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Neuropsychological heterogeneity in ADHD pupils: further evidence from incidental memory testing

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ABSTRACT

This paper reports on a study where the incidental memory of 18 children with ADHD and 18 typically developing (TD) peers was assessed by means of a conventional two-phase recognition memory test. In the study phase participants were required to categorize as a living or non-living a set of 64 stimuli from 8 semantic categories. In the test phase, they were required to recognize "target" (i.e., stimuli from the first set) from "non-target" stimuli. Children with ADHD were overall less accurate and much slower than TD controls in identifying both living and non-living items. Moreover, while most of TD participants made very few, if any, errors, only 7 out of 18 participants with ADHD scored near ceiling, and 2 of them scored below chance level. Following the Signal Detection Theory approach, the participants' performance on the test phase was scored in terms of d prime (d') values. Children with ADHD had lower d' indexes compared to controls both for living and non-living stimuli, although this difference did not reach statistical significance. More interestingly, the variability of the d' values was higher in the ADHD compared to Controls at least for non-living items. Taken together, findings from this study indicate that at least some of the children with ADHD have a genuine impairment in processing visual stimuli. More generally, these results provide further support to the idea that ADHD represents a neuropsychological heterogeneous condition that still requires a deeper characterization to be considered a stable nosographic entity.

Key words

ADHD • Incidental Memory • d prime • Cognitive functioning • Intragroup variability

Introduction

With a prevalence among school-aged children estimated at 7.2% (Thomas et al., 2015) also tending to increase (Rowland et al., 2015), Attention-deficit / hyperactivity disorder (ADHD) is the most common psychiatric disorder of childhood. Considering that signs of ADHD often persist into adolescence and adulthood (e.g., Okie, 2006), it can be estimated that ADHD affects approximately 6%-16% of the world population (Barbaresi et al., 2004).

Being characterized by inattention, hyperactivity, and impulsivity – all of which can lead to impairments in school performance, family functioning and peer relationships – ADHD represents a complex challenge for both researchers and clinicians.

However, despite the large corpus of literature on ADHD developed over the last decades, many issues remain to be settled (Furman, 2005; Singh et al., 2015).

Leaving aside any reference to the genetic markers and the neuroimaging patterns, for the purpose of this study it is relevant to note that there is no single cognitive deficit which is pathognomonic for ADHD and the diagnosis merely relies on behavioral descriptors that can be observed in a wide range of other psychopathologies (Roth & Saykin, 2004).

In view of the latter point, a large literature suggests that individuals with ADHD exhibit relatively poor performance on a broad variety of neuropsychological tests of attention, alertness, executive functions, working memory etc. In search for a test that could

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be, albeit not diagnostic, at least highly suggestive for the presence of ADHD, several samples of ADHD participants have been engaged in a series of tasks ranging from Stroop to priming and Go-noGo task (see Nigg, 2005, for a review). The results were far from straightforward: too many measures resulted to have good positive, but also poor negative, predictive power for ADHD (see Marshall et al., 2021 for a review). As a consequence, abnormal scores on several neuropsychological tests can be taken as predictive of the diagnosis; meanwhile, normal scores on the same test cannot rule ADHD out. Namely, not every person with ADHD is impaired on every test while many individuals with ADHD exhibit a normal-range performance on all the cognitive tests usually used to assess ADHD (Doyle, 2006).

In this complex scenario, however, a dysfunction of working memory has been proved that can play a critical role in the occurrence of ADHD in both children and young adults (Alderson et al., 2013). In turn, an extensive meta-analysis (Willcutt et al., 2005) indicated that groups with ADHD exhibited significant impairment on several executive function tasks, especially those involving working memory, vigilance, response inhibition, and planning.

