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CREATIVE THINKING IN ADOLESCENTS WITH ATTENTION DEFICIT HYPERACTIVITY DISORDER (ADHD)

Anna Abraham,[1,2] Sabine Windmann,[2,3] Rainer Siefen,[4] Irene Daum,[2] and Onur Güntürkün[2]

[1]International Graduate School for Neuroscience (IGSN), Ruhr University Bochum, Bochum, Germany, [2]Institute of Cognitive Neuroscience, Faculty of Psychology, Ruhr University Bochum, Bochum, Germany, [3]School of Psychology, University of Plymouth, United Kingdom, and [4]Westfälische Klinik für Kinder- und Jugendpsychiatrie und Psychotherapie in der Haard, Marl, Germany

A widened attentional focus, that is typically associated with ADHD, has been postulated to be accompanied by enhanced creative ability. However, creativity has been only limitedly examined in ADHD. Performance across several creativity measures were investigated in three groups: adolescents with ADHD, those with conduct disorder, and a healthy control sample. The ADHD group exhibited selective cognitive advantages and disadvantages by demonstrating an enhanced ability in overcoming the constraining influence of examples, but a reduced capacity to generate a functional invention during an imagery task. These findings are interpreted with reference to inhibitory control mechanisms and the contextual modulation of creative cognition.

Keywords: ***creativity, attention deficit hyperactivity disorder, conduct disorder, inhibitory control, prefrontal function, contextual modulation of information processing***

In accordance with the DSM-IV criteria (American Psychiatric Association, 2000), attention deficit/hyperactivity disorder (ADHD) refers to a group of disorders that usually develops during the first five years of life and is generally typified by a combination of pervasive and enduring characteristics of marked inattention, impulsivity, lack of continuing task involvement, overactivity, and disorganized or poorly modulated behavior. As multiple etiological factors have been implicated with regard to this disorder, ADHD is regarded as a complex idiopathic syndrome that is diverse in both its behavioral and cognitive presentation.

From a neurocognitive perspective, a lag or delay in the development of the prefrontal cortex has been assumed to underlie the causes of ADHD (Chelune, Ferguson, Koon, & Dickey, 1986; Rosenthal & Allen, 1978). The prefrontal cortex is the brain structure with

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Address correspondence to Anna Abraham, Institute of Cognitive Neuroscience, Department of Biopsychology, GAFO 04/424, Ruhr University Bochum, D-44780 Bochum, Germany. Tel: 0049 173 4153664, Fax: 0049 234 3214377. E-mail: annaabr@gmail.com

the most prolonged period of postnatal development that continues into adolescence (Huttenlocher, 1990). The emergence of prefrontally guided cognition, as demonstrated by successful performance on delayed-response paradigms, as in the A-not-B task (Diamond, 1988), occurs during late infancy. A steady improvement in performance on frontal measures continues through childhood with adult levels of performance attained only after puberty on complex executive tasks, such as the tower of Hanoi, verbal fluency tests, and some planning tasks (Luciana, 2003; Welsh, Pennington, & Groisser, 1991).

Dysfunctions of different areas of the prefrontal cortex during development are associated with diverse symptoms such as cognitive and social disinhibition, defective response selection, and executive dysfunction as characterised by problems in planning, working memory, set-shifting, anticipation of consequences, and self-regulatory functions (Bradshaw, 2001). As these kinds of manifestations have also been reported in ADHD populations, impaired maturation of the essentially prefrontal processes of selective and exclusionary attention, which normally develop by the age of 12, have been postulated to give rise to the core ADHD symptoms of inattention, distractibility, impaired response inhibition, and excessive restlessness (Fuster, 1997).

The neuropsychological evidence argues strongly in favor of an executive dysfunction hypothesis in ADHD as pervasive deficits have been reported across tasks that demand inhibition, attention, vigilance, and motor control, but not in nonexecutive domains like verbal memory, verbal skills, and visuospatial skills. In their comprehensive review, Pennington and Ozonoff (1996) found the most consistent impairments on tasks that called for attentional or motor inhibition, like the Go/No-Go task, the Stop task, the Anti-Saccade task, the Stroop color-word test, and the matching familiar figures test. In line with this, a recent review of executive deficits in ADHD (Sergeant, Geurts, & Oosterlaan, 2002) found robust evidence for impaired inhibitory function in ADHD as gauged by the Stop task (7 of 8 studies) and the Stroop task (10 of 12 studies).

