child's CAT score (if applicable) and your child's responses on the experimental tasks. This means that your child's identity will be protected from the researcher but their responses can still be matched across tasks.

Because pupils' and parents' assent and consent forms will require a signature, these will be stored securely and separately from participants' anonymised responses. In line with the Data Protection Act all information gained in this study will be stored securely and remain confidential. In the case of electronic data used for statistical analysis, this will be stored on a password protected computer.

**What happens if I change my mind or my child does?**
All participants have a right to withdraw their consent at any time, without consequence. Prior to the study, your child's written assent will also be sought and they will be reassured that their participation is also voluntary.

**What happens if something goes wrong?**
In the unlikely case of concern or complaint, please contact the Chair of the Ethics committee, School of Psychology, University of Southampton, Southampton, SO17 1BJ. (023) 8059 5578.

**Where can I get more information**?
You can email the researcher at amb1g09@soton.ac.uk if you have any questions about the research project.

**If you are happy to let your child participate in this research, please complete the consent form attached and return to [school] by [date].**

Thank you.

**Appendix E**

ASSENT FORM FOR PUPILS (Version 2, 9/9/11)

**Study title**: Creativity and attention deficit: the role of inhibition and delay aversion

**Researcher name**: Alexandra Beaven
**Ethics reference**: 844

Please tick the boxes and sign at the bottom if you are happy to take part in this study:

I am aware of what the study involves ☐

I agree to take part in this research project and agree for my data to be used for the purpose of this study ☐

I understand my participation is voluntary and that I can stop participating at any time without consequence ☐

***Data Protection***
*I understand that information collected about me during my participation in this study will be stored on a password protected computer and that this information will only be used for the purpose of this study. All files containing any personal data will be made anonymous.*

Name of participant (print name)……

Signature of participant……..

Date……

**Appendix F**

## Debriefing Statement for pupils (Version 2, 9/9/11)

## Creativity and attention deficit: the role of inhibition and delay aversion

The aim of this research was to explore the relationship between attention and creativity in a range of pupils of your age. I am interested in whether pupils' ability to tolerate delay and respond to irrelevant information (inhibition) affects this relationship. All pupils range in their ability to pay attention to tasks and I chose a range of pupils to take part in my study. You may have found it easy or hard to stay focused during the tasks but I'm very grateful for your help with this study.

The results of this study will not include your name or any other identifying characteristics. No deception was used in this study.

If you have any further questions please contact me via email on amb1g09@soton.ac.uk

Signature _____ Date _____

Name _____

If you have questions about your rights as a participant in this research, or if you feel that you have been placed at risk, you may contact the Chair of the Ethics Committee, School of Psychology, University of Southampton, Southampton, SO17 1BJ.
Phone: (023) 8059 5578.

Thank you for your participation in this research,

Alexandra Beaven
Trainee Educational Psychologist. University of Southampton

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