7-2013

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Recommended Citation

Antshel, K. M., Hendricks, K., Shprintzen, R. J., Fremont, W., Higgins, A. M., Faraone, S. V., & Kates, W. R. (2013). The longitudinal course of attention deficit/hyperactivity disorder in velo-cardio-facial syndrome. *The Journal of Pediatrics*, 163(1), 187-193.

Published in final edited form as:
J Pediatr. 2013 July ; 163(1): 187–193.e1. doi:10.1016/j.jpeds.2012.12.026.

The Longitudinal Course of ADHD in Velo-Cardio-Facial Syndrome

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Abstract

Objective—To evaluate predictors of persistence of attention deficit/ hyperactivity disorder (ADHD) in a large sample of children with velo-cardio-facial syndrome (VCFS)VCFS with and without ADHD followed prospectively into adolescence.

Study design—Children with VCFS with (N = 37) and without (N = 35) ADHD who were on average 11 years old at the baseline assessment and 15 years old at the follow-up assessment were comprehensively assessed with structured diagnostic interviews and assessments of behavioral, cognitive, social, school, and family functioning. Control participants both with and without ADHD were also followed prospectively.

Results—In adolescence, 65% of children with VCFS continued to have findings consistent with ADHD. Childhood predictors of persistence were higher rates of familial ADHD, having childhood depression, having higher levels of hyperactivity and a larger number of intrusion errors on a verbal list learning test at baseline. Approximately 15% of children with VCFS who did not have ADHD at Time 1 met diagnostic criteria for ADHD at Time 2. All of these children had subthreshold ADHD symptoms at Time 1.

Conclusions—These findings prospectively confirm that persistence of ADHD into adolescence in VCFS is predicted by childhood variables that have been previously documented in the non-VCFS ADHD literature.

Keywords

velocardiofacial syndrome (VCFS); ADHD; 22q11 deletion

Velo-cardio-facial syndrome (VCFS) is caused by an interstitial deletion from chromosome 22 at the 22q11 band. The most common microdeletion syndrome yet identified in humans, VCFS has a reported population prevalence ranging from approximately 1:2000 to 1:6000 (1, 2). In most cases, VCFS is caused by a hemizygous deletion of 3 million base pairs of DNA encompassing 40 genes but approximately 8% have smaller nested deletions of 1.5 million base pairs spanning 34 genes (3). Structural anomalies affect nearly every system of

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The other authors declare no conflicts of interest.

the body and may include congenital heart disease, palatal anomalies, thymic hypoplasia, and endocrine disorders (1).

Attention deficit hyperactivity disorder (ADHD) is one of the most common comorbid disorders associated with VCFS. Approximately 30 – 40 % of individuals with VCFS have an ADHD diagnosis (5, 6). The research examining idiopathic ADHD longitudinally has found that the majority of children diagnosed with ADHD will retain their ADHD diagnosis into late adolescence or adulthood (8, 10, 11). There is little research examining the longitudinal trajectory of ADHD in VCFS. The goal of the present study is to predict which children with VCFS and ADHD are most likely to retain their ADHD status into adolescence.

Similar to the idiopathic ADHD population (14–16), there appears to be a genetic link to ADHD in individuals with VCFS (17). Individuals with VCFS and ADHD had a greater number of first-degree relatives with ADHD(17). However, the utility of having relatives with ADHD in predicting to syndromal persistence of ADHD has not yet been studied in the VCFS population.

The following hypotheses were explored: (1) the majority of children with VCFS and ADHD will maintain their ADHD status as adolescents; and (2) childhood ADHD severity, having relatives with ADHD, and the number of comorbid disorders will be the strongest predictors of ADHD persistence.

Methods

Participants were enrolled in a longitudinal study of risk factors for psychosis in VCFS. At time 1, 80 youth with VCFS (Mean age = 11.9 years, SD = 2.2) and an age- and sex-matched group of 40 non-VCFS youth (community control; Mean age = 12.0 years, SD = 1.9) participated. No age differences existed between the groups at Time 1, $F(1, 118) = 0.21$, $p = .804$, $\eta^2 = .01$.