Such dysfunctions at the level of inhibitory control lie at the heart of the externalizing behavioral problems that are typical of children with ADHD such as distractibility, impetuosity, recklessness, and the inability to delay gratification. Interestingly though, a number of personality traits, such as risk taking, impulsivity, and emotionality, that are characteristic of ADHD children have also been noted to parallel those of highly creative individuals (Cramond, 1994). Torrance and Dauw (1965) were among the earliest to refer to this association in their observation that highly creative children were often characterized by behavioral and conduct problems, which was then credited as arising due to repressed creative needs. Farley (1985) hypothesized that low innate arousability, which is characteristic of ADHD populations, would give rise to a higher sensation seeking drive and an increase in stimulation-seeking behaviors. This could in turn lead to enhanced creative ability in the form of greater flexibility, openness to experience, risk-taking behaviors, preference for complexity, and receptivity to novel ideas and experiences.

On the experimental front however, creative ability has only limitedly been investigated in ADHD. Studies by Shaw and Brown (1990, 1991) brought to light evidence for greater figural or nonverbal creativity among ADHD children in addition to the usage of more poorly focused information in problem solving. However, a later study demonstrated that figural creativity was not enhanced in ADHD boys relative to controls and, moreover, that the administration of Ritalin® did not influence performance either (Funk et al., 1993). The general picture thus remains far from conclusive.

The objective of the present study was to determine whether there was any evidence of individual differences with reference to creative ability in ADHD children when

compared to age- and IQ-matched controls. In order to comprehensively assess creative cognition, a number of measures were employed to tap diverse facets of creative thinking. Drawing from the Geneplore model of creativity (Finke, Ward, & Smith, 1992; Smith, Ward, & Finke, 1995), where many different thought processes are held to underlie creative thinking, it is possible to investigate several discrete mental operations that comprise different elements of creative cognition. The multifaceted nature of creativity is strongly emphasized within this model and examining normative cognitive processes under explicitly generative conditions is held to allow for a more thorough understanding of how creative thought can emerge in all its diversity. Four experimental tasks were employed in the present study to assess different cognitive processes of creative thinking. These included conceptual expansion or the ability to go beyond the framework of established conceptual structures, creative imagery or the ability to create novel but usable combinations from a set of simple geometrical elements, the ability to surpass the constraining influence of recently activated knowledge, and the proficiency in generating alternative uses for common objects.

Conceptual expansion refers to the ability to broaden or loosen the boundaries of acquired concepts (Ward, 1994). This kind of process is typically tapped by an experimental task that requires the subject to imagine an animal that lives on another planet. What is assessed is how much the person's drawing of an animal deviates from existing schemas of animals in general, i.e., of having certain fundamental features like bilateral symmetry of form, presence of common sense organs, and so on. The more one is able to imagine an animal that does not have a bilaterally symmetrical form, that lacks the customary appendages and sense organs found on most animals on this planet and, furthermore, has unusual features that are not found on most animals on earth, the greater one's conceptual expansion.

Drawing from historical and anecdotal accounts of the role of imagery in aiding insights, discoveries, and artistic expression, creative imagery relates to the vividness of abstract imagination in generativity. The creative imagery task (Finke, 1990) requires the construction of an object that falls into a predetermined category (e.g. transportation) using three randomly assigned simple 3-dimensional figures (e.g. a sphere, a cone, and a cross). The invented object is then assessed in terms of "originality", or how unusual and unique the object is, and "practicality", or how functional and usable the object is.

A third phenomenon is that of the constraining effect of examples in the generation of new ideas. When subjects are asked to generate novel ideas for toys or animals after being exposed to exemplars of novel toys or animals by the experimenter, the ideas they produce tend to conform to the ideas in the examples (Marsh, Landau, & Hicks, 1996; Smith, Ward, & Schumacher, 1993). This is assessed by exposing the subject to the same fundamental features across all the exemplars. The degree to which the ideas generated by the subjects incorporate these features from the exemplars is an indication of restrictive effect of recently activated knowledge, in the form of examples, on idea generation. More creative subjects should be relatively immune to these restrictive effects.

