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Which Behavioral and Personality Characteristics Are Associated With Difficulties in Selective Attention?

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Abstract

Objective: The present study investigated the behavioral and personality profile associated with difficulties in selective attention. **Method:** A group of participants with ADHD were assessed for ADHD behaviors. Adults with ADHD (*n* = 22) and without ADHD (*n* = 84) were tested on the conjunctive visual-search task for selective attention and behavioral measures, including ADHD behaviors, Big Five dimension of personality, obsessive compulsive disorder (OCD) symptoms, and sensation-seeking behavior. **Results:** Correlations and multiple regression analysis (group was dummy coded) showed that ADHD behaviors were not related to search performance. However, poorer search performance was related to greater neuroticism, agreeableness, introversion, lower sensation seeking, and, marginally, to OCD symptoms. **Conclusion:** The study findings suggested that difficulties in selective attention are probably not associated with ADHD behaviors, but rather with personality traits characterized by preserving and avoiding high-stimulation behaviors. *(J. of Att. Dis. 2010; XX(X) 1-XX)*

Keywords

selective attention, ADHD, behavior, personality, search task, adults

The *Diagnostic and Statistical Manual of Mental Disorders* defines attention as "the capability or process of selecting out of the totality of available sensory or affective stimuli, those most appropriate or desirable for focus at a given time" (*DSM-IV-TR*, 4th ed., American Psychiatric Association [APA], 2000). Cognitive science has intensely investigated the nature of the attention process using numerous tasks. Visual-search paradigms have been widely used to investigate the cognitive processes mediating target search, and such tasks have been used for a long time, in order to inform on the nature of selective attention (Mullane & Klein, 2008; see Wolfe, 1998, for review). The tasks typically involve detecting a prespecified target item among distractor items. A target defined on the basis of a conjunction of features relative to distractors (e.g., shape and color) tends to be harder to detect by identifying just one feature, as reaction times (RTs) slow down in a linear fashion indicating an increase in the number of distractors. Conjunction search depends on attention-demanding serial-search processes (Treisman & Gelade, 1980) and can be an adequate measure for selective attention (Mason, Humphreys, & Kent, 2003).

Although selective attention processes were investigated intensely, the behavioral expression of selective attention difficulties was barely investigated. It is reasonable to expect that selective attention difficulties would relate to the ADHD behavioral symptoms (APA, 2000). This is because inattention symptoms are prominent in ADHD across the lifespan (Barkley, Anastopoulos, Guevremont, & Fletcher, 1991; Biederman, Faraone, Taylor, & Sienna, 1998; Hervey, Epstein, & Cury, 2004). Some of the ADHD inattentive symptoms (e.g., distracted by stimuli, fails to give close attention to details) seem to be directly related to the inability of selective attention.

Relatively few studies of ADHD (all in children, to the best of our knowledge) have used the conjunctive visual-search task to assess the implications for selective attention. Moreover, these results have been mixed. For example, two studies found that children with ADHD were overall slower and made more errors but did not show differences in RT and accuracy (ACC) as a function of an increased number of distractors (the slope used to assess selective attention) compared to controls (Hazell et al., 1999; Mason et al., 2003). In contrast, some studies using the conjunctive visual-search

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task did find poorer search performance in children with ADHD compared to comparison controls (Booth et al., 2005; Mullane & Klein, 2008; Shalev & Tsal, 2003; Tsal, Shalev, & Mevorach, 2005). Few studies using less traditional tasks for assessing selective attention found that children with ADHD perform worse than controls when exposed to all kinds of flanking distractors (tasks in which a target is located in the middle, flanked to the left and right by compatible or incompatible visual distractors), including auditory stimuli (Brodeur & Pond, 2001); poorer performance was also seen with only incompatible distractors (Shalev & Tsal, 2003).

However, studies that showed selective attention difficulties in ADHD have not taken into account the extent to which their control and ADHD participants may differ in personality characteristics and the potential effect on their results. Several early studies showed that personality traits can relate to selective attention difficulties. In one study neurotic introvert and stable extravert participants were given two versions of a letter-transformation task (low and high complexity) at one of three levels of white-noise intensity. The performance of neurotic introverts was more adversely affected than that of stable extraverts by distracting stimuli resembling task stimuli in the more complex version of a letter-transformation task (Eysenck & Graydon, 1989). It has also been found that introverts, compared to extraverts, were more distracted on the complex divided-attention task for visual selective attention (Szymura & Nqcka, 1998) and were more susceptible to the interference effects of the Stroop task (Edward & Blazej, 2002). An inverse relationship between anxiety and performance in more complex versions of a letter-transformation was also found; high-anxiety participants were more affected by distracting stimuli than low-anxiety ones (Eysenck & Byrne, 1992).