Children with VCFS were recruited from the Velo-Cardio-Facial Syndrome International Center at the State University of New York Upstate Medical University. Only children with a FISH-confirmed deletion of 22q11.2 were included in the sample. Our control participants were recruited from local public schools. The present longitudinal study is a study of the risk factors for psychosis. ADHD, to our knowledge, does not increase the risk for psychosis. Thus, we included control participants with ADHD to increase our comparability with VCFS (who have a high prevalence of ADHD).

At Time 2, 72 youth with VCFS (Mean age = 15.0 years, SD = 2.1) and 23 community controls (Mean age = 14.7 years, SD = 1.4) were included in the analyses. No age, $F(1, 93) = 0.36$, $p = .687$, $\eta^2 = .01$, or sex differences, χ^2 (df = 1) = 0.87, $p = .621$, existed between the groups at Time 2.

An independent samples t-test found no differences in attrition between our two groups, $t(1) = 3.44$, $p = .222$. Furthermore, participants lost to follow-up did not differ from those retained on any relevant Time 1 sociodemographic measures including participant age, sex, and socioeconomic status. In addition, participants lost to follow-up did not differ from those retained on any relevant Time 1 psychiatric or cognitive variables. Thus, those participants who completed Time 2 assessments appear representative of the Time 1 sample. The family moving to a different residence was the most common reason participants were lost to follow-up.

At Time 1, 44% of the control participants with ADHD were prescribed a stimulant medication and 32% of the VCFS participants with ADHD were prescribed a stimulant. There were no statistical differences between the groups in terms of stimulant prescriptions, F (1,51) = 2.03, $p = 341$. At follow-up, 78% of the control participants with ADHD were receiving stimulant medication. Significantly fewer of the VCFS participants with ADHD (38%) were receiving stimulant medication, F (1.51) = 26.43, $p < .001$.

At Time 1, in both groups with ADHD, no other medications besides stimulant medications were prescribed to participants. At Time 2, in the control group with ADHD, no medications besides stimulants were prescribed. At Time 2, in the VCFS group with ADHD, atypical antipsychotics (risperidone, aripiprazole; $n = 6$) and alpha-2 agonists (clonidine, guanfacine; $n = 4$) were prescribed.

At Time 1, of the 37 children with VCFS+ADHD, roughly half ($n = 19$) met criteria for ADHD-Combined type and the remaining ($n = 18$) met criteria for the Inattentive subtype. Among the 16 control participants with ADHD, the majority ($n = 12$) met criteria for ADHD-Combined type and the remaining met criteria for ADHD-Inattentive type ($n = 4$). Differences emerged between groups at Time 1 in terms of ADHD subtype prevalence rates, $\chi 2 = 5.32$, $df = 1$, $p = .009$. Unlike Time 1, there were no differences between groups at Time 2 in terms of ADHD subtype prevalence rates. At Time 2, 59% ($n = 22$) of VCFS participants with ADHD met criteria for the Inattentive subtype and 69% of the control participants with ADHD met criteria for the Inattentive subtype.

Participants were assessed at two time points, with approximately three years between time points. At Time 2, all involved research personnel were blinded to Time 1 findings. Informed consent/assent was obtained from parents and children under protocols approved by the institutional review board.

Each child enrolled in the study was administered a neuropsychological test battery that included tests of all major domains of cognition. Psychological testing was followed by a structured psychiatric interview, administered by a clinical psychologist or a board-certified child psychiatrist. Parents completed behavioral rating inventories and completed forms assessing functional parameters.

Our choice of cognitive measures was influenced by the schizophrenia literature and was selected based upon sensitivity to prodromal psychosis (18–31). Most of the psychological tests, however, are also sensitive to an ADHD diagnosis (32) and are commonly employed in longitudinal ADHD research (33–35).

Measures of general intellectual functioning were the Wechsler Intelligence Scale for Children —Third edition (WISC-III) (36) or Wechsler Adult Intelligence Scale – Third edition (WAIS-III) (37). The WISC-III was administered to all participants at Time 1, and to participants at or under the age of 16 years, 11 months at Time 2. The WAIS-III was administered to all participants over the age of 16–11 at Time 2.