The final two further processes to be examined were that of fluency and uniqueness in verbal creativity using the alternate uses task (Wallach & Kogan, 1965), which is one of the classically employed creativity tasks in experimental investigations. Here, subjects are required to generate as many uses as they can conceive of for common objects, such as a newspaper, and the responses are assessed on the basis of Fluency, or the number of

responses generated, and Uniqueness, or the rarity of the response. Using a newspaper as a medium to make paper hats, for instance, is a less unique idea when compared to having a newspaper to tear into shreds when in a rage (Wallach & Kogan, 1965).

These diverse processes of creative cognition were investigated in this preliminary exploratory study in adolescents with ADHD with an aim to uncover which particular facets of creative cognition, if any, are differentially affected in this population and how this relates to executive inhibitory control dysfunction in this population. A clinical control group of adolescents with conduct disorder was also included within this study. Although only limitedly investigated, many of the deficits seen in conduct disorder parallel that of ADHD, at least superficially. However, despite the issue of extensive comorbidity between these two externalizing disorders, the inhibition deficits seen in conduct disorder have been proposed to arise from a motivational rather than an executive dysfunction (Nigg, 2004). How the performance of the conduct disorder group compares with that of ADHD and an unaffected control group would also enable a better understanding of its neuropsychological profile.

METHODS

Sample Description

The participants were comprised of two clinical case groups and an age- and IQ-matched healthy control group. Patients with attention deficit/hyperactivity disorder (ADHD) and conduct disorder (CD) were recruited with the guidance of the chief consultant psychiatrist (RS) from a local Child and Adolescent Psychiatry Unit. Eleven ADHD (3 girls, 8 boys) patients were included in the final sample of which four had a diagnosis of "attention deficit disorder: predominantly inattentive type" (314.00 in the DSM-IV) and the remaining seven were classified under "attention deficit disorder: combined type, with hyperactivity" (314.01). Except for three patients, all were taking medication during the period of testing. One among the three was undergoing a placebo treatment trial. All the other patients were prescribed stimulant medication in the form of amphetamine or methylphenidate (Ritalin®, Concerta®, Medikinet®). Only one patient was reported as having comorbid emotional disturbances.

A total of 12 patients with CD (4 girls, 8 boys) were included in the final sample of which ten was diagnosed as having "conduct disorder: unspecified onset" (312.89) and two were classified as "oppositional defiant disorder" (313.81). Only three patients in this group were taking medication at the time of testing, which included methylphenidate (Ritalin®), pipamperone (Dipiperon®), and citalopram (Cipramil®). With respect to mild comorbidity, one of the patients had depressive disturbances, three had emotional disturbances, one had attentional disturbances, and two had both emotional and attentional disturbances.

The mean age for the ADHD group was 13.18 years and the CD group was 13.5 years (for both groups: minimum = 12 years; maximum = 15 years). The control group was recruited via newspaper advertisements and consisted of 21 children (9 girls, 12 boys) who had no history of mental illness. They were matched to the clinical case groups based on age (mean: 13.48 years; minimum = 12; maximum = 15) and IQ scores based on the average score obtained on three IQ subscales (Verbal Factor, Reasoning, and Closure) from the Leistungsprüfsystem (LPS; Horn, 1983). Statistical analyses using a nonparametric test of statistical significance, the Mann-Whitney U-test, revealed no significant differences on the LPS between the ADHD group and the control group, $U = 90.5$, $p = ns$, or the CD group and the control group, $U = 124$, $p = ns$.

Materials and Procedure

The array of experimental tasks used in the study included the conceptual expansion task, the recently activated knowledge task, the creative imagery task, and the alternate uses task that were administered within one session lasting approximately one hour (with as many breaks as the participant wanted). Each session commenced with the completion of the LPS subscales followed by the conceptual expansion task. The alternate uses test was then carried out after which the recently activated knowledge task was completed. The final task in the session was the creative imagery task.