While a large corpus of studies investigated the performance of children and adolescents with ADHD in the Digit Span Backwards test (see Ramos et al., 2020 for a comprehensive meta-analysis on this topic), even when children with ADHD were presented with a comprehensive memory test battery (e.g., Oie, Sunde, & Rund, 1999; Rhodes, Park, Seth & Coghill, 2012), incidental memory (i.e., memories that are acquired without intention, see Baddeley, Eysenck & Anderson, 2009) was not investigated, despite its strict relation with several measures of attention and executive functions (Kontaxopoulou et al., 2017) making incidental memory test a valuable clinical and research tool for use with ADHD. Indeed, to the best of our knowledge, very few, very dated, studies challenged individuals with ADHD with a test of incidental memory. Douglas and Peters (1979) found that children with ADHD were more distracted by irrelevant stimuli than TD children. In the study by Copeland and Wisniewski (1981), children with and without learning disabilities were administered tests of central and incidental learning and selective attention. In the frame of a deterioration of performance on generalized cognitive measures, children with hyperactivity performed more poorly than TD peers on attention and memory tasks. Ceci and Tishman (1984) presented children with ADHD and their typically developing (TD) peers with an experimental paradigm involving a central and a peripheral task and found that while TD children outperformed children with ADHD in the central task, the opposite was true in the peripheral task where children with ADHD were more accurate than TD peers in the recall of extrinsic, irrelevant stimuli. This result was taken as evidence of a more diffuse (i.e., less selective) attention in children with ADHD than TD peers. However, it is worthy to note that children with ADHD showed a superior incidental learning only when the task was easy. As the task demand increased and became more challenging, the performance of children with ADHD declined below that of their TD peers.

Hereafter, we aimed to re-assess the issue of the incidental memory of children with ADHD and TD peers by means of a conventional two-phase recognition memory test.

The experimental paradigm allowed us to explore: a) whether children with ADHD differ from their TD peers in accuracy and/or speed in processing the stimuli presented during the study phase; b) whether the two groups of participants show any difference in the recognition task; c) whether – compared with the group of TD peers – the group of children with ADHD exhibit a heterogeneous rather than a homogeneous pattern of performance.

Methods

Participants

Eighteen (15 males and 3 females) children with ADHD, ranging in age between 8 and 11 years, and 18 chronological age – and gender – matched, TD children participated in the study. All participants had normal or corrected-to-normal visual acuity and were naïve as to the purpose of the study.

The participants with ADHD were referred by the local Neuropsychiatric Unit of the National Health Service. According to the evaluations made by an expert, multidisciplinary team of professionals (i.e., psychologists, child neuropsychiatrists, speech therapists), all of them met DSM-5 diagnosis for ADHD, and satisfied the following inclusion criteria: IQs in the range of 90-110; no pervasive developmental disorders; no uncorrected sensory or motor deficits; no stimulant medication.

The TD children were recruited from a local school, selected randomly from a pool of those whose parents consented to their participation in the study and teachers did not report any behavioral or learning problems.

The study was approved by the departmental ethics committee and carried out according to Declaration of Helsinki guidelines. Pupils participated with parental consent. However, they were informed that participation was not mandatory and that they had the right to decline at any time. None of them, however, refused to take part in the study, nor dropped out of it.

Stimuli

The experimental stimuli consisted of two sets of 64 colored pictures of living and non-living items in the same proportion. In turn, both living and non-living items could belong to one of four semantic categories so that – in each set of stimuli – there were 8 animals, 8 flowers, 8 fruits, and 8 vegetables (living items), and 8 musical instruments, 8 vehicles, 8 clothes, and 8 manipulable objects (non-living items). Items were paired together across sets with the caveat that the two members of a pair should be similar, but clearly recognizable from each other; so that – for example – there was a light green apple in the set A and a pale-reddish apple in the set B.

Apparatus and procedures

A commercial software program (E-Prime, Psychology Software Tools, Inc.), was used to implement the experimental paradigm. All the experimental sessions were conducted in a sound- and light-attenuated room using an IBM compatible notebook. Stimuli were displayed on the 15-inch notebook monitor while participants were seated in front of it at a distance of about 60 cm. A mouse connected to the notebook via USB port was used to record the participants' responses.