Academic achievement was assessed using the Wechsler Individual Achievement Test-Second edition (WIAT-II) (38). Attention was assessed using the Gordon Diagnostic System - Continuous Performance Test (CPT) (39). Executive functioning was assessed with the Wisconsin Card Sorting Test (WCST) (40) and Tower of London (TOL). Learning and memory was assessed with the California Verbal Learning Test-Children's version (CVLT-C) (41) and the Visual Span Test (42). All psychological test scores were converted to standard scores or z-scores using published norms. Furthermore, all psychological tests utilized in the current study are commonly employed tests which have adequate psychometric properties (for complete details, see (43)).

The Schedule for Affective Disorders and Schizophrenia for School-Age Children-Present and Lifetime Version (K-SADS-PL) (44) was utilized to make DSM-IV (45) psychiatric diagnoses. The child's primary caregiver (almost always his/her mother) was interviewed with the K-SADS-PL. Every attempt was made to interview the child, but in many cases the child had difficulty responding, often due to difficulties comprehending the questions; in these cases, the K-SADS-PL data was based on the parent's response. A child and adolescent psychiatrist or clinical child psychologist administered the KSADS assessment. Inter-rater reliability, which was calculated for 10 interviews, and assessed with the Kappa coefficient, was .91.

The Premorbid Adjustment Scale (PAS) (46) evaluates the achievement of developmental goals from childhood into adulthood in persons who eventually develop schizophrenia. Although the scale was originally designed as a retrospective instrument to assess premorbid functioning up to six months prior to a psychiatric hospitalization, we used the scale prospectively, rating each participant on the items corresponding to his or her current age. The scale focuses on five areas of functioning: social accessibility-isolation; peer relationships; school functioning; ability to function outside the nuclear family; and the capacity to form intimate socio-sexual ties. Ratings for each item were anchored to descriptive phrases, ranging from 0 (representing "healthiest" functioning) to 6 (representing most impaired functioning). Inter-rater reliability, for ten participants between two doctoral level raters, calculated using an intraclass correlation coefficient of item ratings, ranged from .85 to .90.

The Behavior Assessment Scale for Children (BASC) – Parent report version (47) was administered to provide a continuous measure of adaptive and problem behaviors. Each of the 130 items of the child version of the BASC is rated on a 4-point frequency scale, ranging from *never* to *almost always*.

Family Interview for Genetic Studies (FIGS) (48) is a semi-structured interview designed for psychiatric genetic studies. It screens for diagnostic information about the relatives of study probands. The interview probes for the history and presence of depression, bipolar disorder, substance abuse, schizophrenia, and personality disorders in first- and second-degree relatives. The interview is open-ended, allowing the interviewer to probe for additional disorders such as anxiety and ADHD. Respondents for this study were limited to the parent(s) (and grandparents, if present) that brought the child for the assessments.

Data Analyses

McNemar non-parametric tests for related samples were computed to compare KSADS diagnostic consistency across time. Separate tests were computed for each sample. Repeated-measures multivariate analyses of covariance (MANCOVA) models, with diagnostic group as the main effect, Time 1 variables as the covariate, and psychological test scores or behavioral variables and time as repeated factors were computed. Group and time effects and group-by-time interaction were examined. Finally, to predict ADHD status at Time 2, all Time 1 demographic, cognitive, behavioral and psychiatric variables were entered into a logistic regression using ADHD status (Yes/No) as the outcome variable. Separate tests were computed for both samples.

Results

Control participants both with (n = 16) and without ADHD (n = 7) had a lower socioeconomic status than VCFS participants with (n = 37) and without ADHD (n = 35; Table I). No differences emerged in socioeconomic status as a function of ADHD status.

Sex differences approached significance, χ^2 (3) = 2.40, p = .087; in all groups except the VCFS group, males were more prevalent.

No controls gained an ADHD diagnosis (p = .094), 7 of 16 control participants who had a Time 1 ADHD diagnosis did not have a Time 2 ADHD diagnosis (Table I). In the VCFS sample, 13 of the 37 participants who had a Time 1 ADHD diagnosis did not have a Time 2 ADHD diagnosis (p = .096). Control participants were more likely to lose their ADHD diagnosis relative to VCFS participants (44% vs. 35%, p = .046). Likewise, unlike the control sample, 5 youth with VCFS had a Time 2 ADHD diagnosis yet not a Time 1 ADHD diagnosis. Thus, more participants with VCFS than control participants gained an ADHD diagnosis (p < .001).

