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Medication and creativity in Attention Deficit Hyperactivity Disorder (ADHD)

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Abstract

Background: The aim of this study was to determine the effect of methylphenidate (MPH) on creative potential in a group of children with attention deficit disorder with hyperactivity (ADHD). **Method:** A randomized single blind crossover study was performed with 24 children with ADHD, aged between 8 and 12 (M = 10.0, SD = 1.3), evaluating each child's creativity with and without MPH, using the Torrance Tests of Creative Thinking-Figural (TTCT). **Results:** Children under treatment with MPH showed a lower global Creative Index and lower scores on Fluency, Originality and Creative Strengths, compared to when not under treatment. The capacities for Elaboration, Abstractness of Titles, and Resistance to Closure did not differ whether on or off pharmacological treatment. **Conclusion:** Our finding suggests that is important to take into account the impact that MPH might have on the creative potential of a child with ADHD to develop a more accurate evaluation and to develop better treatment plans.

Keywords: Creativity, Children, Methylphenidate, ADHD, Torrance Test of Creative Thinking (TTCT).

Resumen

Medicación y creatividad en el trastorno por Déficit de Atención con Hiperactividad (TDAH). **Antecedentes:** el objetivo de este estudio fue determinar el efecto del metilfenidato (MPH) en el potencial creativo de un grupo de niños con trastorno por déficit de atención con hiperactividad (TDAH). **Método:** se llevó a cabo un estudio cruzado aleatorizado, simple ciego, en 24 niños con TDAH, con edades comprendidas entre 8 y 12 años (M = 10.0, SD = 1.3), evaluando la creatividad de cada niño con y sin MPH, a través de test de Torrance sobre Pensamiento Creativo, Figurativo (TTCT). **Resultados:** los niños en tratamiento con MPH mostraban un Índice Global Creativo inferior, y puntuaciones más bajas en Fluidez, Originalidad y Fuerzas Creativas, comparados con los que no estaban bajo tratamiento. Las capacidades para la Elaboración, Abstracción de Títulos y Resistencia al Cierre no mostraron diferencias entre los grupos dentro o fuera de tratamiento farmacológico. **Conclusiones:** nuestros resultados sugieren que es importante tener en cuenta el impacto que el metilfenidato podría tener en el potencial creativo de un niño con TDAH para poder realizar una evaluación más correcta y para poder desarrollar estrategias de tratamiento más eficaces.

Palabras clave: Creatividad, Niños, Metilfenidato, TDAH, Prueba de Torrance de Pensamiento Creativo (TTCT).

The effects of stimulant medication for Attention Deficit Hyperactivity Disorder (ADHD) on the cognitive functioning of children with this disorder is less well-understood than the effects of medication on behavioral symptoms (Swanson, Baler, & Volkow, 2011). Effects of stimulant medication on creative thinking have been particularly under-studied. Creative potential has been held by some to be a positive characteristic of those with ADHD (Abraham, Windmann, Siefen, Daum, & Güntürkün, 2006; Cramond, 1994a), but the literature is limited and inconsistent, and the medication status of research participants not always recorded. Therefore, the present study was designed to test medication effects on creative functioning in ADHD.

