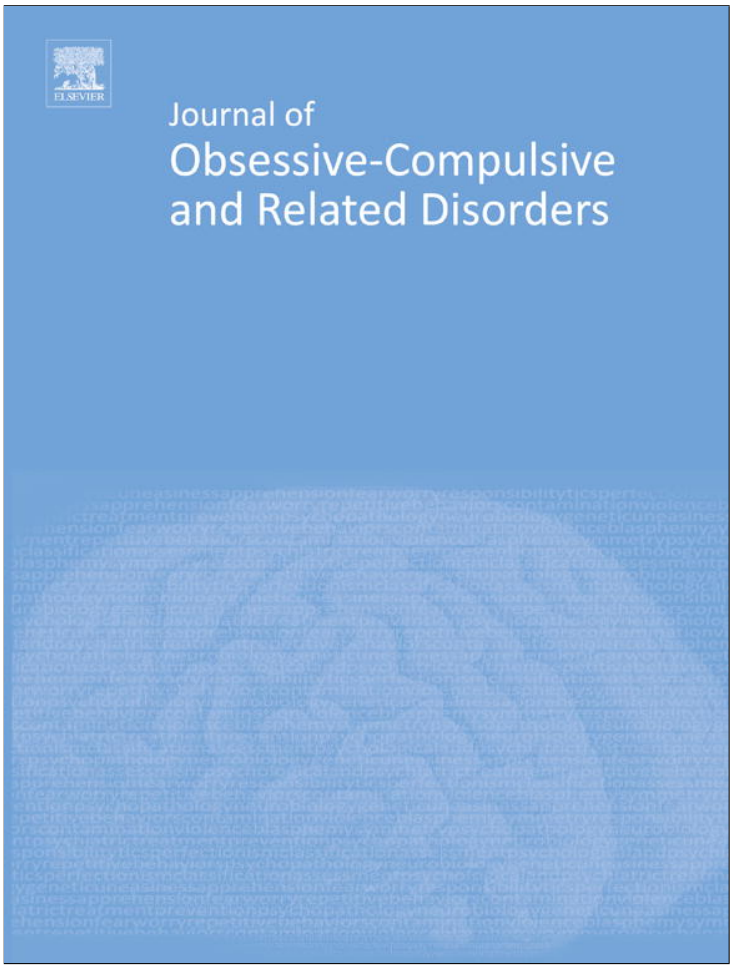

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Journal of Obsessive-Compulsive and Related Disorders 2 (2013) 53–61

Contents lists available at SciVerse ScienceDirect

Journal of Obsessive-Compulsive and Related Disorders

journal homepage: www.elsevier.com/locate/jocrd

Don't judge a book by its cover: ADHD-like symptoms in obsessive compulsive disorder

Amitai Abramovitch [a,b,*], Reuven Dar [c], Andrew Mittelman [b], Avraham Schweiger [d]

[a] Department of Psychiatry, Harvard Medical School, Boston, MA 02114, USA
[b] Department of Psychiatry, OCD and Related Disorders Program, Massachusetts General Hospital, Boston, MA 02114, USA
[c] Department of Psychology, School of Psychological Sciences, Tel Aviv University, Tel Aviv 69978, Israel
[d] School of Behavioral Sciences, The Academic College of Tel Aviv, Rabbenu Yerucham St, Tel Aviv 61083, Israel

ARTICLE INFO

Article history:
Received 15 June 2012
Received in revised form
10 September 2012
Accepted 12 September 2012
Available online 23 October 2012

Keywords:
OCD
ADHD
Comorbidity
DSM
Symptoms
Attention

ABSTRACT

Reported OCD–ADHD comorbidity rates are highly variable and the two disorders are characterized by opposite symptomatology and antithetical pathophysiology. We hypothesized that OCD-related attentional impairment could be misdiagnosed as ADHD symptoms. Thirty adults with OCD, thirty with ADHD, and thirty matched healthy controls (HC) completed disorder-specific measures and an ADHD DSM-IV based questionnaire examining childhood and current symptoms. The ADHD group met significantly more current and childhood ADHD criteria than the other groups. Within the HC and ADHD groups, but not the OCD group, significant positive correlations were found between childhood and current ADHD symptoms. Only within the OCD group, obsessive–compulsive symptoms and ADHD criteria correlated positively. These findings support the predictions of the executive overload model of OCD, suggesting that ADHD-like symptoms in OCD may be a consequence of OCD symptomatology. Clinical implications of a potential misdiagnosis should be considered in light of the probability that stimulant medication exacerbates OCD symptoms. This is particularly important in children, where ADHD diagnosis is based primarily on informant reports.

1. Introduction

Obsessive–compulsive disorder (OCD) and attention deficit/hyperactivity disorder (ADHD) are two common and debilitating neuropsychiatric disorders associated with a robust hereditary component (Faraone et al., 2005; Nicolini, Arnold, Nestadt, Lanzagorta, & Kennedy, 2009), exhibiting worldwide prevalence rates of 2.3% (Ruscio, Stein, Chiu, & Kessler, 2010), and 2.5–4% (Kessler et al., 2006), respectively. Reports of ADHD and OCD co-occurrence have primarily focused on children and adolescents, and frequently suggest a substantial comorbidity between the two disorders. However, research into OCD–ADHD prevalence rates reveals highly inconsistent results. In studies reporting the incidence of ADHD in samples of OCD patients, comorbidity rates vary from a range of 0–25% in some studies (Farrell & Barrett, 2006; Heyman et al., 2001; Ivarsson, Melin, & Wallin, 2008; Storch et al., 2007) to a range of 33–59% in others (Geller et al., 2001, 2002, 2000, 2006, 2007; Geller, Biederman, Griffin, Jones, & Lefkowitz, 1996). Rates were much lower in the few studies that reported the co-occurrence of OCD in samples of juveniles diagnosed with ADHD, ranging between 0% and 6% (Biederman et al., 2006; Moll et al., 2000; Skirbekk, Hansen, Oerbeck, & Kristensen, 2011; Zohar, 1999). Reports from adult samples are relatively limited and collectively suggest a lower average prevalence rate relative to that observed in juveniles. However, as found in juvenile samples, adult studies reveal significant variability in rates of co-occurrence, ranging from 0% to 19% of ADHD in OCD samples (Brakoulias et al., 2011; Kessler et al., 2006; Ruscio et al., 2010), and 1–13% of OCD in ADHD samples (Kessler et al., 2006; Mannuzza, Klein, Bessler, Malloy, & LaPadula, 1998; Shekim, Asarnow, Hess, Zaucha, & Wheeler, 1990).