Each participant performed a study and a test session, separated by an interval lasting half an hour during which participants could stretch their legs and have a snack. In both sessions, instructions were given and a few practice trials were performed to ensure that the participant had understood the procedure.

In the study session participants were required to categorize as a living or non-living each of the 64 stimuli from set A or B (the choice of set was counterbalanced across participants). In the test session – for each of the 128 stimuli from both set A and B – participants must indicate whether it was a target (i.e., a stimulus from the first set) or a non-target (i.e., a stimulus not shown earlier).

Each trial began with an acoustic warning signal which prompted the participant to fixate on a cross displayed at the center of the screen. After an interval unpredictably ranging from 200 to 500 ms, the fixation point disappeared and a picture was shown until the participant responded (or until 4 s had elapsed) to the question displayed on the bottom area of the screen (Living / Non-Living? and Old / New? in the study and test phase, respectively) by pressing with the second finger of their preferred hand the mouse button corresponding to his/her choice (i.e., left button for "Living", right button for "Non-Living", in the study session; left button for "Old", right button for "New", in the test session). In each experimental session, each stimulus was presented once in the center of the screen according to a randomized order. Both speed of responding and accuracy were strongly encouraged. Latencies shorter than 300 ms or longer than 4 s were considered to be outliers and discarded.

Data Analysis

In the study (Encoding) phase, two dependent variables were considered: Accuracy and Speed of Response. The number of correct responses was taken as a measure of Accuracy while the median reaction time (RT) of correct responses provided the measure of Speed of Response to the different types of stimuli. Accuracy and RT data were entered in two separate repeated measures ANOVA with Group (ADHD vs. TD) as the between-subjects factor and Semantic Category (living vs. non-living) as the within-subjects factor. In all the analyses, Bonferroni correction for multiple comparisons was applied, and a p-value of <.05 was considered to indicate statistical significance.

With regard of the Test phase, on each trial, participants were requested to judge whether a stimulus was a target (i.e., from the first set) or a non-target. It follows that, qualitatively speaking, participants' responses could belong to any one of these four categories: Hits, Misses, Correct Rejections and False Alarms. Hits occurred when participants recognized a target, while Misses occurred when participants missed it. In turn, Correct Rejections occurred when participants avoided to report as a target an item previously absent (i.e., they responded "New" to an item not shown in the first set), while False Alarms occurred when participants identified as a target an item previously absent (i.e., they responded "Old" to an item not shown in the first set). Following the Signal Detection Theory approach (Banks, 1960; Righi et al., 2015), we estimated the sensitivity index d' (d prime) according to the formula:

$$d' \text{ (d prime)} = (z_{\text{hits}} — z_{\text{false alarms}}).$$

The d' values were entered in a repeated measures ANOVA with Group (ADHD vs. TD) as the between-subjects factor and Semantic Category (living vs. non-living) and Type (Target vs. Non-Target) as the within-subjects factors. Bonferroni correction for multiple comparisons was applied, and a p-value of <.05 was considered to indicate statistical significance.

Results

Study (Encoding) phase

Accuracy and mean values of Speed of Responses across groups and items are reported in Table 1.

Accuracy – Children with ADHD were overall less accurate than TD controls in identifying both living and non-living (see Table 1) items, so that the between-subjects factor Group was significant [$F(1,34) = 7.60$, $p = .009$)], while the within-subjects factor Semantic Category ($F(1,34) = 0.97$, $p = .331$) and its interaction with Group ($F(1,34) = 0.01$, $p = .922$) were not statistically significant. It is worth noting that while most of TD participants made very few, if any, errors with 16 out of 18 scoring >95%, only 7 out of 18 participants with ADHD scored near ceiling, and 2 of them scored below chance level.