Sensation-seeking behaviors were also found to relate to selective attention. Early findings showed that low sensation seekers were worse than high sensation seekers at focused attention and on tasks requiring selective attention (Martin, 1985), and these effects were stronger in the more novel difficult conditions (Ball & Zuckerman, 1992). In addition, it was found that low sensation seekers performed quite poorly, whereas high-sensation seekers performed considerably better on the perceptual span task (where a target letter character must be identified in a quickly presented array of nontarget letter characters) in the more dense condition, where selective attention demands were greatest (Hardy, Castellon, Hinkin, Levine, & Lam, 2008).

A deficit in the ability to selectively attend to relevant stimuli, while simultaneously ignoring irrelevant competing stimuli, is also central to the symptomatology of obsessive compulsive disorder (OCD; Clayton, Richards, & Edwards, 1999; Cohen, Lachenmeyer, & Springer, 2003). For example, on the global–local task interference (a task in which big letters are comprised of suitable arrangements of small letters, which could either be the same or different than the global letter), the obsessive compulsive cognitive style was associated with local interference, which reflects the effects of distraction by to-be-ignored small details on identification of global information (Rankins, Bradshaw, & Georgiou-Karistianis, 2005; Yovel, Revelle, & Mineka, 2005).

Hence, these studies encourage the assumption that difficulties in selecting a target and ignoring distractors may also associated with introversion, neuroticism, sensation seeking, and OCD symptoms.

The main goal of the present study was to explore the specific personality and behavioral characteristics of selective attention difficulties measured by the conjunctive visual-search task in adults. Participants with ADHD were also assessed for sufficient variability in the ADHD behavioral measures—inattentive symptoms, oppositional-defiant disorder (ODD) symptoms (which include impulsivity), and dysthymia symptoms—which compose the ADHD diagnosis in adults according to the Wender Utah Rating Scale (WURS; Ward, Wender, & Remherr, 1993). The study particularly explored whether the inattentive symptoms that are more prominent in adults with ADHD (Barkley et al., 1991; Biederman et al., 1998; Hervey et al., 2004) would show stronger correlation with search performance relative to the two other ADHD behaviors. In addition, it examined the extent to which ADHD behaviors interact with personality and behavioral characteristics: introversion and neuroticism (Big Five), sensation seeking, and OCD.

It was predicted that poorer search performance would relate specifically to the inattention symptoms of ADHD. In addition, it was predicted that poorer search performance would also relate to high introversion, neuroticism, low sensation seeking, and OCD symptom behaviors.

Method

Participants

The study included 106 participants between the ages of 18 and 35. A total of 22 participants were diagnosed with ADHD (men = 9, women = 13), and 84 participants were comparison controls (men = 44, women = 40). Adults with ADHD symptoms were recruited using advertisements in the university and through Web sites dealing with adults with ADHD. All participants in the study were Hebrew speakers.

The 22 adults with ADHD were diagnosed by a certified psychiatrist or neurologist physicians in several local ADHD clinics according to *DSM-IV* criteria; written documentation verified that 7 adults (women = 4) met the criteria

Table 1. Between Group Differences on ADHD WURS, Big Five, SSSV, and OCD-MOCI Scores

	ADHD[a]	Control[b]			
	M (*SD*)	*M* (*SD*)	*F*(1, 102)	Sig.	η^2
Age	27.5 (4.6)	24.5 (3.4)	4.36	<.05	.052
ADHD WURS					
Inattention symptoms	13.6 (5.3)	4.7 (4.45)	45.8	<.01	.312
ODD	15.3 (7.5)	6.9 (4.5)	39.7	<.01	.282
Dysthymia	19.1 (6.4)	9.9 (6)	34.9	<.01	.257
Total WURS score	48 (14)	21 (11.8)	70.4	<.01	.411
Big Five					
Extraversion	22.6 (6.7)	24.6 (4.9)	1.1	ns	.011
Conscientiousness	20.7 (5.3)	28.9 (5.5)	31.5	<.01	.238
Agreeableness	29.6 (4.04)	32.5 (3.4)	12	<.01	.107
Neuroticism	23.2 (4.7)	19.8 (5.3)	6.4	<.05	.060
Open to experience	32.4 (4.26)	31.5 (4.5)	1.93	ns	.019
Sensation seeking SSSV	22.3 (6.6)	21.2 (5.5)	0.583	ns	.006
OCD symptoms OCD-MOCI	10.3 (4.9)	7.2 (4.3)	6.96	<.01	.064

Note: WURS = Wender Utah Rating Scale; SSSV = Sensation Seeking Scale Form V; OCD = obsessive compulsive disorder; MOCI = Maudsley Obsessive Compulsive Inventory; ODD = opposite defiant disorder.
a. $N = 22$.
b. $N = 84$.

for ADHD, predominantly inattentive, and 15 met the criteria for ADHD combined subtype (who also present with hyperactivity-impulsivity symptoms). In addition, all participants (ADHD and controls) completed the WURS ADHD questionnaire (Ward et al., 1993) for the scores of ADHD behavioral symptoms (see Table 1). More important, none of the comparison control participants reached the total score of 46 cutoff for the diagnosis of ADHD according to the WURS (Ward et al., 1993), (95% CI = 18.7-24.1). In comparison, 69.2% of the ADHD participants scored beyond the cutoff score 46 (95% CI for all ADHD = 42.5-52.9). The participants with ADHD, who scored marginally less than the cutoff score of 46, were mostly the participants with ADHD inattentive subtype (the WURS questionnaire has no criteria for the ADHD inattentive subtype).