While variability of prevalence rates in psychiatric comorbidity research is virtually unavoidable, the extensive inconsistencies amongst the reported OCD–ADHD co-occurrence rates call for further examination of this issue. In part, these inconsistencies may stem from methodological variations. First, there is a difference in reported OCD–ADHD co-occurrence between samples collected from specialty clinics (Geller et al., 2004) and those recruited from the community (Farrell & Barrett, 2006). Additionally, differences in diagnostic criteria and variation in diagnostic instruments may account for prevalence variability. For example, some studies used

* Corresponding author at: OCD and Related Disorders Program, Department of Psychiatry, Massachusetts General Hospital, 185 Cambridge Street, Suite 2000, Boston, MA 02114, USA.
E-mail addresses: aabramovitch@partners.org (A. Abramovitch), ruvidar@post.tau.ac.il (R. Dar), amittelman@partners.org (A. Mittelman), schweige@mta.ac.il (A. Schweiger).

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http://dx.doi.org/10.1016/j.jocrd.2012.09.001

the *Diagnostic and statistical manual of mental disorders*, 3rd ed. (DSM-III) (Geller et al., 1996; Hanna, 1995; Toro, Cervera, Osejo, & Salamero, 1992), while others used the DSM-IV (Heyman et al., 2001; Jaisoorya, Janardhan Reddy, & Srinath, 2003; Masi et al., 2006), which was found to be more lenient in terms of ADHD diagnostic criteria in children (Byrne, Bawden, Beattie, & DeWolfe, 2000). Furthermore, differences in experimenters' clinical experience and training, as well as differences in gender proportions across samples (which may be critical in ADHD samples), may further contribute to prevalence rate disparity.

In the context of OCD–ADHD co-occurrence, it is useful to consider neurodevelopmental aspects in pediatric OCD. (For a review see Abramovitch et al., 2012b). In brief, early onset OCD may be characterized by abnormal neuronal maturational processes. In fact, a recent study demonstrated that while adolescents and adults with OCD show increased frontostriatal brain metabolism as compared to matched healthy controls, young children with OCD showed decreased activity (Fitzgerald et al., 2011), a finding that has been repeatedly demonstrated in children with ADHD (Bush, Valera, & Seidman, 2005). Secondly, the instance of co-occurrence of ADHD and OCD appears to be very common in children with tic disorders (Mathews & Grados, 2011).

We would like to suggest that the variability in reported prevalence rates of OCD–ADHD co-occurrence reflects more than methodological differences between studies. Specifically, we suggest that a genuine OCD–ADHD comorbidity in adults may be an artifact in many cases, notably due to fundamental differences between the two disorders. These differences are reflected in antithetical patterns of brain activity and a very different clinical presentation in OCD as compared to ADHD.

Review of the functional imaging literature on adult OCD and ADHD reveals that whereas both disorders are characterized by abnormal frontostriatal activity (Bush et al., 2005; Harrison et al., 2009), the *pattern* of activity in each disorder is very different. OCD research has repeatedly demonstrated increased metabolic activity in key regions of the frontostriatal network (e.g., orbitofrontal cortex, thalamus, caudate nucleus) (Lacerda et al., 2003a; Mataix-Cols et al., 2003; Saxena et al., 2004; Saxena & Rauch, 2000; Whiteside, Port, & Abramowitz, 2004) in both resting state (Harrison et al., 2009) and during symptom provocation (Mataix-Cols et al., 2004). Other studies reported increased frontostriatal functional connectivity in OCD (Harrison et al., 2009). This pattern of increased frontostriatal activity in OCD – thought to reflect executive hyper-control (Bucci et al., 2004) and a preference toward controlled information processing (Rauch et al., 1997) – contrasts with the virtually opposite pattern of brain activity in ADHD. Numerous studies suggest that ADHD is associated with frontostriatal hypoactivity (Bush et al., 2005). This has been repeatedly demonstrated in selected regions of interest during both resting state and task performance (Cubillo & Rubia, 2010; Dickstein, Bannon, Xavier Castellanos, & Milham, 2006; Wolf et al., 2009). Decreased activity was further demonstrated in functional connectivity studies, suggesting decreased functional connectivity in frontostriatal regions in children and in adults with ADHD (Cubillo et al., 2010; Cubillo & Rubia, 2010; Rubia et al., 2009).

The significant dissimilarity in brain activity described above corresponds to the antithetical clinical manifestation of OCD in comparison with ADHD (Abramovitch, Dar, Hermesh, & Schweiger, 2012a; Carlsson, 2001). Behaviorally, ADHD is characterized predominantly by impulsivity (frequently with concomitant hyperactivity), risk taking, and novelty-seeking behavior (American Psychiatric Association, 2000; Barkley, 2002; Biederman, 2005). In contrast, the behavioral manifestations of OCD seem to lie on the opposite end of an impulsive–compulsive spectrum (Hollander, 2005). Individuals with OCD exhibit inhibited temperament, avoidance of novel stimuli (Alonso et al., 2008; Coll, Kagan, & Reznick, 1984; Muris, Meesters, & Spinder, 2003; Van Ameringen, Mancini, & Oakman, 1998), increased harm and risk avoidance (Ettelt et al., 2008), and less impulsivity than healthy controls (Fullana et al., 2004a, b; Wu, Clark, & Watson, 2006).