Parent ratings of hyperactivity increase as a function of age in the VCFS + ADHD sample relative to the other three samples, F(3, 92) = 22.65, p < .001 (Figure). Conversely, parent ratings of inattention do not change as a function of time, F(3, 92) = 2.03, p =.234. At follow-up, 78% of the control participants with ADHD were receiving stimulant medication. Less of the VCFS participants with ADHD (38%) were receiving stimulant medication, F (1.51) = 26.43, p < .001.

Both ADHD groups were more likely to have comorbid oppositional defiant disorder (ODD) diagnoses, p < .001 (Table I). Both VCFS groups (VCFS, VCFS+ADHD) were more likely to have comorbid anxiety and mood disorders relative to controls with and without ADHD, p < .001. Finally, a higher percentage of the participants with VCFS and ADHD (27.0%) and controls with ADHD (37.5%) had a first degree relative with ADHD than both non-ADHD groups, p < .001.

After controlling for Time 1 variables, no significant differences emerged over time on any PAS or BASC Adaptive Behavioral variables. Although differences exist between the groups at Time 2, after controlling for Time 1 differences, no time X group interactions emerged.

Several behavioral differences existed between groups at Time 1 on BASC Parent Report (Table II; available at www.jpeds.com). Across all BASC domains, the two ADHD groups (with and without VCFS) were rated by parents as having more behavioral symptoms; only the BASC Attention scales, however, reached “clinical importance.” Several cognitive differences existed between the two VCFS groups on Time 1 psychological test performance (Table III). However, only one Time 1 BASC Parent variable predicted Time 2 ADHD status (Table IV). In addition to BASC Hyperactivity, other Time 1 variables which significantly predict ADHD status in the VCFS cohort include CVLT-C Intrusions, CVLT-C List B performance, a Time 1 major depressive disorder diagnosis and having a first degree family relative with ADHD. Of those variables, having a first degree family relative with ADHD was the strongest predictor.

In the control sample, Time 1 CPT errors of commission predicted Time 2 ADHD status. Similar to the VCFS sample, Time 1 parent report of hyperactivity and having first degree relatives with ADHD were predictive of maintaining ADHD status at Time 2. In addition, and unlike the VCFS sample, parent report of attention problems was predictive of Time 2 ADHD status.

Discussion

Our data suggest that the longitudinal persistence of ADHD in VCFS is comparable with the longitudinal trajectory of ADHD in the non-VCFS population. Also consistent with the non-VCFS ADHD literature (50–53), youth with VCFS and comorbid ADHD had significantly

increased prevalence of oppositional defiant disorder relative to adolescents with VCFS yet without ADHD. However, unlike the idiopathic ADHD literature (11, 51–53), mood and anxiety disorders were not more prevalent in the VCFS + ADHD cohort relative to the VCFS cohort. This suggests that VCFS, not ADHD, may be driving the increased prevalence of anxiety and mood disorders in VCFS.

An interesting finding is the increase in parent report of hyperactivity / impulsivity in the VCFS+ADHD cohort. This is the opposite of what is typically reported in the idiopathic ADHD literature (49) where inattention is more enduring. Our finding of increased hyperactivity / impulsivity in the VCFS+ADHD cohort may be a function of the relatively low rates of stimulant treatment in this group. Stimulants lessen hyperactivity / impulsivity symptoms in both the idiopathic ADHD (54) as well as the VCFS+ADHD population (55). Although this has not been tested empirically, it may be that concerns regarding possible manic or psychotic symptoms as a function of stimulant treatment are responsible for the lower stimulant treatment rates in our VCFS + ADHD sample.

Similar to the idiopathic ADHD literature (56–59), genetics appear to play a role in the etiology of those with VCFS who continue to demonstrate clinically significant ADHD across time. If not already doing so, clinicians who assess / treat children with VCFS + ADHD should inquire about first-degree relatives with ADHD.

Childhood hyperactivity appears to be a better predictor of which children with VCFS + ADHD will continue to have ADHD as adolescents. This is in contrast to our control ADHD sample in which both hyperactivity and inattention levels during childhood predicted syndromal ADHD persistence. The low predictive power of inattentive behaviors in the VCFS sample may be a function of the general cognitive delays inherent in this population. Inattentive behaviors are considered relatively common in individuals with lowered general intellectual functioning (60–62).