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ADHD is a disorder characterized by the presence of symptoms of inattention and/or hyperactivity/impulsivity, together with a level of intensity inappropriate for the child's age, all of which have a negative impact at school or in the family. At present, ADHD is considered the most frequent disorder in childhood psychopathology. A meta-analysis by Polanczyk, Salum, Sugaya, Caye and Rohde (2015) finds a world-wide prevalence of 3.4% in children and adolescents. Moreover, Cramond (1994a) was among the first to suggest a common etiology for ADHD and creativity, listing impulsiveness, adaptability, spontaneity, low tolerance for boredom, or the ability to daydream as behavioral features of ADHD. These characteristics are also found in creative children. A number of trade books (e.g., Guerrero, 2006; Hartmann & Paladino, 2003) have similarly suggested that the traits comprising ADHD could be present in creative individuals: being inventors of new ways of doing things, acting with an open mind, not following routines, seeking risks, being impatient. In his theory of intelligence, Guilford (1956) described five operational categories: cognition, memory, evaluation, convergent production, and divergent production. Guildford defined divergent production, now called *divergent thinking,* as a flexible, original and flowing process, contrasting it with convergent thinking, which is more logical, rigid, and less diverse. He developed the Alternative Uses Task (Guilford, 1967) as a measure of creativity. The person being tested is asked to generate as many uses as posible for a common household ítem such as a paperclip. Responses are scored for total number (fluency), how unusual the answers are compared to others (originality), number of different categories (flexibility), and extent of detail (elaboration). Torrance (1988) built on Guilford's concept of divergent thinking, defining creativity as the capacity to identify omissions in information, formulate and test hypotheses, produce new ideas, recombine them, look for and propose alternatives, and communicate the results. He developed the Torrance Tests of Creative Thinking (TTCT; Torrance, 2008) to operationalize and measure these characteristics based on observable productions. The Figural-TTCT evaluates the ability of an individual to think creatively with images (Kaufman, Plucker, & Russell, 2012). These tests have become the most widely used and cited measure of creative potential (Kim, 2011). Cramond (1994b) examined the overlap of creativity and ADHD by looking, on the one hand, at creativity in a group of children with ADHD and, on the other hand, at the incidence of ADHD in a group of highly creative children. Using the Figural-TTCT, the authors found that 32% of ADHD children obtained a score above the 90th percentile, and half above the 70th percentile. Within a group of highly creative children, 26% met criteria for ADHD measured with the SNAP-IV scale (Swanson, 2003). Healey and Rucklidge (2006) found that 40% of creative children showed elevated levels of ADHD symptomology, although none met diagnostic criteria for ADHD. According to Fugate, Zentall and Gentry (2013), children with ADHD and high intelligence show more creativity than gifted students without ADHD. On the other hand, in studies conducted by Sang, Yu, Zhang and Yu (2002) and by Healey and Rucklidge (2005), using the TTCT, it could not be confirmed that children with ADHD were more creative than those not diagnosed with the disorder.

A potential mechanism accounting for the association between ADHD and creativity lies in differences in cortical development in ADHD and non-ADHD children. The human prefrontal cortex requires a long time to reach maturity, during which children have a marked deficit in cognitive control compared to adults (Thompson-Schill, Ramscar, & Chrysikou, 2009). Immature cognitive control hinders performance in many tasks; at the same time, it may impact on other aspects of cognitive development, such as the acquisition of language and creativity (Chrysikou, Novick, Trueswell, & Thompson-Schill, 2011). According to Barkley (1997a); El-Sayed, Larsson, Persson, Santosh and Rydelius (2003); and Shaw et al. (2007), ADHD children show a greater delay in cortical maturation in relation to other children of the same age without ADHD. The implication is that these children's attention is out of focus and they can get distracted by irrelevant stimuli. At the same time, these children may be able to consider a greater number of events, consistent with divergent thinking.

On the nother hand, multi-modal treatment of ADHD includes use of drug therapy, as specified in the clinical practice guidelines (Pliszka, 2007). A number of studies (e.g., MTA Cooperative Group, 1999) provide evidence for substantial reduction of the ADHD symptoms in the short term with the medication methylphenidate and other stimulant medications, e.g., strengthened attentional field and more focused attention (Swanson et al., 2011). Parents describe the benefits of drug treatment but also report that children can become so over-focused that they are "zombie-like" (Hansen & Hansen, 2006). Animal studies have shown that drug treatment can decrease curiosity, exploratory effort, and cognitive flexibility, with the effects also including excessively focused, repetitive behaviors, such as scratching, excessive cleaning, gnawing or staring (Arnsten & Dudley, 2005).

Given the effects of stimulant medication, many past reports about ADHD and creativity have been questioned for not ascertaining whether the children participating in the studies were being medicated or not. In this respect, in one of the first studies of the effects of MPH on flexibility of thinking in hyperactive children, Dyme, Sahakian, Golinko and Rabe (1982) found an increase in errors in perseveration with high doses of 1.0 mg/kg of MPH. Solanto and Wender (1989) similarly reported that eight children in their ADHD group showed a pattern of cognitive perseveration after taking MPH. These children gave a very high number of responses but without increasing the number of different response categories. Subsequently, Tannock and Schachar (1992) reported that children with ADHD on MPH showed at least temporarily reduced cognitive flexibility. Swartwood, Swartwood, and Farrell (2003), in a sample of eight children with ADHD and treatment with MPH, reported no overall differences in children's creativity, but did observe lower scores with drug treatment on the elaboration subscale of a test of divergent thinking. Other authors found no association between MPH and lowered creativity. In tests of visual attention, Tannock, Schachar and Logan (1993) did not find excessive focusing. Douglas, Barr, Desilets and Sherman (1995) found no adverse effects on flexible thinking and other cognitive processes; instead, MPH seemed to improve the effort or persistence in the task. Funk, Chessare, Weaver and Exley (1993) found no significant differences in creativity between ADHD and control groups, whether the ADHD participants were medicated or not.