We believe that there is a growing convergence of evidence that may, at least in some cases, challenge the diagnostic validity of OCD and ADHD comorbidity. Most notably, we are concerned by the substantial variability in the reported co-occurrence between the disorders, and particularly the contrasting clinical manifestation and brain pathophysiology. Specifically, we suggest that OCD-related neuropsychological impairments in both executive function and attention (Chamberlain, Blackwell, Fineberg, Robbins, & Sahakian, 2005; Kuelz, Hohagen, & Voderholzer, 2004; Lacerda et al., 2003b; Penades, Catalan, Andres, Salamero, & Gasto, 2005), which may stem from a very different mechanism than in ADHD (Abramovitch et al., 2011; Abramovitch et al., 2012a), could potentially lead to misdiagnosis of ADHD in individuals with OCD. Abramovitch et al. (2012a) recently proposed an executive overload model of OCD wherein continuous attempts to control automatic processes, which are manifested by an overload of obsessive thoughts, consume valuable cognitive resources and result in neuropsychological impairments. This model suggests that OC symptoms in OCD are the cause of the observed impairments in executive functions and attention, and thereby are conceptualized as an epiphenomenon. The authors emphasize that this mechanism is different from the hypoactivated frontostriatal system in ADHD that hinders normative neuropsychological and behavioral functioning. Thus, the executive overload model of OCD suggests that individuals with OCD may be inattentive or forgetful and may perform poorly in planning tasks, similar to patients with ADHD. Subsequently, these manifestations of inattention may lead to an incorrect ADHD diagnosis in patients who actually have OCD (Abramovitch et al., 2011; Abramovitch et al., 2012a). The epiphenomenon hypothesis is further supported by reports of an improvement in neuropsychological functioning following successful treatment in OCD patients (Kuelz et al., 2006).

The current investigation was designed to examine if OCD-related attentional impairments may be perceived as symptoms of ADHD. Our aim was to examine DSM-IV ADHD criteria in adults with OCD and adults with ADHD, comparing each group's symptomatology across the developmental trajectory while assessing potential association with OC symptoms. Finally, we aimed to characterize individuals with OCD that match the minimum number of DSM-IV ADHD core criteria in order to examine the validity of full-blown OCD–ADHD comorbidity. Based upon the dissimilar clinical manifestation of ADHD and OCD, we hypothesized that the OCD group would report less valid ADHD criteria than the ADHD group. However, we anticipated that due to associated neuropsychological impairments, the OCD group would meet more criteria than non-patient, healthy controls. Based on the premise that behavioral impulsivity is not associated with OCD, we hypothesized that these differences would not be pronounced in the impulsive cluster, where we expected to find no difference between the OCD and the non-patient healthy control (HC) groups.

We further expected a difference between the OCD and the ADHD samples in terms of reported childhood symptoms. ADHD is a congenital disorder that persists across the developmental trajectory and life span (Biederman, 2005; Biederman, Petty, Evans, Small, & Faraone, 2010), whereas OCD exhibits an average age of onset of 19.5 years (Ruscio et al., 2010). Thus, the onset of ADHD would always precede the onset of OCD. In fact, Ruscio et al. (2010) observed this to be true in 100% of individuals with both ADHD and OCD. Based on our previous work suggesting that

neuropsychological impairments in OCD are an epiphenomenon of OCD symptoms (Abramovitch et al., 2011; Abramovitch et al., 2012a), we predicted no difference in ADHD symptoms between the OCD and healthy controls in early childhood (prior to the onset of OCD). Based on the same rationale, we hypothesized that the number of valid current ADHD criteria would correlate significantly with the number of valid childhood criteria only in the ADHD and HC groups, but not within the OCD group. Finally, based on research suggesting that OCD symptom severity is positively correlated with neuropsychological impairments (Abramovitch et al., 2011; Harrison et al., 2009; Lacerda et al., 2003; Segalas et al., 2008), we expected to find significant association between obsessive-compulsive symptoms and the number of DSM-IV ADHD criteria only within the OCD group.

2. Methods

2.1. Participants

Participants included 30 individuals with OCD, 30 individuals with ADHD, and 30 healthy control individuals with no psychiatric or neurologic history. All participants were male, as the skewed gender preponderance of ADHD — approximately 1:3 to 1:10 female to male ratio (Biederman et al., 2002) — makes it difficult to recruit female participants with ADHD. The three groups were matched for age and education.

The OCD sample was recruited from a regional outpatient adult anxiety disorders unit. Inclusion criteria were male gender, age >18, and a primary diagnosis of OCD. Participants with a history of any neurological or psychotic disorder, post-traumatic stress disorder, bipolar disorder, Tourette's syndrome, tic disorder, substance abuse disorder, or DSM-IV Axis II disorder were excluded from this study. Participants from the OCD group had their diagnosis re-validated using the Mini International Neuropsychiatric Interview (MINI) (Sheehan et al., 1997,1998). The OCD group included medicated and un-medicated participants. Of the 30, 17 participants were taking selective serotonin reuptake inhibitors (SSRI's), out of which four participants were taking an additional low dose of neuroleptic medication. Thirteen participants were un-medicated. Axis I comorbid disorders (i.e. dysthymia, social phobia, panic disorder, generalized anxiety disorder, and depression) were found in 24 participants, whereas 6 individuals were diagnosed exclusively with OCD.

The ADHD group consisted of 30 male college students diagnosed with ADHD. These participants were recruited from a learning disabilities program in a regional college in Israel. In order to establish an ADHD diagnosis and adhere to inclusion/exclusion criteria, participants in the ADHD group were re-assessed using the MINI, a DSM-IV based ADHD questionnaire, and any available records. Exclusionary factors for the ADHD group were similar to as in the OCD group. While OCD diagnosis was not necessarily exclusionary, all subjects within the ADHD group had no DSM-IV comorbid diagnoses and no previous hospitalizations. Additionally, all ADHD group subjects were unmedicated.