Speed of Response – Children with ADHD were overall much slower than TD controls in categorizing both living and non-living items (see Table 1), so that – also in this case – the between-subjects factor Group was significant [$F(1,34) = 11.10$, $p = .002$)], while the within-subjects factor Semantic Category ($F(1,34) = 1.94$, $p = .173$) and its interaction with Group ($F(1,34) = 4.20$, $p = .50$) were not significant.

Test phase

Descriptive statistics about d' values are summarized in Table 2.

Children with ADHD had lower d' values compared to controls both for living and non-living stimuli. However, these differences were not statistically significant ($F(1,34) = 2.46$, $p = .126$). Likewise, d' values associated to non-living stimuli were higher than d' values associated to living stimuli (in both groups) albeit the within-subjects factor Semantic Category was not significant ($F(1,34) = 3.68$, $p = .063$). The minimum and maximum d' values in the ADHD group were min = -1.21, max = 1.38 (4 out of 18 negative values) for living category and min = -0.75, max = 1.73 (4 out of 18 negative values) for non-living category. In turn, the minimum and maximum d' values in the control group were min = -0.34, max = 1.94 (1 out of 18 negative values) for living category and min = 0.00, max = 1.45. Negative values were taken as evidence of the fact that these participants misunderstood the task. Thus, their data were excluded from the analyses.

With regard to the variability of the two groups (Figure 1 and Figure 2), the TD children showed interquartile range values equal to .74 and .55 for living and non-living category respectively.

In reverse, the interquartile range values of d' of children with ADHD was much greater with non-

Tab. 1 - Study phase. Accuracy and Speed of Response across Groups and Items (18 participants for each group).

	ADHD				TD			
	Accuracy (%)		RT (msec)		Accuracy (%)		RT (msec)	
	Mean	sd	Mean	sd	Mean	sd	Mean	sd
Living	84.6	16.7	1199	614	96.4	5.9	637	140
Non-living	86.1	21.8	1055	621	98.3	2.2	665	122

Tab. 2 - Test phase. Descriptive statistics about d' across Groups and Items (18 participants for each group).

	ADHD		TD	
	Mean	sd	Mean	sd
Living	0.29	0.63	0.57	0.58
Non-living	0.46	0.71	0.74	0.39

living (.94) than living category of items (.73). Comparing the variances values across groups and category, it was observed that the variability of the d' values was higher in the ADHD with respect to Controls for the non-living items ($F(17,17) = 3.31$, $p = .018$) but not for the living ones.

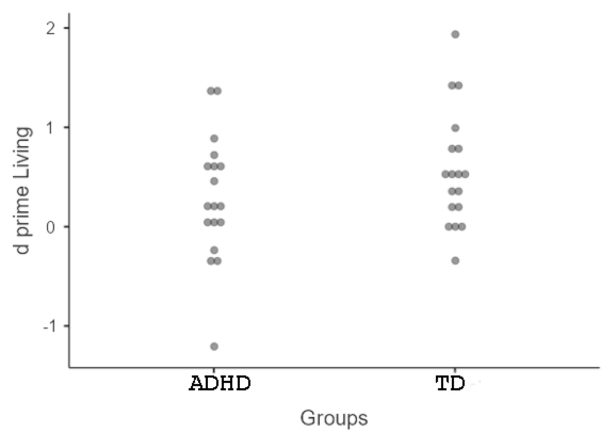

Fig. 1 - Distribution of d' values across Groups for the living category.

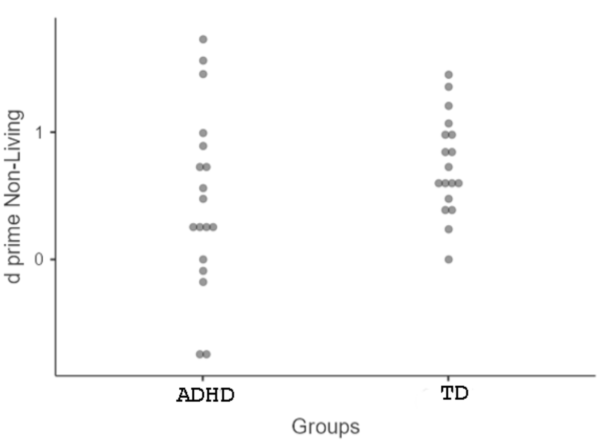

Fig. 2 - Distribution of d' values across Groups for the non-living category.