A total of 76 participants (9 with ADHD) were Tel-Aviv University undergraduates who participated in the experiment for course credit, and 30 (13 with ADHD) of them were volunteers. Five of the volunteers (two with ADHD) were students from other universities and the rest had no university experience (all participants completed at least 11 years of education).

Exclusion criteria for all participants in the study included known brain injuries, history of psychiatric disorders other than ADHD, and individuals on medications other than medications for ADHD treatment. A total of 3 participants were initially excluded due to former psychiatric evaluation other than ADHD and self-report for regular use of prescribed antidepressant medications. Four of the ADHD participants were taking regular medication for ADHD treatment. For these participants, medications were not in use during the day of testing. All participants had normal or corrected-to-normal vision.

Measures

Questionnaires. ADHD symptoms were assessed using the 25-item WURS (Ward et al., 1993). In this scale, adult participants retrospectively rate their own childhood symptoms from 0 (*not at all or slightly*) to 4 (*very much*). Total scores range from 0 to 100. For the best diagnoses of adults with ADHD using this scale, Ward et al. (1993) suggested a cutoff ADHD score of 46, at which point a sensitivity of 86% and a specificity of 99% have been reported. The WURS has shown satisfactory split-half internal reliability with a Spearman–Brown corrected correlation of $r = .90$ ($p < .0001$; Ward et al., 1993). In addition, high test–retest reliability ($r = .81$) and alpha reliability of .88 have been reported (Rossini & O'Connor, 1995). In addition, the WURS has three behavioral factors: inattention symptoms at school or work (6 items), oppositional or defiant symptoms (9 items), and dysthymia (10 items). Alpha reliabilities ranged between .87 and .95 (McCann, Scheele, Ward, & Roy-Byrne, 2000), and between .84 and .9 in the current study.

The Big Five "Mini-Marker" (Saucier, 1994) was used to assess extraversion, conscientiousness, neuroticism, agreeableness, and openness to experience. This version includes 40 traits, 8 for each dimension. For each trait, ratings were made on a 5-point scale ranging from 1 (*not at all*) to 5 (*extremely*). The items of this questionnaire were selected from the Goldberg (1992) 100-item scale. Comparison with the original scale showed that this scale uses fewer difficult items, lower between-scale (dimensions) correlations, and higher mean interitem correlations; alpha reliability coefficients are somewhat lower, ranging from .69 to .84 (Saucier 1994), and between .65 and .87 in the current study.

Sensation-seeking behavior was assessed using the Sensation Seeking Scale Form V (SSSV; Zuckerman, 1994; Zuckerman, Eysenck, & Eysenck, 1978). This is a rating scale comprising 40 forced-choice items. For each item, the participant is presented with two statements describing preferred sensation-seeking behavior. For each item, a score of 0 is for non–sensation-seeking behavior and a score of 1 is for sensation-seeking behavior. A maximum general total score of 40 represents extreme sensation-seeking behavior. The Hebrew translation of the SSSV has shown high structure reliability similar to the English version (Birenbaum, 1986; Birenbaum & Montag, 1987). In different studies, alpha reliabilities of the SSSV ranged from .77 to .82 (Zuckerman, 1994) and .80 in the current study.

The Maudsley Obsessive Compulsive Inventory (MOCI; Hodgson & Rachman, 1977) was used to assess OCD symptoms. It is a 30-item yes or no inventory. The total OCD symptoms score ranges from 30 (*the highest*) to 0 (*the lowest*). Test–retest reliability of .8 and alpha reliability of .73 have been reported (Hodgson & Rachman, 1977). The MOCI was translated into Hebrew, back-translated and revised, and then normed, and found to be reliable and valid (Zohar, LaBuda, & Moschel-Ravid, 1995). Alpha reliability of .76 was found in the current study.

Selective Attention Test. The conjunctive visual-search task was used to assess selective attention (Treisman & Gelade, 1980). The stimulus presentation and data collection were computer controlled. All stimuli were presented against a dark background. Viewing distance was set at about 50 cm so that 1 cm represents about 1.15 degree of visual angle. Four 40-trial blocks were preceded by 10 practice trials during which auditory feedback was given on accuracy. No feedback was provided during experimental trials. Participants were required to respond as fast and as accurately as possible. Measures were derived from mean ACC and mean RT for correct responses as described in the following section.