The aim of this study was to evaluate whether the creativity of a group of 24 children would be affected by ADHD stimulant treatment. For this purpose, we compared creativity defined as divergent thinking in children with ADHD, using a crossover design so that each child was evaluated both under drug treatment and without it. This design controls for age and intellectual level, as each child is his or her own control. Creativity was operationalized using the Torrance Figural Tests of Creative Thinking (Torrance, 1998, 2008) scored for each of the five dimensions of creativity *(Fluency, Originality, Elaboration, Abstractness of Titles and Resistance to Closure)*, the sum of 13 *Creative Strengths* that measure characteristics of creative personality, and the Creative Index, which combines the five dimensions and the Creative Strengths score.

Method

Participants

A total of 24 children with ADHD combined subtype according to the criteria of the *Diagnostic and Statistical Manual of Mental Disorders DSM - IV-TR* (*DSM-IV-TR,* American Psychiatric Association [APA], 2000*)*, participated in the study, 21 males and three females. Participants were referred from the Center for Child Mental Health. They were part of a population of 156 patients at the Children and Juvenile's Mental Health Center referred through primary-care physicians in the years 2011-12 to confirm an ADHD diagnosis. Inclusion criteria included confirmed ADHD diagnosis, age range 8 to 12 years, and normal intellectual capacity. The remaining 132 children did not qualify for the study due to exclusion criteria: being outside the age range, Intelligence Quotient (IQ) value below 85, uncorrected hearing or vision impairment, or co-morbid psychiatric diagnosis. The average age of participants was 10.0 years, (*SD* = 1.3) and average IQ was 98.8 (*SD* = 9.5). IQ was assessed with Kauffman's Brief Intelligence Test (K-BIT), adapted for Spanish by Cordero and Calonge (2000). Verification of ADHD diagnosis was carried out by a clinical psychologist and psychiatrist using the clinic's standardized semi-structured interview to collect developmental history and symptoms. Associated pathologies were discarded and specific symptoms required for the diagnosis of ADHD were identified using both the interview and the results of SNAP-IV rating (Swanson, 2003) carried out by teachers. Criteria for ADHD followed the *DSM - IV-TR* (APA, 2000). To be included in the study, the children were required to present six or more symptoms of inattention and six or more symptoms of hyperactivity-impulsivity. Thus, selected children all had a confirmed diagnosis of ADHD Combined Type. ADHD children with learning disorders were not excluded, and learning disorders were present in the majority of the children selected for the study. The TTCT test does not require special academic skills or technical execution of drawings; therefore, there was no need to exclude these children.

The medication used in the study was Osmotic Release Oral System® (OROS) methylphenidate, to ensure homogeneity of the results. The specialist (neurologist or psychiatrist) adjusted the dose and monitored the effects. To ensure an effective response, drug treatment was adjusted for each child. Doses ranged from 18mg to 36 mg taken once a day. None of the children was taking any concomitant medication. This research was approved by the local ethics committee. All participants enrolled in this study provided written informed consent.

Instrument

Torrance Figural Tests of Creative Thinking (TTCT), parallel forms A and B (2008). The Figural-TTCT tests are perhaps the best-established and most used tests of creativity (Plucker, 1999) enabling comparison to other studies of creativity. The tests also offer the advantage that the scores do not penalize lack of precision. The Figural-TTCT is composed of three activities requiring 10 minutes each to complete: (a) construction of a drawing starting with an oval-shaped figure; (b) completing ten drawings on the basis of 10 incomplete figures; (c) making an original drawing on the basis of stimuli consisting of two parallel lines (form A) / circles (form B). Tests A and B were used randomly to avoid a learning effect (Torrance, Ball, & Safter 1992).

Across the three activities, five dimensions comprising creativity thinking abilities and 13 creative strengths are evaluated. The scores are combined to obtain a Creative Index.