The control group consisted of 30 males. Following the stringent matching procedure, research assistants used convenience sampling to recruit and screen HC participants. All participants in the control group were free from past or present learning disability as well as any neurological, developmental, or psychiatric condition, as verified by the MINI. This study was approved by the Institutional Review Board of both the university and the mental health center. All participants signed an informed consent in accordance with the Declaration of Helsinki.

2.2. Procedure

After signing an informed consent, all participants completed a general demographic questionnaire and were administered the MINI. A licensed neuropsychologist (AA) closely supervised the screening procedure. This study was part of a larger research project for which all participants took a short computerized neuropsychological battery following the interview. Subsequently, all participants completed the Eysenck Impulsiveness-Venturesomeness-Empathy Scale (IVE), an ADHD DSM-IV based questionnaire, and the Obsessive–Compulsive Inventory-Revised (OCI-R).

2.3. Measures

The Hebrew version of the *Mini International Neuropsychiatric Interview* (MINI) version 5.0.0 (Sheehan et al., 1997, 1998) was used for OCD diagnosis and comorbidity screening in all participants. The MINI is a brief structured psychiatric diagnostic instrument that has been found to have good psychometric properties (Sheehan et al., 1997).

The *obsessive–compulsive inventory-revised* (OCI-R) is an 18 item self-report measure that was specifically developed to evaluate OC symptoms and OCD symptom dimensions. The OCI-R has been found to have very good psychometric properties in both clinical and non-clinical samples (Foa et al., 2002; Hajcak, Huppert, Simons, & Foa, 2004).

A *DSM-IV based self-report questionnaire* was developed in Hebrew to cover all the necessary criteria for ADHD diagnosis. The DSM-IV diagnosis of ADHD necessitates that some current ADHD symptoms have been evident before the age of seven. To address this prerequisite, we asked participants to indicate whether they exhibited each behavior/symptom in the past 6 months and/or in childhood (before the age of 7).

The *Eysenck Impulsiveness Venturesomeness Empathy Scale* (IVE) (Eysenck & Eysenck, 1978) is a 63-item questionnaire designed to assess impulsivity and risk-taking. This questionnaire, which was translated into Hebrew, measures impulsivity, venturesomeness, and empathy, and is considered one of the most commonly used self-report questionnaires for the assessment of impulsivity (Parker, Bagby, Webster, & Jackson, 1997). Since items comprising the empathy scale are used as buffer items (Eysenck & Eysenck, 1978), this scale was not included in our analyses. The IVE has good psychometric properties, exhibiting reliability coefficients of 0.79 and 0.85 for venturesomeness and impulsivity, respectively (Eysenck & Eysenck, 1978).

2.4. Statistical analyses

We used univariate analyses of variance (ANOVA) to analyze group differences on demographic variables as well as on impulsivity and obsessive–compulsive symptoms. Least significant difference (LSD) pairwise contrasts were performed to examine specific contrasts. To examine differences in ADHD DSM-IV criteria between the groups, we performed eight ANOVAs and corresponding LSD analyses. We used a significance level of 0.00625 (0.05 divided by 8 tests) for each test to control for inflation of Type I error. Pearson's correlation coefficients were calculated to examine within-group associations between childhood and current ADHD criteria and between OC symptoms and ADHD criteria.

3. Results

The groups did not differ significantly in age or education ($p=.39$ and $p=.16$, respectively). The ADHD group mean age was 29.5 ± 6.8 years, with an average education level of 13.5 ± 1.3 years. The HC group mean age was 30.2 ± 6.4 years with an average education level of 14.0 ± 1.6 years. The OCD group mean age was 31.9 ± 7.86 years with an average education level of 13.2 ± 1.8 years. The mean age of onset of the OCD group was 19.0 ± 6.8 years.

The groups differed significantly on the IVE impulsiveness scale (Table 1, $p < .001$). Least significant difference (LSD) pairwise contrasts revealed that the ADHD group scored significantly

Table 1
Impulsivity and obsessive–compulsive symptoms ratings across groups.

	OCD		ADHD		HC		F (2, 87)	Sig.
	Mean	SD	Mean	SD	Mean	SD		
IVE impulsiveness	8.50[a]	4.13	15.00[a]	3.63	7.63[a]	4.64	29.212	$<.0001$
OCI-R Total Score	32.90[b]	11.96	21.15[b]	9.10	8.30[b]	5.62	52.790	$<.0001$

OCI-R: Obsessive–compulsive inventory revised. IVE: Eysenck's impulsiveness venturesomeness empathy scale.

[a] LSD pairwise contrasts ADHD > HC = OCD, $p < .0001$.

[b] LSD pairwise contrasts OCD > ADHD, OCD > HC, ADHD > HC, $p < .0001$.

Table 2
Current and childhood DSM-V ADHD criteria by clusters.

ADHD DSM-IV criteria cluster	OCD ($n=30$)		ADHD ($n=30$)		HC ($n=30$)		F (2, 87)	LSD pairwise contrasts			Cohen's d effect size		
	Mean	SD	Mean	SD	Mean	SD		OCD vs. HC	OCD vs. ADHD	ADHD vs. HC	OCD vs. HC	OCD vs. ADHD	ADHD vs. HC
Total current symptoms	7.10	3.77	11.83	3.31	3.00	3.15	50.056***	***	***	***	1.18	1.33	2.73
Current attentional symptoms	3.80	2.11	6.90	1.12	1.30	1.66	83.567***	***	***	***	1.32	1.83	3.95
Current impulsive symptoms	1.07	1.01	1.80	1.06	0.63	0.67	12.001***	n.s.	**	***	–	0.71	1.32
Current hyperactive symptoms	2.17	1.60	3.23	1.75	0.93	1.31	16.203***	**	*	***	0.84	0.63	1.49
Total childhood symptoms	6.53	4.12	13.23	3.13	5.43	4.05	37.209***	n.s.	***	***	–	1.83	2.07
Childhood attentional symptoms	3.50	2.58	6.97	1.61	2.66	2.22	33.014***	n.s.	***	***	–	1.61	2.22
Childhood impulsive symptoms	0.93	1.01	2.00	1.02	1.13	0.97	9.608***	n.s.	***	**	–	1.05	0.87
Childhood hyperactive symptoms	2.00	1.55	3.87	1.59	1.60	1.57	17.796***	n.s.	***	***	–	1.19	1.44

DSM-IV = Diagnostic and statistical manual of mental disorders, 4th ed.; ADHD = Attention-deficit/hyperactivity disorder; OCD = Obsessive–compulsive disorder; HC = Healthy controls; LSD = Least significant difference.