Conceptual expansion was assessed with the use of the Ward "animal task" (Ward, 1994). In this task participants were required to imagine and draw animals that lived on another planet that is wholly unlike Earth. The fact that the planet to be imagined was to be very different from Earth was strongly emphasized. Participants were asked to generate animals that were of two different species. The drawings were subsequently coded in accordance with the procedures described by Ward (1994, Experiment 1) with the help of two independent scorers who had to simply note the presence of fundamental features common to animals found on Earth and the presence of atypical features (see Figure 1). Both scorers were blind to the hypothesis of the experiment and had no information about the participants. Using an intraclass correlation coefficient, the intercoder reliability was found to be highly significant ($\alpha = .906$, $p < .0001$). A coding was deemed valid when both scorers were in agreement. In the occasional situation when both scorers were not in agreement, a third scorer was consulted and the majority result was accepted. The coded data yielded the five elements of conceptual expansion on this task: (a) bilateral asymmetry, (b) lack of appendages, (c) lack of sense organs, (d) unusual appendages, and (e) unusual sense organs (as shown in Figure 1). In the case of elements (b) and (c), if one or more of the four customary appendages or sense organs were present in a drawing it would qualify as a presence of an appendage or sense organ. Only a complete absence of all customary appendages and sense organs would be scored as lack of appendages or a lack of sense organs. Presence or absence of an element gave rise to a score of 1 or 0, respectively. Thus the total expansion score for

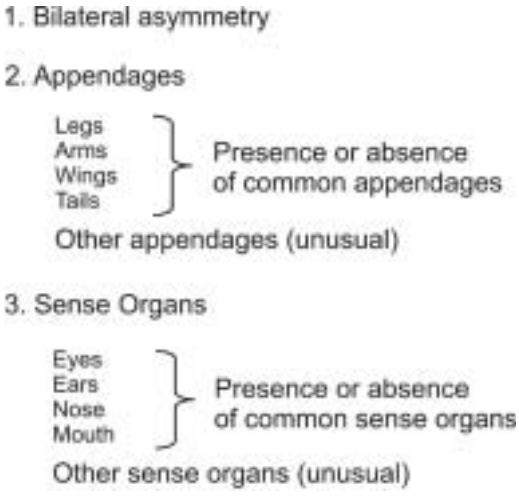

Figure 1 Stimuli used in the creative imagery task (adapted from Finke, 1990, p. 41. © 1990, Lawrence Erlbaum Associates, Inc.).

each picture ranged from 0–5. Statistical analyses on this task were carried out by averaging the scores obtained on both the drawings for each subject.

The participants were then required to complete the recently activated knowledge task (Smith et al., 1993). In this task, subjects are asked to imagine that they are employed by a toy company that is in need of new ideas for toys. The subject's task is to imagine and draw a new and different toy of his or her own creative design within an allotted period of 5 minutes. Duplication of toys that currently exist or previously existed was not allowed. Prior to the drawing of the toys, the subject is exposed to exemplars of three examples of toys (taken from Smith et al., 1993) that have three fundamental elements in common: the presence of a ball, the presence of high physical activity, and the presence of electronics. The subjects' drawings are thus assessed on the extent to which they include these three fundamental features of the examples (total score ranging from 0–3). As in the case of the conceptual expansion task, two independent scorers were employed for the assessment of this task and both were blind to the hypothesis of the experiment and had no information about the participants. They were required to indicate whether these three features were present in each drawing and both scorers were found to be in perfect agreement in their judgment.

In the creative imagery task (Finke, 1990), the participant is asked to assemble an object that falls into a predetermined category using three figures from an array of simple three-dimensional figures (See Figure 2 for stimuli). Except for altering the form of the figures, the participants were allowed to vary the figures provided to them in any way with regard to size, orientation, position, texture, and so on. The participants were required to put the figures together in a meaningful way so as to form a useful object from a certain category. Following the procedure utilized by Finke (1990), the figures and the category were randomly assigned to each participant. As each participant was given six trials, a maximum of six inventions per person were obtained. The inventions were rated by two trained raters along two dimensions—Originality (how unusual and unique the invention is) and Practicality (how functionality and usable the invention is) using a five point scale. The interrater correlations (intraclass correlation coefficient) on the creative imagery measures were significant for both the originality scale, (α = .32, p < .0001), and the practicality scale (α = .46, p < .0001). The average of their ratings was taken as the scores for the

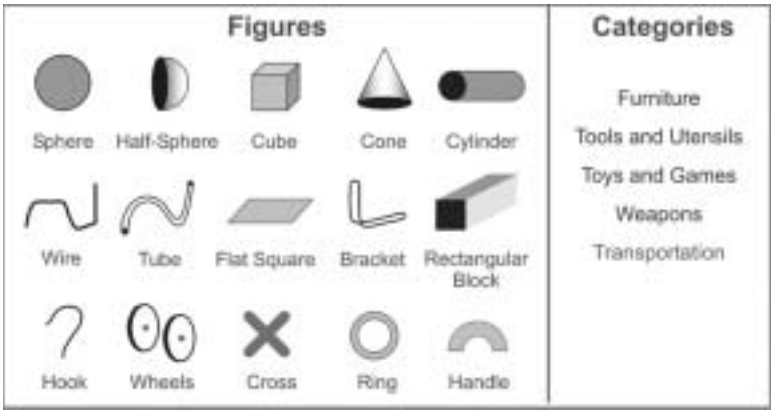

Figure 2 Properties that are coded from the drawings to make up the elements on the conceptual expansion task (adapted from Congnitive Psychology, 27, Waro, T. B., Structured imagination: The role of conceptual structure in exemplar generation, p. 7. © 1994, Elsevier).