A MDD diagnosis in childhood also appears to predict the stability of ADHD across time in the VCFS population. This finding, although not present in our control ADHD sample, is consistent with some extant ADHD data (63) and suggests that MDD in the context of ADHD may be predictive power for what is to come in adolescence.

The CVLT-C appears to be the best psychological test for predicting persistence of ADHD in the VCFS population. Having higher levels of errors of intrusions (recalling items that were not on the list) and lower performance on List B (the interference trial) both predicted which children with VCFS + ADHD would become adolescents with VCFS + ADHD. To our knowledge, the CVLT-C has not been used longitudinally in the idiopathic ADHD literature.

Our results must be interpreted in the context of methodological limitations. Our control sample was small. Second, ADHD is a difficult diagnosis to make in the context of intellectual delays (64). Third, because we did not manipulate treatment as an independent variable, we cannot use our data to describe the impact that the relative absence of treatment has on ADHD stability. Fourth, we relied exclusively on parent report of school functioning rather than querying the teachers directly.

These findings confirm that persistence of ADHD into adolescence in VCFS is predictable by childhood variables that are also predictive in the non-VCFS ADHD population.

Acknowledgments

Funded by the National Institute of Mental Health (MH64824 and MH65481 to W. K.). S. F. has received consulting fees and served on advisory boards for several pharmaceutical companies.

Abbreviations

VCFS	velo-cardio-facial syndrome
ADHD	attention deficit / hyperactivity disorder
MDD	major depressive disorder

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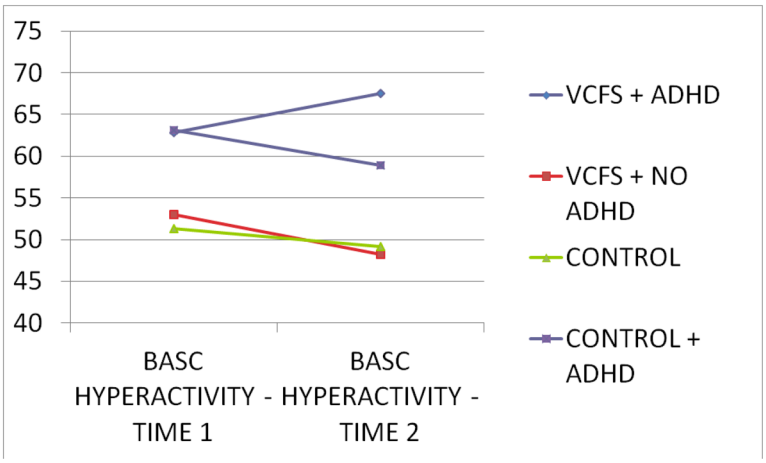

Figure 1.
BASC Parent T-Scores at Times 1 and 2

Table 1

Characteristics of Adolescents with and without ADHD at Time 2 (3-year Follow-Up)

	Time 1 ADHD Status			
	VCFS	**VCFS+ADHD**	**Control**	**Control+ADHD**
N	35	37	7	16
Age	15.2 (2.0)	14.9 (1.8)	14.7 (1.4)	14.8 (1.9)
Sex (% male)	40	62	72	56
Hollingshead SES	49.2 (12.2)	48.3 (12.2)	43.1 (14.7) *c d **	44.3 (13.0) *c,d**
Number continuing to have ADHD at Time 2 (%)	5 (14.3) *a**	24 (64.9) *a b c ****	0 (0) *b c d ****	9 (56.3) *a b d****
Treated with Stimulant (%)	0 *b d****	38 *a b c****	0 *b d****	78 *a b d****
Comorbid ODD (%)	11.4 *a**	24.3 *a c****	0 *b c d ****	25 *a c****
Comorbid Anxiety disorder (%)	51.4 *a b ****	54.0 *a b****	0 *b c d ****	18.8 *a cd****
Comorbid Mood disorder (%)	62.9 *a b ****	64.9 *a b ****	0 *b c d ****	6.3 *a cd****
Relatives with ADHD (%)	3.7 *b d****	27.0 *a c****	0 *b c d ****	37.5 *a c****

Note. VCFS = Velocardiofacial syndrome (VCFS). ADHD = Attention deficit hyperactivity disorder. ODD = Oppositional Defiant Disorder. For pairwise comparisons:

a vs. Controls;

b vs. Controls + ADHD;

c vs. VCFS;

d vs. VCFS + ADHD

* $p \leq 0.05$;