Discussion

Since the first descriptions (Aman, 1984), decades of research on ADHD have failed to identify a clear and stable pattern of cognitive impairment associated with the syndrome so that a remarkable neuropsychological heterogeneity is perhaps the most distinguished feature of ADHD (Singh et al., 2015) and there is also someone who questions whether the ADHD should be considered as a disease (Furham, 2005).

In particular, there is a lack of consensus on the exact nature of the attention problems typical for ADHD (Johnson et al., 2008) and which other constructs related to attention problems are most affected, although reliable evidence suggests that symptoms of ADHD may arise from a primary deficit of working memory (Ramos et al 2020) and/or executive functions (Willcutt et al., 2005).

In this study we focused on the construct of incidental, non-intentional memory; that is a memory that is acquired without conscious effort or intention to remember. Incidental memory is based on the assumption that any information that was processed meaningfully is remembered, despite the lack of prior effort made to memorize it. In this vein, the typical experimental paradigms used to study incidental memory consist of two phases: the study phase in which participants process stimuli that are not asked to remember, and the test phase in which participants are asked to recall (or recognize) those stimuli. It follows that individual performances on these tests are affected by a series of cognitive abilities such as the ability to focus and sustain attention and the ability to inhibit responses to irrelevant stimuli.

To the best of our knowledge, very few studies addressed the issue of incidental memory in individuals with ADHD. Even more interestingly, the available evidence is far from conclusive. Douglas and Peters (1979) found that children with ADHD are more susceptible than their TD peers to distraction, not attributable to a deficit of selective attention. Conversely, Copeland and Wisniewski (1981) along with a poorer performance on generalized cognitive measures, found an impairment of selective attention which affected the performance of children with ADHD on incidental memory tasks. Among the others, one paper deserves attention. Ceci and Tishman (1984) investigated the incidental memory of children with ADHD and, quite surprisingly, found that – at least when the encoding demand was very easy – children with ADHD outperformed their TD peers on incidental recognition.

In the present study, we re-addressed this topic by means of a properly devised experimental paradigm. To this purpose, 18 children with ADHD, and 18 chronological age – and gender – matched, TD children were examined with a conventional two-phase recognition memory test. In the study phase participants were required to categorize as a living or non-living a set of 64 stimuli from 8 semantic categories. In the test phase, they were required to recognize “old” (i.e., stimuli from the first set) from “new” (i.e., stimuli not shown earlier) stimuli.

As to the categorization task, the main result was that TD participants were significantly more accurate and faster than participants with ADHD. Actually, while most of TD participants scored at ceiling, children with ADHD were overall less accurate with only 7 of them having a comparable performance to TD peers and 2 of them scoring below chance level. The simplest interpretation would be that the worst performance of children with ADHD depended on their haste and lack of concentration (Rapport, 2009). Such an interpretation, however, is contradicted by the fact that children with ADHD took much more time than TD controls to accomplish this task. Namely, notwithstanding that they spent more time, they made more errors, thus suggesting that at least some of them had a genuine impairment in processing visual stimuli (Kibby, Vadnais & Jagger-Rickels, 2019).

However, the most interesting findings came from the test phase. First, it is worth noting that not all the participants understood correctly the task: four children with ADHD and one TD control recognized as target new rather than old stimuli, as demonstrated by their d' negative values. Thus, their data were excluded from the analysis. That further reduced the relatively small sample of participants and may have contributed to making the differences not statistically significant.

Strictly speaking, the fact that, despite the significant differences in the study phase with reduced accuracy and speed exhibited by ADHD children, no significant differences emerged in the test phase for neither condition, could be interpreted as a proof against the hypothesis of a deficit in incidental memory in children with ADHD in line with Ceci and Tishman (1984).