The task was to search for a target defined as a specific conjunction of color and shape. The target was a blue square (0.8 cm on each side) appearing among an equal number of red squares (0.8 cm on each side) and blue circles (0.8 cm in diameter). There were 4 display sizes of 4, 8, 16, or 32 items (distractors), which are equally frequent and randomly intermixed within a block. The items were randomly positioned within a 7 × 6 matrix extending 9.5 cm in width and 8 cm in height. Half of the displays contained a target. Each display, preceded by a 1,000 msec white central fixation cross, remains on the screen until response. Participants were required to respond with their right finger to the presence of the target and with their left finger to its absence.

The main measure used to assess selective attention was the *combined slope* of RT and ACC together, defined as the slope of the regression line of 8, 16, and 32 distractor displays over the combined index (reaction time [RT]/accuracy [ACC][1]) calculated for each set size (except set size = 4) separately and only for target present condition (see Appendix). This measure simply reflects the rate differences in mean RT/ACC among 8, 16, and 32 distractor displays. For each individual a higher score on this measure indicates greater differences between the variant set sizes (steeper slope), which indicated poorer performance. The *error rates for target-present 32-item displays* were used as a second measure. Only the high-density display for errors was used, due to low levels in error rates overall (see Results). All measures derived from the target present conditions were deemed acceptable, because nontarget conditions are difficult to interpret (Mason et al., 2003).

Statistical Analyses. For basic between-group (ADHD vs. control) comparisons on demographics, personality and behavioral traits, and cognitive attention variables, MANCOVAs were used (age was entered as a covariate). A correction for multiple comparisons was adjusted according to Keppel's multiple-comparison corrections (Keppel, 1991, p. 169). Of primary interest was the relationship between performance on the visual-search task and the WURS ADHD symptoms, Big Five, sensation-seeking, and OCD scores. Two related strategies were employed to formally test these relationships. First, Pearson correlations between the visual search measures and the behavioral scores were computed. A correction for multiple comparisons was adjusted according to Keppel's multiple-comparison corrections (Keppel, 1991, p. 169). In addition, to overcome possible overlap in relationships between variables and to examine the extent to which scores on the WURS, Big Five, sensation seeking, and OCD as well as group, gender, university experience (dummy-coded), and age made unique contributions to performance on the visual task, multiple regression analysis was used. To detect interactions, group personality and behavioral scores were entered using a stepwise procedure. Examination of variance inflation factors (VIF) showed that the highest value reached 3.259, which indicated nonconsiderable multicollinearity.

Results

Between-group differences on behavioral and personality measures. Overall, no significant gender differences were found. Hence, data of men and women were pooled. MANCOVAs were conducted for the comparisons between

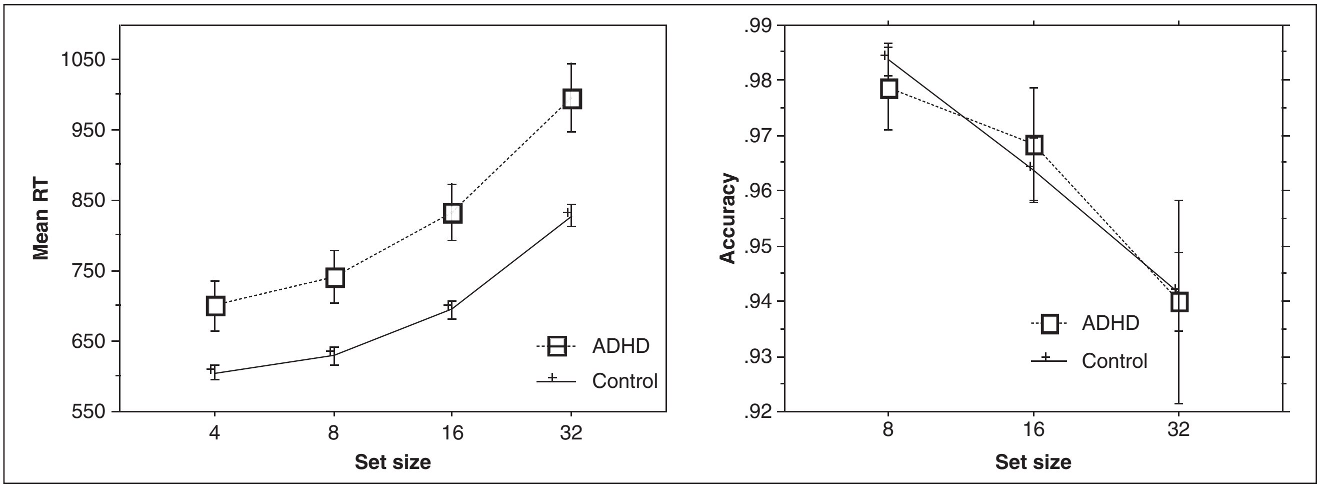

Figure 1. Conjunctive search performance for the control and ADHD groups on mean RT in msec (A) and percentages of ACC rate (B), with standard errors, for target-present trials as a function of display size.