inventions and each participant consequently obtained an average score of practicality and originality from the six inventions they generated across trials.

In the alternate uses task (Wallach & Kogan, 1965), participants were required to generate as many uses as possible for three common objects: a newspaper, a shoe, and a brick. There was no time limit for this task. The subjects' responses are assessed on the basis of two dimensions—Fluency, which is judged by the number of acceptable solutions generated for each object, and Uniqueness, which is assessed by the infrequency of the generated use. A response to an item was judged to be unique if it was given by only one person from the entire sample (based on the scoring procedure in Wallach & Kogan, 1965, pages 30–32). The total score for the Fluency and Uniqueness measures was the sum of fluency and uniqueness scores obtained across all three objects.

RESULTS

Table 1 includes the descriptive data across all variables for the clinical and control groups. All statistical analyses were two-sided and, due to the small sample size, nonparametric. The Kruskal-Wallis *H* Test, the nonparametric equivalent of the one-way ANOVA, was used for comparisons between all three groups. Significant differences were found on the total score of recently activated knowledge task (RAK), $H = 7.56$, $p < .05$, and the originality-imagery score of the creative imagery task, $H = 12.43$, $p < .01$, alongside a weak trend on the practicality-imagery score, $H = 4.85$, $p = .088$.

The Mann-Whitney *U* test was used when contrasting each clinical group individually with the control group. On the RAK total score, the control group showed significantly poorer performance relative to the ADHD group, $U = 51$, $p < .05$, while the comparison with the CD group revealed a trend for the same pattern, $U = 72$, $p = .088$. The pattern of performance of the groups on this measure is illustrated in Figure 3 where higher scores reflect a greater tendency to be constrained by the examples and create toys that are fundamentally similar to the toy examples. Comparisons on the conceptual expansion

Table 1 Descriptive data for the ADHD, CD, and control groups across all the variables

	ADHD		CD		Control	
	Mean	*SD*	Mean	*SD*	Mean	*SD*
LPS—Average Score	46.80	7.94	51.85	6.21	50.16	4.86
Conceptual Expansion (CE) – Total	1.09	0.58	1.39	1.11	1.07	0.80
CE—Bilateral asymmetry	0.23	0.34	0.11	0.33	0.14	0.32
CE—Lack of appendages	0.09	0.20	0.22	0.36	0.10	0.26
CE—Lack of sense organs	0.00	0.00	0.00	0.00	0.05	0.15
CE—Unusual appendages	0.23	0.34	0.61	0.49	0.31	0.37
CE—Unusual sense organs	0.55	0.35	0.44	0.46	0.48	0.33
Originality—Creative Imagery	2.36	0.39	2.10	0.41	2.55	0.35
Practicality—Creative Imagery	2.60	0.45	2.74	0.53	2.98	0.51
Recently Activated Knowledge (RAK)—Total	1.20	0.63	1.56	0.88	2.14	0.96
RAK—Presence of a ball	0.20	0.42	0.33	0.50	0.52	0.51
RAK—Presence of a high physical activity	0.20	0.42	0.33	0.50	0.62	0.50
RAK—Presence of an electronic device	0.80	0.42	0.89	0.33	1.00	0.00
Alternate Uses—Uniqueness	2.27	2.41	1.44	1.67	2.14	2.01
Alternate Uses—Fluency	18.55	5.82	14.33	4.18	17.29	6.37