The five creative thinking abilities include: Fluency (the number of meaningful responses), Originality (the number of responses that are statistically infrequent); Elaboration (the ability to expand or embellish ideas, based on the number of additional details used in the development of the response beyond what was strictly necessary to express the basic idea); Abstractness of Titles (the ability to assign a title that synthesizes the drawing and that goes beyond specifically labeling it); and Resistance to Premature Closure (the ability to keep the mind open long enough to let original ideas arise) (Torrance et al., 1992). In addition, on the basis of longitudinal studies, Torrance et al. (1992) included thirteen criteria to measure different creative strengths: emotional expressiveness, storytelling articulateness, movement or action, expressiveness of titles, synthesis of lines or circles, unusual visualization, internal visualization, extending or breaking boundaries, humor, richness of imagery, colorfulness of imagery, and fantasy.

All of the scores are continuous variables. The five dimensions are norm-referenced. We used standard scores by age for each of the dimensions of creativity and for the composite Creative Index, with mean = 100 and standard deviation = 20. The standard score ranges of each subscale are Fluency, 40-153; Originality, 40-154; Elaboration, 40-160; Abstractness of Titles, 40- 160; and Resistance to Premature Closure, 40-160. Scoring Creative Strengths is criterion-referenced. The range is 0 – 26 based on a scoring guide that allots + or ++ for each strength.

Various studies of test - retest reliability of the Figural-TTCT have yielded correlations of around 0.90 (Torrance, 1990). The value of coefficient alpha was 0.79 (Kim, 2006). In relation to validity, there are strong and statistically significant correlations between scores in childhood and subsequent creative achievements up to 50 years later (Torrance, 1981; Cramond, Matthews-Morgan, Bandalos, & Zuo, 2005; Runco, Millar, Acar, & Cramond, 2010). For Kim (2008), the TTCT was the best predictor of outcomes in life, more so than the traditional measure of intellectual ability**.**

Procedure

Creativity was examined in 24 ADHD children using a crossover design. Children were randomly assigned to two groups. In one group, children were assessed before treatment with methylphenidate and again after methylphenidate treatment began. In the other group, children were assessed while being treated with methylphenidate and then after drug withdrawal. Parents were requested to withdraw the child from medication for 48 hours before testing, coinciding with the weekend so as to minimize academic interference. None of the children had previously received any drug treatment before starting the study. Thus, each child acted as his or her own control, with a mean interval between the two assessments of 27 days (minimum interval was 11 days and maximum was 48 days).

Figural-TTCT data were collected individually. The evaluation was carried out early in the morning to avoid fatigue, under the same conditions, the same location (an office, with play equipment), and the same procedures for subjects with medication and without medication. Testing with medication took place approximately 90 minutes after ingestion of the drug to ensure its effect. The test duration was 30 minutes following 15 minutes preparation to establish the right climate. Following the manual, children were instructed to be very creative and to make drawings that no one would have imagined before; they were offered colored pencils; and they were presented the test once their motivation and interest were enlisted. Each of the three parts of the test was completed in 10 minutes, during which the children made their drawings and attached an explanatory title to each. The examiners did not know whether the child was medicated or not. Scoring the tests was performed independently by a trained person who was blind to medication and to sequence.

Data analysis

Scores were normally distributed to the groups, as assessed by the Shapiro-Wilk normality (p>0.05). There was homogeneity of variances, as assessed by Levene's test of homogeneity of variance (p>0.05). Scores of children while on methylphenidate and not on methylphenidate were compared using a repeated measures ANOVA. Sequence was a between-subjects effect and interaction betwen medication status and sequence tested whether the effect of being on or off medication differed by sequence of the two conditions. Effect-size calculations using a partial eta squared indicated the magnitude of the difference between the children when medicated or not medicated, taking sequence into account. All analyses were performed with SPSS 20.0.

Results

There was no statistically significant interaction between medication status and the sequence in which children were evaluated for any of the measures. For the Creative Index, $F(1, 22) = 0.522$, $p = .478$, $\eta^2 = .023$. For the five creative abilities and the creative strengths score, Fluency $F(1, 22) = 0.678$, $p = .419$, $\eta^2 = 0.03$; Originality $F(1, 22) = 0.01$, $p = .912$, $\eta^2 = 0.00$; Elaboratión $F(1, 22) = 0.546$, $p = .468$, $\eta^2 = 0.02$; Abstraction Titles $F(1, 22) = 0.066$, $p = .800$, $\eta^2 = 0.00$; Resistance Closure $F(1, 22) = 2.753$, $p = .111$, $\eta^2 = 0.11$; Creative strengths $F(1, 22) = 0.154$, $p = 0.699$, $\eta^2 = 0.00$. Main effects for medication status are shown in Table 1, including means and standard deviations when not on methylphenidate and when on the drug, and effect sizes. There were statistically significant differences on the Creative Index, Fluency, Originality, and Creative Strengths, with children scoring higher when off medication than when on it. There were no statistically significant differences on Elaboration, Abstractness of Titles, and Resistance to Closure.