However, caution should be used before taking this lack of statistical evidence as conclusive proof that no such difference exists. As clearly shown in Table 2, it is evident – from a descriptive point of view – that children with ADHD had lower discriminability capacity between old (i.e., target) and new (i.e., non-target) stimuli compared to controls for both living and non-living stimuli. Furthermore, it is also evident (see Figure 1 and 2) that – consistently with findings from adults (Klein et al., 2006) – interindividual variability was much larger among participants with ADHD than their TD peers, at least for non-living items. There is not a straightforward explanation for this difference: it could be imputable to the lack of statistical power or it may reflect a more meaningful distinction in the processing between different types of items. This issue remains open for future research.

We are aware of some intrinsic limitations of the study, including the relatively small sample size and the absence of definition of the ADHD subtypes, their distribution in the sample and the lack of certainty about the possible presence of psychiatric comorbidities. Notwithstanding that, our findings cast doubt on the notion that ADHD represents a stable nosographic entity (Bayon & Zurita, 2018). Conversely, they further support the idea that ADHD may be best conceptualized as a neuropsychological heterogeneous condition such that neuropsychological testing may only be supportive of the ADHD diagnosis, but it cannot be used in isolation to diagnose ADHD (Nass, 2006).

To sum up, more work is needed to better understand the heterogeneity of ADHD and its clinical and pathophysiologic implications (Doyle, 2006). Meanwhile, ADHD seems to be a syndrome in search of an underlying mechanism and, perhaps, a better name.

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References

Alderson R.M., Kasper L.J., Hudec K.L., Patros C.H. Attention-deficit/hyperactivity disorder (ADHD) and working memory in adults: a meta-analytic review. *Neuropsychology*, **27**(3): 287-302, 2013.

Aman M.G. Hyperactivity: nature of the syndrome and its natural history. *Journal of Autism and Developmental Disorders*, **14**(1): 39-59, 1984.

Baddeley, A., Eysenck, M. W., & Anderson, M. C. (2009). *Memory*. Hove and New York: Psychology Press.

Banks W.P. Signal detection theory and human memory. *Psychological Bulletin*, **74**(2): 81-99, 1960.

Bayon M. D. and Zurita G. L. The paradigms of attention deficit hyperactivity disorder: Epistemological issues. *L'information psychiatrique*, **94**(6): 506-511, 2018.

Barbaresi W., Katusic S., Colligan R., Weaver V., Pankratz D., Mrazek D., Jacobsen S. How common is attentiondeficit/hyperactivity disorder? Towards resolution of the controversy: results from a population-based study. *Acta Paediatrica*, **93**: 55-59, 2004.

Ceci S. J. and Tishnan J. Hyperactivity and incidental memory: evidence for attentional diffusion. *Child Development*, **55**(6): 2192-2203, 1984.

Copeland A.P. and Wisniewski N.M. Learning disability and hyperactivity: deficits in selective attention. *Journal of Experimental Child Psychology*, **32**(1): 88-101, 1981.

Douglas V.I. and Peters K.G. Toward a clearer definition of the attentional deficit of hyperactive children. pp. 173-247. In: Hale G.A. and Lewis M. (Eds.) *Attention and cognitive development*. Plenum: New York: NY, USA, 1979.

Doyle A.E. Executive Functions in Attention-Deficit/Hyperactivity Disorder. *Journal of Clinical Psychiatry*, **67**: 21-26, 2006.

Furman L. What Is Attention-Deficit Hyperactivity Disorder (ADHD)? *Journal of Child Neurology*, **20**(12): 994-1002, 2005.

Johnson K.A., Robertson I.H., Barry E., Mulligan A., Dáibhis A., Daly M., Watchorn A., Gill M., Bellgrove M.A. Impaired conflict resolution and alerting in children with ADHD: evidence from the Attention Network Task (ANT). *Journal of Child Psychology Psychiatry*, **49**(12): 1339-47, 2008.