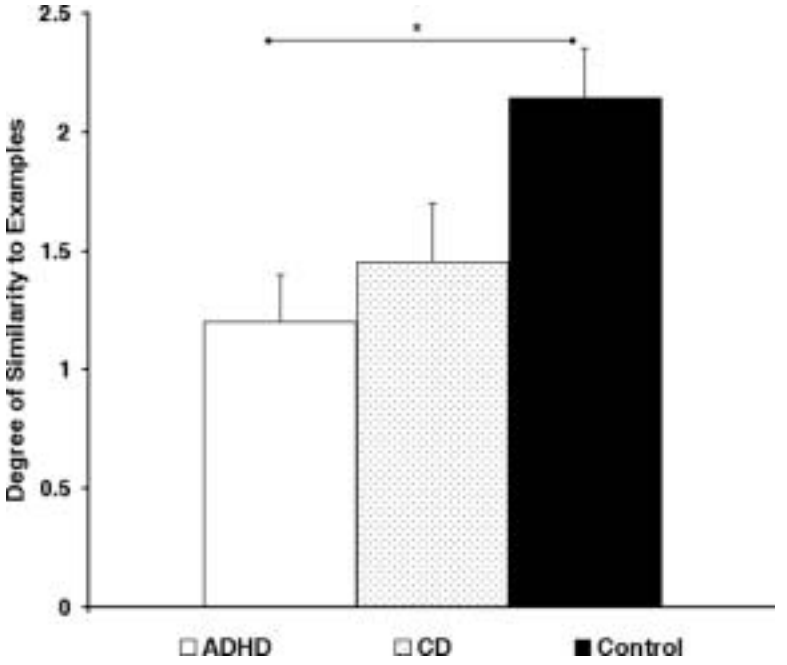

Figure 3 Mean scores of the ADHD, conduct disorder, and control groups on the recently activated knowledge task. Higher scores reflect lower performance.

task however, revealed no significant differences for either the ADHD group, $U = 111.5$, $p = ns$, or the CD group, $U = 106.5$, $p = ns$ relative to the control group.

There was a dissociation between the performance of both clinical groups on the creative imagery task such that the ADHD group performed no differently from the control group on the originality dimension, $U = 80$, $p = ns$ but was significantly poorer on the practicality dimension, $U = 65$, $p < .05$. The CD group, on other hand, performed comparably to the control group on the practicality dimension, $U = 87$, $p = ns$, but was significantly poorer on the originality dimension, $U = 33.5$, $p < .001$. Figure 4 displays the contrasting performance profiles of the groups on the two creative imagery measures where lower scores reflect poorer performance.

Due to the divergence in the performance of the two clinical groups, correlations between the two imagery variables were carried out individually for each of the groups using Kendall's tau. A significant negative correlation between the originality-imagery and practicality-imagery scores was found for the ADHD group ($\tau = -.52$, $p < .05$). Although such an association did not emerge when assessing the performance of the control group ($\tau = .074$, $p = ns$), the same pattern of results was found for the CD sample, with a significant negative correlation between the two imagery measures ($\tau = -.74$, $p < .01$).

On the alternate uses task, no significant differences were found on the fluency dimension between the ADHD and control groups, $U = 98.5$, $p = ns$, or the CD and control groups, $U = 68$, $p = ns$. The same pattern was true of the uniqueness dimension, where the performances of the ADHD group, $U = 111.5$, $p = ns$, and the CD group, $U = 73.5$, $p = ns$, were not significantly differentiable from the healthy control group.

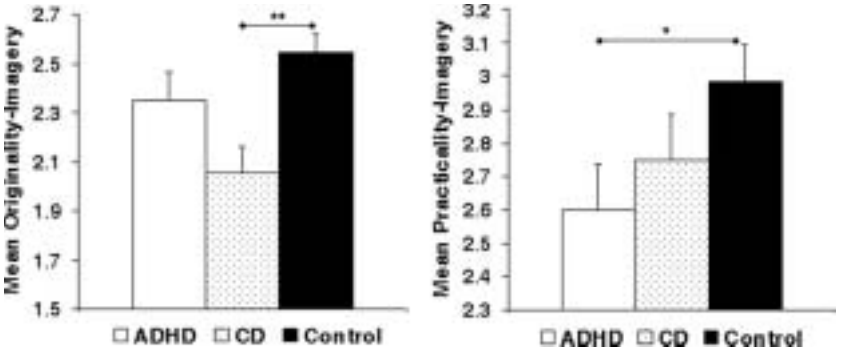

Figure 4 Mean scores of the ADHD, conduct disorder, and control groups on the originality (left) and practicality (right) dimensions of the creative imagery task.