ADHD and comparison control groups on all the dependent variables: age, WURS ADHD symptoms, Big Five personality traits, OCD, and sensation seeking. The results are presented in Table 1. As shown in the table, ADHD participants were older in age (entered as a covariate in the following analysis) and had substantially higher inattention, ODD, dysthymia, and total WURS ADHD scores. In addition, the ADHD participants had lower conscientiousness, lower agreeableness, and higher neuroticism from the Big Five and higher OCD symptoms, compared to controls.

As most of the participants were university students (11 with ADHD and 70 controls) and some were not students, without university experience (11 with ADHD and 25 controls), and as the proportions of student participants differed in ADHD compared to control groups, the interactions between university students and nonstudents and between ADHD and control groups were studied in the context of all behaviors, including for measures such as personality and cognitive search task. These interactions were conducted to ensure that the differences between ADHD and controls were not influenced by university-experience differences. The results showed that only for age, total WURS, and sensation seeking the interactions between students and nonstudents and between ADHD and controls remained significant: $F(1, 102) = 4.43$, $p < .05$, $\eta^2 = .042$; $F(1, 102) = 4.298$, $p < .05$, $\eta^2 = .041$; $F(1, 102) = 3.45$, $p = .05$, $\eta^2 = .033$. Post hoc comparisons indicated that the nonstudents with ADHD were the oldest and had the highest total WURS scores, whereas the student ADHD group had the highest sensation-seeking scores compared to the other groups, although multiple comparisons correction revealed that these differences were marginal ($p \leq .1$). In addition, there were no significant interactions between students and nonstudents and between ADHD and controls on any of the cognitive search-task measures (Fs ≤ 1.327).

The fact that these were the only interactions found indicates that, in general, no essential differences between university student and nonstudent participants in each group (ADHD and control) were evident.

Between-group differences on the conjunctive search task. Technical problems forced us to exclude ACC levels in the four distractors display. As acceptable in tasks using RT, we eliminated trials that were extremely deviated by +2 or –2 *SD* of RT from the relevant mean RT condition. Overall, mean low percentage rates of 2.5% of trials for each participant were excluded. No significant gender differences on any of the search measures were found. Hence, data of men and women were pooled.

The mean RT and ACC differences between ADHD and control groups in each display size are presented in Figure 1 (1A and 1B, respectively). The repeated measure ANCOVA of mean RT (Figure 1A) as a function of the interaction between display size (number of distractors) and groups (ADHD vs. control; age was entered as a covariate) revealed a significant main effect of display size: $F(3, 309) = 205.20$, $p < .0001$, $\eta^2 = .694$. Post hoc comparisons showed a significantly gradual decline in speed of response among 4, 8, 16, and 32 distractor displays ($p < .0001$). The results also showed the main effect of groups in which, overall, ADHD participants were significantly slower than controls: $F(1, 103) = 17.6$, $p < .0001$, $\eta^2 = .175$. The interaction between group and display size was also significant: $F(3, 309) = 4.501$, $p < .01$, $\eta^2 = .048$. Post hoc comparisons showed only a marginally greater decline in response speed in the ADHD group as a function of increasing 8 to 16 and

Table 2. Pearson's Correlations Between the Conjunctive Search Measures and ADHD WURS, Big Five, SSSV and OCD-MOCI Scores

ADHD WURS	Search slope (RT/ACC) as a function of set size	Error rates (32 set size)
Inattention symptoms	A –.119	A .189
	C .078	C –.050
	T .169	T .018
ODD	A .054	A .110
	C –.032	C .075
	T .127	T .084
Dysthymia	A .295	A –.126
	C –.137	C .0698
	T .106	T .031
Total WURS score	A .141	A .073
	C –.057	C .064
	T .158	T .064
Big-Five		
Extraversion	A –.484*	A .045
	C –.083	C .055
	T –.223*	T .049
Conscientiousness	A –.124	A .056
	C –.044	C .026
	T –.166	T .022
Agreeableness	A .148	A –.289
	C .271*	C –.231*
	T .148	T –.242*
Neuroticism	A .464*	A –.144
	C .221	C –.100
	T .313**	T –.093
Open to Experience	A .090	A .279
	C .166	C –.120
	T .147	T –.032
Sensation seeking SSSV	A –.485*	A .073
	C –.214	C .184
	T –.264**	T .160
OCD Symptoms OCD-MOCI	A .296	A .261
	C .142	C .060
	T .247*	T .110

Note: WURS = Wender Utah Rating Scale; ACC = accuracy; RT = reaction time; SSSV = Sensation Seeking Scale Form V; OCD = obsessive compulsive disorder; MOCI = Maudsley Obsessive Compulsive Inventory; ODD = opposite defiant disorder; A = ADHD (N = 22), C = control (N = 84), T = total sample (N = 106).
*p < .05. **p < .01.