** $p \leq 0.01$;

*** $p \leq 0.001$.

Table 2

Parent BASC T-Scores by Diagnosis and ADHD at Time 1

	VCFS + ADHD (N=37)	VCFS + No ADHD (N=35)	Control + ADHD (N=16)	Control + No ADHD (N=7)
	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD
Hyperactivity	63.0 ± 17.0	53.1 ± 9.0	62.9 ± 14.7	52.0 ± 8.6
Aggression	52.4 ± 10.9	48.1 ± 9.4	52.9 ± 8.7	47.4 ± 7.3
Conduct Problems	52.3 ± 9.2	48.5 ± 7.7	53.1 ± 8.5	46.2 ± 8.5
Anxiety	58.0 ± 13.2	56.7 ± 12.8	56.1 ± 10.9	46.5 ± 9.5
Depression	60.5 ± 13.1	53.4 ± 12.4	51.4 ± 8.0	48.0 ± 12.3
Somatization	60.2 ± 18.5	58.0 ± 10.8	52.0 ± 10.0	48.2 ± 9.9
Atypicality	60.1 ± 18.1	52.1 ± 12.1	55.8 ± 12.7	49.6 ± 9.9
Withdrawal	63.8 ± 14.8	62.0 ± 17.2	55.8 ± 12.7	52.2 ± 17.0
Attention	69.2 ± 18.7	62.8 ± 9.9	66.1 ± 10.6	55.8 ± 9.3
Social Skills	39.5 ± 7.9	41.1 ± 9.1	46.0 ± 11.4	45.3 ± 10.0
Leadership Skills	34.8 ± 6.9	38.1 ± 8.9	42.0 ± 5.1	44.7 ± 9.7
Externalizing Composite	58.6 ± 11.9	48.6 ± 8.5	55.9 ± 9.0	47.1 ± 7.1
Internalizing Composite	61.4 ± 13.8	57.1 ± 11.6	54.3 ± 8.8	47.1 ± 10.8
Behavioral Symptom Index	65.3 ± 14.6	55.3 ± 10.9	59.0 ± 9.2	49.2 ± 9.3
Adaptive Skills Index	36.0 ± 7.4	38.7 ± 9.2	43.4 ± 8.8	44.2 ± 10.0