As a check, all the analyses on the CD group were repeated after excluding the three patients with mildly comorbid attentional disturbances ($n = 9$) and the results remained essentially unchanged. The CD group still showed significantly poorer performance on the originality-imagery measure, $U = 33$, $p < .01$, but was otherwise not differentiable from the control group on the practicality-imagery score, $U = 68.5$, $p = ns$, fluency-alternate uses measure $U = 68$, $p = ns$, uniqueness-alternate uses measure, $U = 73.5$, $p = ns$, or the total expansion score, $U = 75.5$, $p = ns$. Slight differences in the pattern of performance were however found on the recently activated knowledge task as the trend for superior performance on part of the CD group relative to the control group was no longer found, $U = 64$, $p = ns$.

DISCUSSION

The aim of this preliminary study was to investigate whether altered functionality on diverse processes of creative cognition would be found in an ADHD sample in comparison to a clinical group of adolescents with conduct disorder and a matched healthy control group. This was a first screening attempt to examine creative cognition in ADHD in order to establish firm groundwork to direct future investigations. Despite the low sample size, the relatively comorbidity-free sample of ADHD adolescents coupled with stringent nonparametric analyses in the present study allowed for reliable findings to emerge.

The chief findings on the part of the ADHD group relative to the healthy control group included superior performance on the recently activated knowledge task, but poorer performance on the practicality measure of the creative imagery task. A different pattern of results emerged for conduct disorder group as they exhibited poorer performance on the originality component of the creative imagery task in comparison to the control group. Drawing comparisons between the groups' performances across the different creative cognition tasks would enable a clearer understanding of what these findings signify.

The ADHD and control groups performed comparably on the conceptual expansion task, whereas the ADHD group exhibited better performance on the recently activated knowledge task. The conceptual expansion task and the recently activated knowledge task are similar in that both tasks require that something novel be generated and performance across these tasks reflect the influence of contextual restrictions on information processing. However, the essential difference between the tasks lies in the type of context that is activated.

In classifying contexts that exert a modulatory influence on cognition, Park and her colleagues (2003) identified contexts provided by stored representations in long-term memory as one kind. An example of the workings of this kind of context would be in a semantic priming task where associations between stored representations would influence the readiness to respond on a lexical decision task. Another type of cognitive context is that which is provided by task-relevant information that is actively held in short-term working memory. An example for the effects of this type of context is the AX-type Continuous Performance Task where the subject is required to respond to an X only if an A precedes it.

It may be possible to relate the creative cognition tasks of the conceptual expansion and recently activated knowledge within the framework of this classification. Long-term memory related implicit or "passive" contextual effects were proposed to be tapped by the conceptual expansion task, where a context in the form of representations of appropriate schemata in stored memory are activated. In the case of the conceptual expansion task used in the present study, a context, as provided by the word "animal," activates the schema "animal" that in turn influences actions.

On the other hand, short-term memory "active" contextual effects are implicated in the case of the recently activated knowledge task, as an immediate context is induced with the presentation of three exemplars of novel toys directly prior to when the subject is required to create a new toy. This type of context actively interferes with the ability to generate a new toy as it is difficult to inhibit explicit recently activated information that is directly pertinent to the task at hand. The ADHD group was able to generate more unique responses on the recently activated knowledge task by overcoming the influence of such active contexts. This would be possible in view of their attentional problems and marked distractibility, which would allow them to be unimpeded by such relevant information as their attention is constantly diverted from a particular focus.

The issue of context also has a direct bearing on the creative imagery task. An interesting dissociation emerged between the performances of the ADHD and conduct disorder groups in contrast to that of the control group such that the ADHD group was poorer on the practicality dimension of the task while the conduct disorder group was poorer on the originality dimension of the task. The practicality dimension of the creative imagery task taps the ability to make inventions that are functional and usable. The significantly lower score obtained by the ADHD group could be attributed to the impulsive tendencies that is characteristic of ADHD children. Hasty or erratic responses and the resulting lack of appropriate goal-directed planning in this type of generative situation could have resulted in the creation of inventions that are less functional and practical than otherwise. It is also possible of course that an invention's practicality may not be readily apparent, especially that of a very original invention, but this would be more in the case of an exception rather than the general rule.

With regard to the originality dimension on the creative imagery task where the propensity to make unusual and unique inventions is gauged, enhanced performance could be abetted a broader and less focused influence of one's stored knowledge (passive contextual modulation) as it would allow for the generation of more atypical and uncommon inventions. By the same token, poor performance on this dimension would be related to a stronger than customary influence of passive contextual control.