* $p < .05$.
** $p < .01$.
*** $p < .0001$.

higher on the impulsivity scale than the HC and the OCD groups ($p < .001$), with no significant difference between the OCD and the HC groups ($p = .41$). Significant differences between the groups were also found on the OCI-R total score ($p < .001$). LSD analyses revealed that the OCD group scored significantly higher than the HC group ($p < .001$) and the ADHD groups ($p < .001$). The ADHD group scored significantly higher than the HC group on the OCI-R total score ($p < .001$).

3.1. Overlapping ADHD criteria

We performed eight univariate analyses of variance (ANOVA) and LSD analyses to compare the groups on the number of ADHD general (i.e., attentional), impulsive, hyperactive, and total valid criteria, both currently and in childhood (defined in the DSM-IV as before the age of 7). As presented in Table 2, we found significant overall differences between the ADHD, OCD, and HC groups on all clusters and on the total number of ADHD criteria in both childhood and adulthood. LSD analyses revealed significant differences between the ADHD and HC groups on all clusters including the total number of ADHD symptoms in both childhood and adulthood (average Cohen's d effect size = 2.01). Similarly, LSD analyses revealed significant differences between the ADHD and OCD groups on all symptom clusters in both childhood and adulthood (average Cohen's $d = 1.27$). LSD analyses between the OCD and HC groups yielded significant differences in the total number of current symptoms ($p < .001$, Cohen's $d = 1.18$), current number of attentional symptoms ($p < .001$, Cohen's $d = 1.32$), and current number of hyperactive symptoms ($p = .003$, Cohen's $d = 0.84$), wherein the OCD group exhibited higher average valid criteria in all of these categories. No significant differences were found between the OCD and HC groups regarding the current number of impulsive symptoms or on any of the clusters pertaining to childhood ADHD symptoms.

As ADHD is a congenital disorder while OCD is associated with a later onset, and in light of our assumption that ADHD-like symptoms in OCD are associated with OCD symptoms, we did not expect to find significant correlation between childhood and current ADHD criteria within the OCD group. To examine the association between the number of adult and childhood ADHD symptoms, we computed within-group Pearson's correlations between the number of valid DSM-IV ADHD criteria in adulthood and in childhood by clusters (i.e., inattention, impulsivity, hyperactivity and total number of valid criteria). As presented in Table 3, significant moderate to strong positive correlations were found within the ADHD group between the number of criteria in adulthood and childhood on the total number of valid criteria ($p = .001$, Fig. 1), inattention ($p = .035$), impulsivity ($p < .0001$), and hyperactivity ($p = .001$). Similarly, we noted significant medium to strong positive correlations within the HC group on the total number of valid criteria ($p < .0001$), inattention ($p < .0001$), impulsivity ($p < .0001$) and hyperactivity ($p = .004$). In contrast, within the OCD group, a significant moderate positive correlation was found only between the number of childhood and current impulsivity criteria ($p = .015$).

Table 3
Pearson's correlations between number of valid DSM-IV ADHD criteria in childhood and adulthood.

DSM-IV Clusters	OCD ($n=30$)	ADHD ($n=30$)	HC ($n=30$)
Total number of DSM-IV criteria	−.048	.590**	.654***
Inattention	−.07	.418*	.673***
Impulsivity	.440*	.669***	.608***
Hyperactivity	.236	.592**	.507**

DSM-IV = Diagnostic and statistical manual of mental disorders, 4th ed.; ADHD = Attention-deficit/hyperactivity disorder; OCD = Obsessive–compulsive disorder; HC = Healthy controls.

* $p < .05$.
** $p < .01$.
*** $p < .0001$.

In order to examine the hypothesis that ADHD symptoms in OCD are associated with OC symptoms only within the OCD group, we performed Pearson's correlations between the OCI-R total score and the number of current valid DSM-IV criteria in each of the clusters. As presented in Table 4, significant positive correlations between the OCI-R total score and ADHD criteria were found only within the OCD group. Within this group, the OCI-R total score was significantly positively correlated with the total number of DSM-IV ADHD criteria ($p = .013$), and the number of criteria in the hyperactive cluster ($p = .019$). Along the same lines, a positive, though non-significant, correlation between the number of DSM-IV inattention criteria and the OCI-R was found only within the OCD group ($p = .074$). None of the correlations within the ADHD and HC groups were significant, with Pearson's r coefficients ranging from −.14 to .28, indicating small effect sizes.

To assess the prevalence of potential co-occurrence between ADHD and OCD in our sample, we compared self-reported DSM-IV