Kibby M.Y., Vadnais S.A., Jagger-Rickels A.C. Which components of processing speed are affected in ADHD subtypes? *Child Neuropsychology*, **25**(7): 964-979, 2019.

Klein C., Wendling K., Huettner P., Ruder H., Peper M. Intra-subject variability in attention-deficit hyperactivity disorder. *Biological Psychiatry*, **60**(10): 1088-1097, 2006.

Kontaxopoulou D., Beratis I.N., Fragkiadaki S., Pavlou D., Yannis G., Economou A., Papanicolaou A.C., Papageorgiou S.G. Incidental and Intentional Memory: Their Relation with Attention and Executive Functions. *Archives of Clinical Neuropsychology*, **32**(5): 519-532, 2017.

Marshall P., Hoelzle J., Nikolas M. Diagnosing Attention-Deficit/Hyperactivity Disorder (ADHD) in young adults: A qualitative review of the utility of assessment measures and recommendations for improving the diagnostic process. *The Clinical Neuropsychologist*, **35**(1): 165-198, 2021.

Nass R.D. Evaluation and Assessment Issues in the Diagnosis of Attention Deficit Hyperactivity Disorder. *Seminars in Pediatric Neurology*, **12**: 200-216, 2006.

Nigg J.T. Neuropsychologic theory and findings in attention-deficit/hyperactivity disorder: the state of the field and salient challenges for the coming decade. *Biological Psychiatry,* **57**(11): 1424-1435, 2005.

Oie M., Sunde K., Rund B.R. Contrasts in memory functions between adolescents with schizophrenia or ADHD. *Neuropsychologia*, **37**(12): 1351-1358, 1999.

Okie S. ADHD in adults. *New England Journal of Medicine*, **354**: 2637-2641, 2006.

Ramos A.A., Hamdan A.C., Machado L. A meta-analysis on verbal working memory in children and adolescents with ADHD. *The Clinical Neuropsychologist*, **34**(5): 873-898, 2020.

Rapport M.D., Kofler M.J., Alderson R.M., Timko T.M. Jr., Dupaul G.J. Variability of attention processes in ADHD: observations from the classroom. *Journal of Attention Disorders*, **12**(6): 563-573, 2009.

Rhodes S.M., Park J., Seth S., Coghill D.R. A comprehensive investigation of memory impairment in attention deficit hyperactivity disorder and oppositional defiant disorder. *Journal of Child Psychology Psychiatry*, **53**(2): 128-137, 2012.

Righi S., Gronchi G., Marzi T., Rebai M., Viggiano M.P. You are that smiling guy I met at the party! Socially positive signals foster memory for identities and contexts. *Acta Psychologica*, **159**: 1-7, 2015.

Roth R.M. and Saykin A.J. Executive dysfunction in attention-deficit/hyperactivity disorder: Cognitive and neuroimaging findings. *Psychiatric Clinics of North America*, **27**: 83-96, 2004.

Rowland A.S., Skipper B.J., Umbach D.M., Rabiner D.L., Campbell R.A., Naftel A.J., Sandler D.P. The Prevalence of ADHD in a Population-Based Sample. *Journal of Attention Disorders*, **19**(9): 741-754, 2015.

Singh A., Yeh C.J., Verma N., Das A.K. Overview of Attention Deficit Hyperactivity Disorder in Young Children. *Health Psychology Research*, **3**(2115): 23-35, 2015.

Thomas R., Sanders S., Doust J., Beller E., Glasziou P. Prevalence of attention-deficit/hyperactivity disorder: a systematic review and meta-analysis. *Pediatrics*, **135**(4): e994-e1001, 2015.

Willcutt E.G., Doyle A.E., Nigg J.T., Faraone S.V., Pennington B.F. Validity of the executive function theory of attention-deficit/hyperactivity disorder: a meta-analytic review. *Biological Psychiatry*, **57**(11): 1336-1346, 2005.