Table 1
Effects of methylphenidate on performance in each of the five creative abilities, creative strengths score, and composite Creative Index on the Figural-TTCT

ADHD (N = 24)					
Ability	**Off MPH M (SD)**	**On MPH M (SD)**	**F**	**p**	**η^2**
Fluency	112.12(18.12)	101.29(17.33)	13.63	.001*	.38
Originality	110.96 22.79)	97.38 (16.50)	9.28	.006*	.30
Elaboration	75.46 (20.68)	75.96 (21.41)	0.03	.855	.00
Abstractness of Titles	90.67 (22.12)	82.83 (25.65)	2.98	.099	.12
Resistance to Closure	66.21 (13.11)	61.63 (9.66)	2.39	.136	.024
Creativity Strengths	13.21 (6.25)	10.29 (6.41)	5.22	.032*	.19
Creativity Index	103.54 (16)	92.96 (14.90)	15.91	.001*	.42

* p<.05

Discussion

The main finding of this study is that scores on a creativity test are the same or higher for children with ADHD when not medicated as when they are medicated. In particular, medicated ADHD children have a more limited number of responses, indicated by their lower scores on Fluency. As described in previous studies, when medicated, some of the children showed perseveration in reproducing the same sketch (Abraham et al., 2006; Solanto & Wender, 1989; Dyme et al., 1982). Originality was also lower when children with ADHD were taking the drug than when they were not. These results are consistent with the explanation that medicated children experience a greater focusing of attention, as argued by Solanto and Wender (1989), which would prevent using all available environmental stimuli for inspiration. Possibly, as described in Douglas, et al. (1995), when on medication, cognitive tasks involving a single correct solution, like those performed at school, will be favored, but not those involving creative thinking.

ADHD children showed similar results in their capacity to elaborate their responses in both conditions. This result differs from earlier studies (Swartwood et al., 2003; Tannock & Schachar, 1992), although in these two studies, elaboration was evaluated

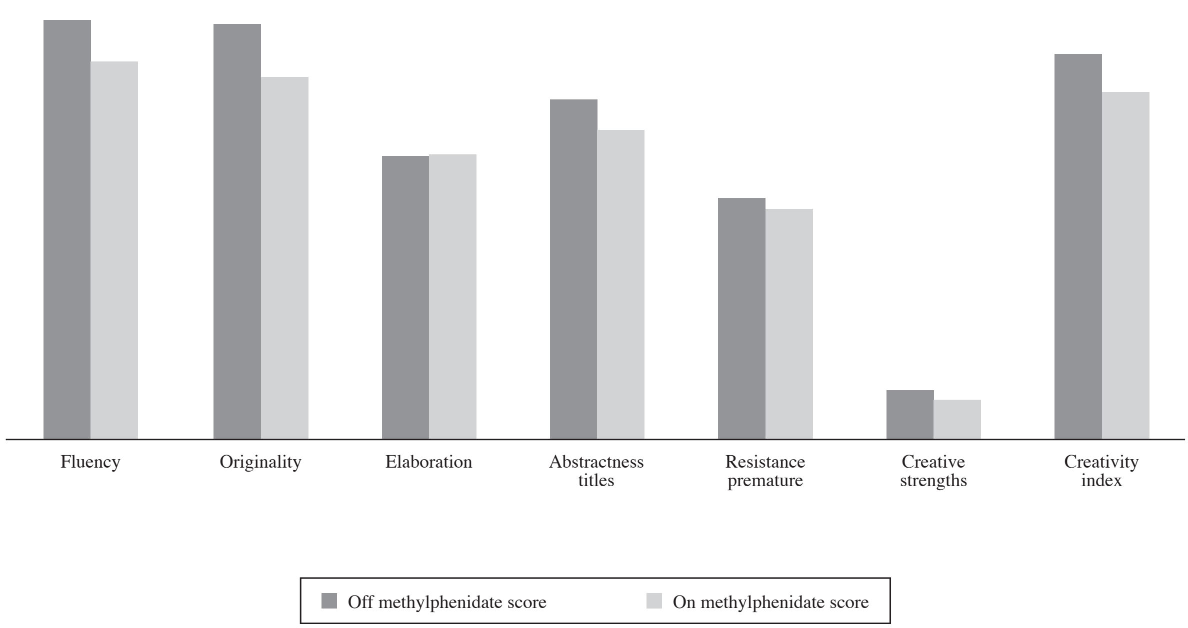

Figure 1. *Averages obtained for each of the variables in Figural-TTCT, and Creativity Index in the 24 same children in conditions off/on methylphenidate*