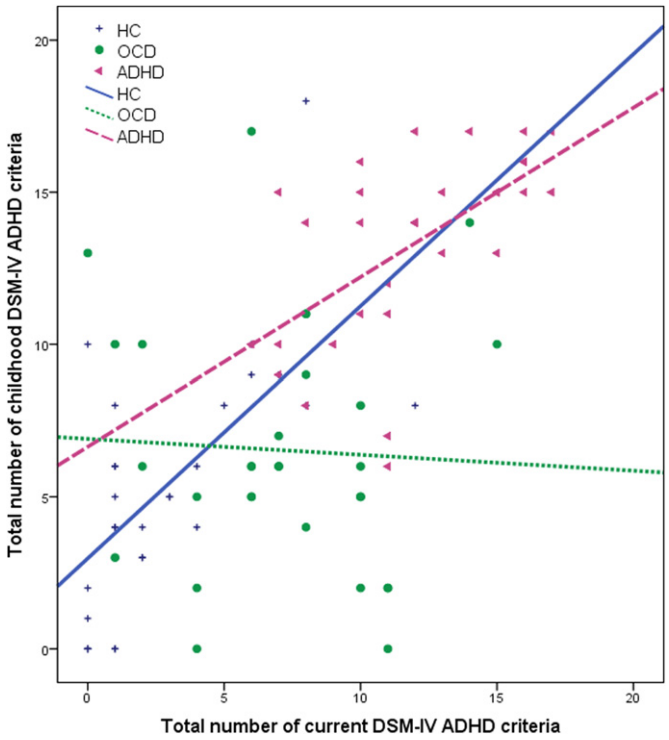

Fig. 1. Correlation between current and childhood DSM-IV ADHD criteria across groups. DSM-IV=Diagnostic and statistical manual of mental disorders, 4th ed.; ADHD=Attention-deficit/hyperactivity disorder; OCD=Obsessive–compulsive disorder; HC=Healthy controls.

Table 4
Pearson's correlations between the OCI-R total score and number of current DSM-IV ADHD criteria.

DSM-IV clusters	OCD (n=30)	ADHD (n=30)	HC (n=30)
Total number of DSM-IV criteria	.446*	.232	.220
Inattention	.332	.109	.134
Impulsivity	.265	−.138	.259
hyperactivity	.424*	.271	.279

OCI-R=Obsessive–compulsive inventory—revised; DSM-IV=Diagnostic and statistical manual of mental disorders, 4th ed.; ADHD=Attention-deficit/hyperactivity disorder; OCD=Obsessive–compulsive disorder; HC=Healthy controls.

* $p < .05$.

ADHD criteria between the three groups. All participants in the ADHD group and none of the participants in the HC group met ADHD diagnosis. Within the OCD group, five participants reported six or more DSM-IV ADHD inattention criteria (i.e., criterion A1 threshold), as well as criteria B and C. Whereas these patients did not meet subsequent criteria D and E for ADHD (see Section 4), we were interested in the differentiating characteristics of this group in comparison to the rest of the OCD group and the ADHD group. Because the small sample size does not permit the use of conventional statistical tests, we computed the Cohen's d effect size of these comparisons. The participants from the OCD group that met six or more ADHD criteria had higher average ratings on the IVE impulsivity scale (Cohen's d=.74), situated at the 73rd percentile within the OCD group. These participants exhibited a higher average OCI-R total score (Cohen's d=.85), with a mean OCI-R total score corresponding to the 70th percentile of the overall OCD group. Compared to the ADHD group, these five OCD patients exhibited a lower average score on the impulsivity scale (Cohen's d=1.37) and demonstrated fewer current valid criteria (A1 and A2; Cohen's d=.35). In the same vein, these five patients reported fewer childhood ADHD criteria than the ADHD group (Cohen's d=1.35).

4. Discussion

The current study aimed at examining two hypotheses extracted from the Executive Overload Model of OCD (Abramovitch et al., 2011; Abramovitch et al., 2012a). Abramovitch et al. (2011, 2012a) performed a direct neuropsychological comparison between adult ADHD, OCD, and HC groups. While there were comparable neuropsychological impairments in OCD and ADHD, there was evidence that these impairments represented different underlying mechanisms. Specifically, the authors suggested that in ADHD, frontostriatal hypoactivity impairs inhibitory abilities required for normal performance of executive functions, attention, memory, and working memory tasks. In contrast, the authors outlined an 'Executive Overload Model' of OCD, according to which the continuous and excessive attempts to control behavior and thoughts manifest in an overflow of obsessive thoughts which in turn "flood" the executive system and thereby impair neuropsychological functioning in OCD (Abramovitch et al., 2011; Abramovitch et al., 2012a). Following the predictions from this model, and based on the contrast between patterns of brain activity and clinical presentation, this study aimed to examine whether ADHD symptoms in OCD may be considered ADHD-like symptoms that actually result from OC symptoms.

The Executive Overload Model predicts that individuals with OCD will present some behaviors associated with impairments in executive function and attention and thus will meet more ADHD DSM-IV criteria than HC but less than the ADHD group due to the secondary nature of these symptoms. Additionally, in accordance with studies demonstrating that neuropsychological impairments in ADHD are associated with behavioral impulsivity (Chhabildas, Pennington, & Willcutt, 2001), and evidence showing lack of behavioral impulsivity in OCD (Fullana et al., 2004a; Wu et al., 2006), we expected that the OCD group would not differ from HC on the impulsivity cluster. In accordance with these hypotheses, we found that the ADHD group had demonstrated significantly more current valid criteria than the HC and OCD groups. The OCD group reported significantly more current ADHD attentional, hyperactive, and total criteria than the HC group, but did not differ on the impulsivity cluster or on the IVE impulsivity score.

As mentioned above, ADHD is a congenital disorder that persists across the life span and thus does not have a specific age of onset. Therefore, we hypothesized that the coherence of ADHD symptoms across the developmental trajectory would not be pronounced in OCD. In accordance with our hypothesis, no differences were found between the OCD and HC groups in the inattention, hyperactivity, impulsivity, and total number of ADHD childhood criteria. Differences in childhood ADHD criteria between the HC and OCD group were not expected, as the earliest age of onset in our OCD sample was 10 years old and our retrospective childhood questionnaire targeted an earlier period. Moreover, our OCD sample had an average age of onset of 19 years. Thus, we did not expect to find attentional symptoms associated with OCD prior to the age of onset of OCD.