16 to 32 distractor displays compared to the control group (p = .1 and p = .17, respectively).

Accuracy level in general was high (Figure 1B). The repeated-measure ANCOVA of accuracy, as a function of the interaction between display size and group (ADHD vs. control), revealed a significant main effect of display size: $F(2, 309) = 8.499$, $p < .001$, $\eta^2 = .149$. Post hoc comparisons showed only significantly lower accuracy levels in the 32 distractor displays compared to 8- and 16-distractor displays (p < .01). However, there was no main effect of differences arising out of the interaction between ADHD and control group, and there was no interaction between groups and display size ($F < 1$).

Correlations between the search task, ADHD behaviors, and personality. For representation of performance in the selective attention task, the combined slope measure was used. This measure, as mentioned, describes the combined performance of mean RT/ACC as a function of set size. Error rates were minimal (or accuracy was high), so only the error rates of the 32 distractors—greatest density display—for basic reliability were used.

Pearson's correlations matrix for ADHD, control, and overall sample, between the combined slope and error rates of the 32-distractor display and the WURS ADHD, Big Five, sensation seeking, and OCD scores are shown in Table 2.

As we can see, the combined slope did not correlate significantly with ADHD inattention symptoms, ODD, and dysthymia, or with the WURS ADHD total scores. However, significant correlations were found between poorer search performance as measured by the search slope and higher neuroticism, lower extraversion (or higher introversion), and lower sensation-seeking scores in the ADHD group and overall sample. And finally, poorer search performance was correlated with higher OCD symptoms in the overall sample.

The 32-distractor error-rate measure did not correlate with most of the personality and behavioral scores of this study.

Looking at ADHD and control groups in Table 2 overall, the same patterns of correlation are seen with nonsignificant differences between the groups. The only meaningful difference between the ADHD and control groups seems to be greater than overall correlations between the search slope and personality and behavioral measures in the ADHD group compared to the control group. This impression of difference between the groups may relate to greater range and variability for all of the personality traits, behaviors, and cognitive measures in the ADHD compared to control group.

Multiple-regression analysis. To overcome the interrelationship between the measures (e.g., neuroticism was related with both ADHD and search performance) and validate the behavior and personality profile of selective attention, a multiple-regression analysis was conducted. All the behaviors and personality traits, including age, gender, university experience, and group (as a dummy code variable), predicted the search combined slope measure.

As shown in Table 3, there is a clear behavioral and personality profile and pattern to search performance. Greater neuroticism, agreeableness, and introversion (low extraversion) and lower sensation seeking significantly predicted poorer search performance as measured by the combined search slope. Only the interaction between neuroticism

Table 3. Multiple Regression Results for the Search Combined Slope Measure[a]

	R^2	F	b	SE	β	t	Sig.
Model 1	.394	$F(12, 93) = 5.15$ $p < .001$					
Age			1.024	0.635	.156	1.613	ns
Gender			−0.609	1.237	−.048	−0.492	ns
University experience			−0.138	1.8	−.163	−0.77	ns
Group (ADHD vs. control)			7.02	4.1	.407	1.69	<.1
ADHD WURS			−1.060	0.839	−.166	−1.264	ns
Extraversion			−1.146	0.576	−.179	−1.856	<.05
Conscientiousness			−0.361	0.706	−.056	−.511	ns
Agreeableness			2.184	0.612	.341	3.570	<.001
Neuroticism			2.500	0.680	.394	3.678	<.001
Open to experience			0.701	0.553	.112	1.135	ns
OCD			0.717	0.636	.113	1.128	ns
Sensation seeking			−1.306	0.626	−.205	−2.086	<.05
Model 2	.425	$F(13, 92) = 5.301$ $p < .001$					
Age			0.838	0.630	.127	1.331	ns
Gender			−0.154	1.234	−.012	−0.125	ns
University experience			−0.776	1.786	−.032	−0.434	ns
Group			1.910	2.199	.111	0.869	ns
ADHD WURS			−1.173	0.825	−.184	−1.422	ns
Extraversion			−0.979	0.571	−.153	−1.713	<.1
Conscientiousness			−0.446	0.694	−.070	−0.643	ns
Agreeableness			2.433	0.612	.380	3.974	<.001
Neuroticism			2.249	0.678	.355	3.319	<.001
Open to experience			0.721	0.533	.103	1.02	ns
OCD			0.496	0.633	.078	0.784	ns
Sensation seeking			−1.165	0.618	−.183	−1.886	<.05
Group*neuroticism			4.274	2.049	.260	2.086	<.05

Note: WURS = Wender Utah Rating Scale; OCD = obsessive compulsive disorder.
a. $N = 106$.

and group (last row, Model 2) showed a significant increment of 3.1% in R^2 change ($F = 4.35$, $p < .05$), implying that neuroticism as a predictor of poorer search performance was elevated in ADHD compared to the comparison control group. However, there was no significant relationship between the WURS ADHD total score and the search slope, which suggests that ADHD behavioral symptoms were not part of this profile.