It may be possible to relate the poor performance on part of the conduct disorder group on the originality dimension to a low motivation and perseverative response style induced in situations that provoke passive contextual processing. However, it must also be

noted that the conduct disorder group exhibited no significant insufficiencies in performance relative to the control group on the conceptual expansion task, which should also be affected by such alterations in passive contextual processing. This discrepancy may be due to the core differences between the conceptual expansion task and the creative imagery task with the latter involving far more abstraction during execution. In the conceptual expansion task, one's existing conceptualization of animals limits the ability to expand the animal concept, whereas in the imagery task random figures must be mentally visualized and manipulated to form a particular object within a category. A greater degree of abstraction, and consequently more effort, is hence called for in the latter task as the conceptual structures drawn upon are not as well-defined.

There was also some evidence for a trade-off between performances on the imagery measures as the results indicated the presence of a strong negative correlation between the originality-imagery and practicality-imagery measures for both the ADHD and the conduct disorder groups but not the control group. What appears to be the case then is that the ADHD group, in an effort to produce more unusual responses, tended to make inventions that were less functional, whereas the opposite was true of the conduct disorder group such that they generated more usable and practical responses but as a consequence generated less unusual or original responses.

How these results relate to the wider spectrum of neuropsychological deficits and theories of ADHD and conduct disorder functioning is less clear-cut because, to date, only a limited number of studies have been carried out to directly contrast ADHD and conduct disorder populations in terms of frontal and executive functions. On balance though, inhibitory control deficits along appear to be chiefly characteristic of ADHD while conduct disorder populations seem to demonstrate such dysfunctions only in the presence of comorbid ADHD (Leung & Connolly, 1997; Ossmann & Mulligan, 2003; Schachar, Mota, Logan, Tannock, & Klim, 2000). Given that the performance of the conduct disorder group did not closely parallel that of the ADHD group in the present study, the type and degree of distractibility seen in conduct disorder appears to at least be of a different nature from that of ADHD.

On the final measure of creative cognition, the alternate uses task, no significant differences resulted on either dimensions of uniqueness or fluency. A lack of inhibitory control therefore does not appear to confer any advantage or disadvantage to the ADHD group on the uniqueness measure of the alternate uses task. This measure taps the extent to which original and uncommon responses are generated for which, just as in the case of conceptual expansion, the influence of long-term representations or passive contextual factors and not active contextual factors, would be implicated. Combined with the results from the other tasks, the evidence thus appears to indicate that there is no discernible altered functioning at the level of passive contextual control in the case of ADHD.

The suggestion that greater levels of distractibility and poor inhibitory control, just as is seen in ADHD, would allow for the generation of more nonstereotypical responses is not a new one. In arguing that individual differences in how attention is focused underlie differences in creative ability, Mendelsohn (1976) highlighted the role of "defocused attention" or widened attentional capacity. The essence of his argument was that in order to arrive at a creative idea, the elements present in one's attentional stream need to be combined and the type of combination is what determines the creativeness of the idea. The greater the number of elements present or activated in one's attentional stream, the greater the number of resulting combinations. For instance, if only two elements are activated at the same time, only one combination would result, but if four elements are concurrently active, six pairs of combinations would be possible.

The wider one's attentional focus then, the more the number of elements activated in one's attentional stream and with it, the enhanced possibility of arriving at a more unique blending of elements and consequently more original ideas. In the case of ADHD, it seems that the widening of attentional focus and distractibility that is associated with the disorder confers a selective advantage on specific facets of creative thinking that call for disregarding an immediate context that is currently within the purview of one's attentional stream.

The present study is among the few comprehensive investigations of creative cognition with reference to developmental psychopathology and the implications of the findings are noteworthy and constitute an original contribution to the literature. The obtained results can be extended in specific ways to allow for a more thorough understanding of creative cognition with regard to select facets of development and psychopathology. Comparisons with other pathological populations with altered prefrontal function, like that of autism or frontal lobe patients, would help validate and extend these ideas of the mechanisms underlying the contextual modulation of creative cognition. Cross-sectional studies across different age groups would additionally help determine whether the current findings of advantageous processing alter with normal development, the implications of which would be especially noteworthy for the debate regarding the developmental lag versus the developmental deviation hypothesis of ADHD.

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