We further hypothesized that the continuous nature of ADHD would be evident in associations between childhood and current symptoms in the ADHD and HC groups, but not the OCD group. In line with our hypothesis, we found strong correlations between childhood and current symptoms within the ADHD and HC groups on the inattention, impulsivity, hyperactivity, and total number of criteria clusters. In contrast, no associations were found in all other clusters within the OCD group with the

exception of medium association in the impulsivity criteria cluster. Several studies found significant associations between neuropsychological impairments (e.g., in attention, memory and executive functions domains) and OCD symptom severity (Abramovitch et al., 2011; Abramovitch et al., 2012a; Harrison et al., 2009; Lacerda et al., 2003b; Segalas et al., 2008). Thus, we suggest that the absence of clinical childhood OCD symptoms is pronounced in the face of the absence of a significant association between current and childhood ADHD criteria.

Following this line of thought, we expected that the clinical manifestation of executive functions and attentional impairments, as pronounced in most ADHD DSM-IV criteria (e.g., "Is often easily distracted by external stimuli"), would correlate significantly with OC symptoms within the OCD group. In line with this hypothesis, we found that while no association was found between ADHD criteria and OC symptoms within the ADHD and HC groups, positive correlations were found between these variables within the OCD group. In our view, these results further support the possibility that ADHD symptoms in OCD may be at least in part a consequence (i.e., an epiphenomenon) of executive impairments associated with OCD disorder-specific symptomatology and thus may be conceptualized as ADHD-like symptoms.

Notably, the ADHD group scored higher on the OCI-R relative to controls, but significantly lower than the OCD group, potentially supporting the argument for a connection between the two disorders. However, we did not find significant association between ADHD symptoms and OCI-R scores within the ADHD group. Furthermore, individuals with ADHD may experience significantly more intrusive, unwanted, and worrisome thoughts than controls. It has been suggested that this phenomenon may be a cognitive corollary of impulsivity in which individuals with ADHD may experience a deficient ability to inhibit thoughts as well as behavior (Abramovitch & Schweiger, 2009). However, another explanation for this finding may be offered. Specifically, the consequences of impulsive behavior and neuropsychological impairments in ADHD may lead to attempts to compensate through behaviors and mental acts such as checking and worrying. This hypothesis in itself demands an empirical investigation.

In the present study, five participants (16.7%) from the OCD group met DSM-IV diagnostic criteria A, B, and C for ADHD in adulthood. However, these individuals did not meet criterion D (i.e., clear evidence of clinically significant impairment in social, academic, or occupational functioning) for ADHD, but did for OCD. In other words, these individuals reported OCD symptoms and not ADHD symptoms as the cause for social, occupational, or academic impairment. Moreover, it appears that criterion E [i.e., "the symptoms do not occur exclusively during the course of a Pervasive Developmental Disorder, Schizophrenia, or other Psychotic Disorder and are not better accounted for by another mental disorder (e.g., Mood Disorder, Anxiety Disorder, Dissociative Disorder, or a Personality Disorder)"] poses another diagnostic concern. Specifically, the presentation of ADHD symptoms in OCD may be an overlooked epiphenomenal expression of OCD symptom severity, as supported by our findings that ADHD-like symptoms are associated with OC symptoms. These findings are supported by several studies that observed an association between OC symptom severity and impairment in attention, executive function, and memory (Abramovitch et al., 2011; Abramovitch et al., 2012a; Lacerda et al., 2003b; Penades et al., 2005; Segalas et al., 2008; Tallis, 1997; Tallis, Pratt, & Jamani, 1999).

Some studies have suggested that OCD–ADHD comorbidity is characterized by more severe impairments (Geller et al., 2003; Masi et al., 2006). We therefore examined the characteristics of the small group of OCD patients in our sample that met ADHD DSM-IV criteria A, B, and C. Bearing in mind the limitations posed by the small sample size, our analysis revealed that these patients reported more impulsive behavior and higher OC ratings than the OCD group. However, the OCD patients met about half the number of childhood criteria, while reporting a very similar number of current ADHD symptoms to the ADHD participants. This seems contrary to the hypothesis that OCD–ADHD co-occurrence is characterized by more severe ADHD symptoms, but in line with our hypothesis that ADHD symptoms in OCD are secondary to and associated with OC symptoms.

The lack of correlation between childhood and current ADHD symptoms in the OCD group, together with the association between OC symptoms and ADHD criteria, and the lack of difference between HC and OCD on childhood ADHD criteria support our hypothesis that OCD patients may be characterized by *ADHD-like* symptoms resulting from executive function impairment. As further suggested by the higher OC symptom severity within the group of OCD participants matching the primary six criteria threshold for ADHD diagnosis, our results may be the first to offer an alternative explanation to a full-blown comorbidity between ADHD and OCD in adulthood.

It appears that converging evidence challenges the concept of genuine comorbidity between the two disorders. First, as discussed above, numerous studies found that the two disorders are characterized by an opposite pattern of brain activity, in which ADHD is associated with frontostriatal hypoactivity (Bush et al., 2005; Cubillo et al., 2010) and OCD with hyperactivity in the same regions (Harrison et al., 2009; Saxena & Rauch, 2000; Whiteside et al., 2004). In fact, two recent studies directly comparing ADHD and OCD (Rubia, Cubillo, Woolley, Brammer, & Smith, 2011; Vloet et al., 2010) observed dissociation between brain activity and symptom severity.

Second, clinically, it appears that the hallmark symptoms of impulsivity and risk-taking in ADHD on one hand, and compulsivity and harm avoidance in OCD on the other, seem to lie at the opposite ends of a continuum. OCD-like compulsive rituals are characterized by repetition, timing, and accuracy, requiring precise allocation of focused attention on different sets of stimuli (Boyer & Lienard, 2006; Eilam, Zor, Szechtman, & Hermesh, 2006). In fact, because of these high cognitive demands, it has been suggested that OCD compulsive rituals *"resemble the tasks designed by cognitive psychologists in the study of working memory"* (Boyer & Lienard, 2006). Thus, it seems highly unlikely that individuals with ADHD would be able to perform precise and repetitive rituals. Furthermore, to the best of our knowledge and clinical experience, there is no evidence that individuals with ADHD perform OCD-like repetitive rituals. In fact, we are unfamiliar with evidence suggesting reckless, impulsive, or risk taking behaviors in individuals with primary OCD.