Table 3

Time 1 Psychological Test Standard Scores

Psychological Test	VCFS	VCFS+ADHD	Control	Control+ADHD	Main Effects
		WISC-III			
Full Scale IQ	70.4 (13.9) ***	71.8 (13.3) ***	95.1 (14.2)	93.8 (14.8)	C, CA > VCFS, VCFSA
Verbal IQ	72.4 (15.2) ***	75.5 (13.2) ***	95.3 (13.7)	91.1 (12.8)	C, CA > VCFS, VCFSA
Performance IQ	71.2 (11.8) ***	70.8 (14.9) ***	96.3 (13.9)	97.7 (14.7)	C, CA > VCFS, VCFSA
FD IQ	80.4 (14.6) ***	80.4 (12.6) ***	96.0 (14.9)	94.0 (17.0)	C, CA > VCFS, VCFSA
Processing Speed IQ	85.6 (16.9) ***	81.5 (15.4) ***	99.8 (16.3)	94.2 (13.9)	C, CA > VCFS, VCFSA
		WIAT-II			
Reading	78.2 (16.3) ***	77.5 (13.3) ***	98.6 (11.2)	94.6 (14.3)	C, CA > VCFS, VCFSA
Math	71.3 (18.4) ***	71.6 (13.6) ***	95.7 (14.5)	93.4 (12.8)	C, CA > VCFS, VCFSA
Written Expression	73.2 (16.3) ***	74.7 (14.2) ***	94.8 (11.3)	94.0 (13.3)	C, CA > VCFS, VCFSA
		CVLT-C			
List A Total T-Score	38.4 (11.7) **	35.6 (12.4) ***	45.7 (12.2)	41.5 (13.5)	C, CA > VCFS, VCFSA
List A Trial 1	− 0.7 (1.0) **	− 0.9 (0.7) **	− 0.2 (0.7)	− 0.6 (0.7) *	C > CA, VCFS, VCFSA
List A Trial 5	− 0.9 (1.3) **	− 1.1 (1.0) ***	− 0.3 (1.2)	− 0.8 (0.6) **	C > CA, VCFS, VCFSA
List B	− 0.7 (1.0) **	− 1.6 (1.2) ***	− 0.4 (0.6) *	0.0 (0.9)	C > CA, VCFS > VCFSA
List A Short Delay	− 0.8 (0.8) ***	− 1.2 (0.8) ***	− 0.2 (0.8)	− 0.2 (0.5)	C, CA > VCFS, VCFSA
List A Long Delay	− 0.8 (0.9) ***	− 1.3 (0.9) ***	− 0.1 (0.8)	− 0.2 (0.9)	C, CA > VCFS, VCFSA
Total Intrusions	0.0 (0.8)	1.7 (0.8) ***	0.2 (0.5)	1.1 (0.8) ***	VCFS, C > VCFSA, CA
Total Perseverations	− 0.2 (0.7)	− 0.2 (0.6)	− 0.2 (0.3)	− 0.1 (0.4)	----- -----
		Visual Span			
Forward Z-Score	− 0.7 (0.6)	− 0.9 (0.6)	− 0.4 (0.7)	− 0.7 (0.4)	----- -----
Backward Z-Score	− 1.2 (0.9) **	− 1.4 (0.6) **	− 0.7 (1.0)	− 0.7 (0.4)	C, CA > VCFS, VCFSA
		CPT – GDS Vigilance Task			
Omission Z-Score	− 1.1 (1.5) ***	− 1.4 (1.0) ***	− 0.1 (0.8)	− 0.6 (0.9) *	C > CA > VCFS, VCFSA
Commission Z-Score	− 1.1 (0.9) **	− 3.0 (0.9) ***	− 0.1 (0.9)	− 2.4 (0.5) ***	C > VCFS > CA, VCFSA

Psychological Test	VCFS	VCFS+ADHD	Control	Control+ADHD	Main Effects
			WCST		
Perseverative Errors	73.7 (18.3) ***	68.7 (20.1) ***	91.3 (16.4)	84.5 (13.3)	C, CA > VCFS, VCFSA
Nonperseverative Errors	86.6 (18.0) **	81.0 (11.7) ***	94.3 (18.2)	87.4 (14.4) **	C > VCFS, CA > VCFSA
			Tower of London		
Total Moves Z-Score	− 0.4 (0.4) ***	− 0.4 (0.8) ***	0.7 (0.5)	− 0.5 (0.8) ***	C > CA, VCFS, VCFSA

Note. C = Control group. CA = Control group with ADHD. VCFS = Velocardiofacial syndrome. VCFSA = VCFS + ADHD. WISC-III = Wechsler Intelligence Scale for Children – 3rd edition (Wechsler, 1991). FD = Freedom from Distractibility. WIAT-II = Wechsler Individual Achievement Test-Third edition. CVLT = California Verbal Learning Test – Children's version (CVLT-C). GDS-CPT = Gordon Diagnostic System - Continuous Performance Test (CPT). WCST = Wisconsin Card Sorting Test. IQ = Intellectual Quotient.

* p < .05;

** p < .01;

*** *p* < .001.

Table 4

Significant Results from Logistic Regression Predicting Time 2 ADHD status in VCFS and Control Participants from Time 1 Variables

VCFS

Time 1 Variable	β	*p*
Psychological Tests		
CVLT-C Total Intrusions Standard Score	.486	.036
CVLT-C List B Standard Score	.468	.041
Behavioral / Psychiatric		
BASC Parent Hyperactivity T-score	.103	.050
MDD diagnosis	.163	.042
First Degree Relative with ADHD	.523	.010

Control

Time 1 Variable	β	*p*
Psychological Tests		
CPT Errors of Commission Z-score	.442	.002
Behavioral / Psychiatric		
BASC Parent Hyperactivity T-score	.230	.034
BASC Parent Attention Problems T-score	.321	.024
First Degree Relative with ADHD	.445	.017

Note. CVLT-C = California Verbal Learning Test-Children's version. BASC = Behavioral Assessment Scales for Children. CPT = Continuous Performance Test. MDD = Major Depressive Disorder.