Discussion

The aim of the present study was to explore the behavioral and personality characteristics associated with difficulties in selective attention. Selective attention was assessed by the conjunctive visual-search task using a rigorous combined RT/ACC slope measure. In contrast to the first study hypothesis, the main results showed that the behavioral symptoms of ADHD or specifically the inattentive symptoms were not significantly related to search performance as measured by the search slope. However, neuroticism, introversion, agreeableness, low sensation seeking, and, marginally, OCD symptoms, were related to poorer search performance and personality traits that are characterized by avoiding and preserving kinds of behaviors. This pattern of results was not essentially different between the ADHD and comparison control groups. Surprisingly, and somewhat different from the correlation results (Table 2), the regression analysis showed that agreeableness was highly related to poorer search performance. It may be a statistically valid but artificial outcome due to a high number of covariates, or alternatively, it could be a true effect. Nevertheless, future studies are needed to resolve this issue.

The results in which ADHD participants were overall slower but did not show considerable differences in their speed and accuracy ability to select a target as a function of set size, compared to controls, is in agreement with previous studies of children that used the same conjunctive visual search-task measure (Hazell et al., 1999; Mason et al., 2003). In addition, the present results are in agreement with less traditional tasks for measuring selective attention in ADHD. Accordingly, nonsignificant differences between children with ADHD and comparison controls were found on the visual discrimination task (Van der Meere & Sergeant, 1988), perceptual load (Huang-Pollock, Nigg, & Carr, 2005), or the attentional blink task (Mason, Humphreys, & Kent, 2005). Moreover, Huang-Pollock and her colleagues

(2005) also did not find selective attention differences between the ADHD inattentive subtype and the ADHD combined subtype.

The present results are also in agreement with adult studies using three visual selective attention tasks (Stroop test and two negative priming tasks). It was found that although the ADHD group was consistently slower to name target stimuli than the control group, there were no differences in interference and negative priming between the two groups (Pritchard, Neumann, & Rucklidge, 2007) or differences between ADHD inattentive and the ADHD combined subtypes (Pritchard, Neumann, & Rucklidge, 2008).

However, the present study results are in contradiction to studies that did show differences between ADHD and controls on the conjunctive visual search (Booth et al., 2005; Mullane & Klein, 2008; Shalev & Tsal, 2003; Tsal et al., 2005). The present results are also in contradiction with those of Brodeur and Pond (2001), which showed that children with ADHD perform worse than controls when exposed to all kind of flanking distractors. This inconsistency could be explained by maturation differences (if we were to compare the present adults-only study to the study that focused exclusively on children), although we suggest that the main result differences possibly lie in the concept and measures used for assessing selective attention. Most of the above studies that did find group differences did not assess the ability to select a target as a function of display size used in the present study. This suggests that the overall speed of response differences were due to mechanisms independent of serial search as was previously suggested (Hazell et al., 1999; Mason et al., 2003).

Nevertheless, and in keeping with the present results, Huang-Pollock and colleagues (2005) emphasized that despite the fact that inattention symptoms are primarily the core definition of ADHD, the literature supports the move away from theories of cognitive selective attention dysfunction as a primary feature of ADHD.

The present results in which neuroticism, introversion, and low sensation seeking were related to poor search performance are in agreement with several early studies. Eysenck and Graydon (1989) found that the performance of neurotic introverts was more adversely affected than that of stable extraverts by distractions resembling task stimuli in a more complex version of a letter-transformation task. Also, high-anxiety participants were found to be more affected by distracting stimuli than low-anxiety participants (Eysenck & Byrne, 1992). Moreover, introverts, compared to extraverts, were more distracted on the complex divided-attention tasks for visual selective attention (Szymura & Nqcka, 1998). In addition, findings showed that low sensation seekers were worse than high sensation seekers on task conditions where selective attention demands were greatest (Ball & Zuckerman, 1992; Hardy et al., 2008; Martin, 1985). Thus, although the procedures of these studies are different from the conjunctive search task, they showed (similar to the current results) that interference by distractors relates to neuroticism, introversion, and low sensation seeking, and personality and behaviors that are characterized by avoiding and preserved kind of behaviors.