Third, with regards to response to treatment, several studies suggest that successful treatment for OCD, including CBT and/or SSRI medication, results in *reduction* in frontostriatal brain activity that is subsequently correlated with reduction in OC symptomatology (Baxter, 1992; Freyer et al., 2011). In contrast, successful treatment for ADHD, particularly stimulant medications, is associated with an *increase in* brain activity and symptomatic improvement (Bush et al., 2008; Volkow, Wang, Fowler, & Ding, 2005). In fact, there is evidence that methylphenidate may exacerbate OC symptoms and even induce full-blown OCD in patients diagnosed with ADHD (Koizumi, 1985; Kouris, 1998; Serby, 2003; Woolley & Heyman, 2003). Other studies demonstrated that Quinpirole, a Dopamine agonist, induced compulsion-like behaviors in rats that may be significantly reduced following SSRI administration (Zadicario, Ronen, & Eilam, 2007).

Fourth, the DSM-IV criteria for ADHD demonstrate prominent shortcomings concerning the diagnosis of ADHD in adults. The fact that the DSM-IV field trials did not include an adult

population is reflected in certain criteria such as "runs and climbs excessively" and "has difficulty playing … quietly" (McGough & Barkley, 2004). More importantly, some of the DSM-IV ADHD criteria pertaining to restlessness, increased speech, concentration difficulties, over-activity etc., are also symptoms of other anxiety, affective and personality disorders (McGough & Barkley, 2004). Thus, the meager discriminant validity of DSM-IV ADHD core criteria may lead researchers and clinicians to misidentify behavioral expressions of attentional impairments in OCD and other disorders as ADHD symptoms. More generally, attention and executive impairments characterize numerous psychiatric disorders. For example, attentional impairments are found in nearly every anxiety disorder (Ferreri, Lapp, & Peretti, 2011), eating disorders (Duchesne et al., 2004), bipolar disorder (Quraishi & Frangou, 2002), major depressive disorder (Zakzanis, Leach, & Kaplan, 1998), post-traumatic stress disorder (Horner & Hamner, 2002), schizophrenia (Pukrop & Klosterkotter, 2010), antisocial personality disorder (Dolan & Park, 2002), and borderline personality disorder (Ruocco, 2005).

It is reasonable to assume that attentional impairments that influence numerous aspects of human behavior will be manifested in behaviors that are similar to DSM-IV ADHD criteria (e.g. difficulties in concentration, feeling of restlessness, avoidance of tasks that require cognitive effort, distraction by extraneous stimuli). For example, with regards to OCD, the DSM-IV ADHD criterion "often does not seem to listen when spoken to directly," may reflect an overflow of obsessive thoughts that hinders the individual's ability to be attentive. Thus, it is plausible that in the present research, the five participants in the OCD group that met diagnostic criteria A, B, and C for adult ADHD were actually reporting OCD-related phenotypical expressions of executive and attentional impairment. These individuals had severe OC symptoms that increased ADHD-like phenotypical expressions, corresponding to a misdiagnosis of comorbid ADHD.

Although in need of further substantiation, our results are important in light of the pediatric ADHD diagnostic process, which relies substantially on informants such as parents and schoolteachers (Root & Resnick, 2003). Given the similarities in attentional and executive impairments between OCD and ADHD, a misdiagnosis in children is also (and perhaps more) probable. A misdiagnosis of an inattentive child as having ADHD, when in fact the child actually has OCD, may have adverse consequences. As noted above, there are several studies showing that stimulant medications exacerbate and even induce OCD. Thus, prescribing stimulant therapy to a child who was mistakenly diagnosed with ADHD instead of OCD may result in significant exacerbation of the OC symptoms.

This study is not without limitations. First, only male participants were included and our results should be replicated using both genders. Second, whereas the DSM-IV diagnoses of our participants were based on the clinician-administered MINI, the other measures were self-report questionnaires that were partially retrospective. The latter may be more prone to errors. Research suggests, however, that DSM-IV based self-report questionnaires have good psychometric properties and do not differ from other ADHD rating scales when used in the adult ADHD population (McCann & Roy-Byrne, 2004). Third, our attempt to statistically examine the characteristics of a group of five participants within the OCD group who met ADHD core criteria is very limited and should be replicated. Finally, research into psychiatric comorbidity presents a very complex and daunting task and our study utilized a somewhat indirect methodology as a first step to examine an alternative explanation to OCD–ADHD comorbidity. Nevertheless, we believe that our initial results are sufficient to warrant clinical attention to the possibile misinterpretation of ADHD-like symptoms. For future reseach it may be useful to conduct a longitudinal study examining the manifistations of OCD and ADHD and their co-occurrence starting from early childhood.

5. Conclusion

To the best of our knowledge, this study is the first to provide an alternative explanation for the common notion of full-blown comorbidity between OCD and ADHD in adults. While further research is required to explicate this issue, clinicians ought to pay careful consideration to OCD symptoms in the diagnostic process of individuals suspected of having ADHD, and be mindful that OC symptomatology has the possibility to manifest through ADHD-like symptoms. This was also noted by McGough & Barkley (2004) in a review of current diagnostic controversies in adult ADHD, where the authors suggested that "*Clinicians should make efforts to obtain third-party corroboration whenever available and should carefully document the evidence of the disorder as justification for treatment*," and concluded that "*Clinicians must maintain a high suspicion for coexisting psychiatric conditions and should provide reasoned polytherapy when justified*" (McGough & Barkley, 2004; p. 1954).

Role of funding sources

No funding was received for this study.

Contributors

All authors materially participated in the research and/or manuscript preparation and approved the final manuscript. Author AA designed the study, conducted the literature search, performed the statistical analysis, and wrote the first draft of the manuscript. Authors RD and AS participated in the research design, provided expert consultation, and participated in the preparation of the final manuscript. Author AM participated in the literature searches, provided research summaries, and participated in the writing process from the initial draft to the final version of the manuscript.

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