by means of the Test of Divergent Thinking (TDT) in which the subjects are asked to give verbal (not graphic) responses. Other creative abilities did not differ by condition, including Abstractness of Titles and Resistance to Closure. At present, the significant increase in the diagnosis of ADHD and the use of drugs to correct deficit disorder treatment has raised the concern of their use or abuse. Methylphenidate is the most common and effective drug therapy currently used to treat ADHD (Faraone, 2009), its positive effects on the core symptoms of the disorder are known, but no clear consensus has yet been reached on how it affects cognitive functions (Swanson et al., 2002). The action of methylphenidate is related to dopamine neurotransmission, part of the mechanism that inhibits receiving dopamine in brain areas such as the cerebral cortex, amygdala and nucleus accumbens and which can increase extracellular concentration (Volkow et al., 2001), improving attention and decreasing distraction as observed with fMRI in individuals performing work under the effect of methylphenidate. The drug reportedly improves dopaminergic transmission in the same areas of the brain that play an important role in cognition and emotion, areas considered central to the etiology of ADHD. Studies with positron emission tomography PET confirmed this hypothesis (Swanson et al., 1999; Volkow et al., 2002). The greatest difficulty in knowing how MFD affects the different brain functions is because it has yet not been possible to find a stable pattern of neuropsychological differences in ADHD the model proposed by Barkley (1997b), which has been advocated for decades to explain the difficulties of ADHD based on response inhibition, that is, the inability to control both internal and external stimuli that occur during the execution of a task, to resist distraction and exercise self-control resulting in an executive dysfunction. This explanation of the underlying cognitive processes in ADHD has been of great theoretical importance. However, in their meta-analysis Willcutt, Doyle, Nigg, Faraone, and Pennington (2005) find that weaknesses exist in executive functions, but suggest that these deficits among individuals with ADHD are not enough to cause all cases of ADHD. Thus far, it has not been possible to confirm a consistent pattern in neuropsychological testing with ADHD, which is why stimulant medications are directed at improving different measures depending on the severity of symptoms and type of tasks assessed (Turner, Blackwell, Dowson, McLean, & Sahakian, 2005) and are known to decrease the behavioral symptoms of ADHD. There is no clear pattern to identify cognitive functions impaired in ADHD, and, as indicated by Swanson et al. (2011), stimulant medications have different effects depending on the required task, so the aim of our study was to identify how stimulant medication affects a complex cognitive process such as creativity, assessed, in our case, by products (drawings made during the child in the TTCT) based on the measures of divergent thinking. The possible implications of this study are the importance of diagnosis and treatment of children with ADHD typically focused on identifying and reducing their limitations and weaknesses, while seeking to improve their attention span and impulsivity control, and to put brakes on their hyperactivity. Enlisting creative ability may boost children's motivation and engagement in the classroom (Beghetto & Kaufman, 2014). Moreover, as treatment with stimulants could affect and limit the creative ability of children referred for ADHD, it is important to perform a strict diagnosis and to consider choice of treatment before initiating MPH. Moreover, in assessing creativity in children with ADHD, if the evaluation is conducted when the child is medicated, creative capacity could be hidden.

It is important to acknowledge in this study: the sample size, which, although small, is mitigated with crossover design and strict inclusion criteria. Also, this study was limited to a single measure of creativity administered in a single setting. Finally, it was not possible to administer a placebo in one of the sample groups, since the children participating in the study were patients with a confirmed diagnosis of ADHD confirmed and needed actual treatment. All these issues are important limitations of this study. To summarize, treatment with MPH, which is used as the first choice medicine in the case of ADHD children, lowers their global level of creativity, measured by the Creative Index, and, in particular, their Fluency and Originality and the presence of Creative Strengths. However, capacity for Elaboration, Abstractness of Titles and Resistance to Closure were not affected, whether under pharmacological treatment or without it.

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