The results of the current study seem logical because it is reasonable to expect that difficulties in ignoring distractors in selecting a desirable target may relate to a state of stimulus overloading and high arousal; thus, the preferred behaviors in the external environment would be avoidance of high stimulation and more emotionally preserved behavior. This explanation has some support from Eysenck's (1967) theory suggesting that different levels of internal arousal are related to individual personality differences on the introversion–extraversion–neuroticism continuum. Eysenck (1967, 1992) hypothesized that neurotic introverts tend to be chronically highly aroused at the physiological level (Bullock & Gilliland, 1993). Thus, if a task is less demanding or more monotonous and requires sustained attention only, neurotic introverts perform better than extraverts. However, if a task becomes more demanding or less monotonous and selective or divided attention is required, neurotic introverts are at a disadvantage. In such situations, the overall amount of excitation surpasses their optimal level of arousal.

Accordingly, the present study's results are in agreement with the prediction of the arousal model. As the search task for selective attention contains a large number of stimuli to cope with, neurotic introverts would find it difficult to perform, because the overall amount of excitation easily surpasses their optimal level of arousal. However, it is still unclear what are the exact causes and effects of relationship between attention processes, internal arousal, and personality traits; future studies are needed to resolve this issue.

It is interesting to note that the characteristics such as avoidance of high stimulation and emotionally preserved behavior, which were found to relate to poor search performance, are somewhat different from the common behavioral characteristics associated with ADHD. This is because among ADHD behaviors, alongside the inattention and low organization symptoms, ADHD is associated with external behavioral characteristics such as hyperactivity-impulsivity, ODD, and high sensation seeking (Dinn, Aycicegi, & Harris, 2004; Shaw & Giambra, 1993; Ward et al., 1993). It was suggested that some of the core deficits of ADHD are in arousal and sustained attention (Johnson et al., 2007), and some suggest that people with ADHD seek external stimulation through increased activity and intense sensory experiences to increase their levels of arousal (for a review, see White, 1999). According to Eysenck's theory (1967, 1992), some of the main ADHD behaviors may be comparable to externalized behaviors that are mediated by low levels of arousal. Thus, different internal arousal levels may also explain why ADHD behaviors are different from the personality traits that are characterized by emotionally preserved behaviors, which were found to relate to difficulties in selective attention.

There are a few limitations to this study. The main limitation comes from the relatively small number of 22 participants with ADHD. As a consequence, the statistical power to detect, at the least, moderate correlations in this group were relatively low ($1-\beta > .65$, $p < .05$). However, the statistical power for detecting medium-to-large effect-size differences between ADHD and control samples on behaviors and cognitive search task measures in this study was sufficient ($1-\beta > .85$, $p < .05$). In addition, it is important to note that ADHD participants were mainly used for a sufficient variability on ADHD WURS symptoms, because they represent the higher range of ADHD symptoms in the overall study sample. Accordingly, the power to detect moderate-to-high correlations and regression prediction effects between behavioral and search performance measures in the overall study sample was sufficient ($1-\beta > .85$, $p < .05$).

The second comes from the demographic background of the participants in this study. ADHD participants were older compared to control participants, which could apply for maturation differences. Nevertheless, age was entered as a covariate variable to partially overcome this difference. In addition, the majority of the control group (83%) and half of the ADHD group (50%) were university students. Yet it should be noted that nonessential differences between university students compared to participants without university experience were found in each ADHD and control group. Even so, this variable was entered as a covariate in the regression analysis (see Table 3). Nonetheless, the proportion of student participants in the samples is greater than in the general population, and this may limit generalizability. Finally, intelligence was not assessed in this study for a potential confounder, yet most of the participants were students with at least an average score on a psychometric test (similar to SAT, for university requirements).

In summary, the present results suggest that difficulties in selective attention are probably not a major factor relating to behavioral symptoms of ADHD; rather, difficulties in selective attention probably relate to personally traits that are characterized by avoidance of high stimulation and emotionally preserved kinds of symptomatic behaviors. However, this suggestion should be considered in light of the conjunctive visual-search task used in this study for theoretically measuring selective attention.

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Appendix

The *combined slope* measure = (RT8/ACC8, RT16/ACC16, RT32/ACC32)

=> $(3 \times [8 \times RT8/ACC8 + 16 \times RT16/ACC16 + 32 \times RT32/ACC32] - [8+16+32] \times [RT8/ACC8 + RT16/ACC16 + RT32/ACC32]) / (3 \times [8 \times 8 + 16 \times 16 + 32 \times 32] - [8 + 16 + 32] \times [8 + 16 + 32])$.

Mean RT (msec) is a function of set size B. ACC rate is a function of set size.

Note

1. Mean RT was divided in ACC to eliminate speed of response versus accuracy known as the trade-off effect. In this manner if someone was less accurate, his score was higher, which pointed toward poorer performance.

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