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Comparison of the Cognitive Disengagement and Hypoactivity Components of Sluggish Cognitive Tempo in Autism, ADHD, and Population-Based Samples of Children

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Abstract

An international Sluggish Cognitive Tempo (SCT) Work Group proposed a new term for SCT, "cognitive disengagement syndrome," that more accurately describes the syndrome than does SCT. According to the Work Group, symptoms of SCT represent a cognitive dimension (cognitive disengagement) and a motor dimension (hypoactivity). Our study determined (1) if distinct factors representing cognitive disengagement and hypoactivity emerged when SCT items were factor analyzed and (2) the degree of differences in cognitive disengagement and hypoactivity within diagnostic groups. Mothers rated 1,177 children with autism, 725 with ADHD-Combined, and 307 with ADHD-Inattentive (4–17 years) and 665 elementary school children (6–12 years) on the Pediatric Behavior Scale (PBS). SCT prevalence rates were autism 32%, ADHD-Inattentive 27%, ADHD-Combined 18%, and elementary school students 7%. Factor analysis of the SCT items yielded two factors reflecting cognitive disengagement (in a fog/confused and stares/preoccupied/in own world) and hypoactivity (sluggish/slow moving/low energy, drowsy/sleepy/not alert, and tires easily) in all diagnostic groups. Cognitive disengagement prevalence rates and scores were significantly higher than hypoactivity in the autism and ADHD-C groups and in the autism and ADHD-C subgroups of children with SCT (but not in the ADHD-I and elementary school total groups and SCT subgroups). Our findings factor analyzing five SCT items support two SCT subfactors: cognitive disengagement and hypoactivity.

Keywords Sluggish cognitive tempo · Cognitive disengagement · ADHD · Autism · Elementary school students

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An international Sluggish Cognitive Tempo (SCT) Work Group (Becker et al., in press) has proposed "cognitive disengagement syndrome" (CDS) as a new term for SCT that more accurately describes this syndrome than does the term SCT. Symptoms of SCT represent both a cognitive dimension (e.g., spacey, blank staring, daydreaming, in own world, in a fog, and confused) and a motor dimension (hypoactive, slow moving, lethargic, and drowsy) (Becker et al., in press). This constellation of cognitive and motor symptoms is consistent across clinical and community samples in factor analytic studies, has strong convergent and divergent validity, and is statistically related to but distinct from other symptom constellations, such as attention deficit hyperactivity disorder (ADHD)-Inattentive symptoms and other psychopathologies (Becker et al., 2016; Dvorsky et al., 2019; Hartman et al., 2004; Lee et al., 2014; Mayes et al., 2020, 2021a; Mayes, Waschbusch, Fernandez-Mendoza, & Calhoun, 2021b; Penny et al., 2009; Saez, Servera, Becker, & Burns, 2019; Willcutt et al., 2014).

The term SCT was criticized quite some time ago (Barkley, 2014) and again recently (Waschbusch, 2021) because of lack of empirical evidence that SCT results from a cognitive tempo deficit (e.g., slow processing speed) and because the term may be pejorative and offensive (e.g., possibly implying that the individual has low intelligence or is slow witted). Results of a

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recent qualitative study (Becker et al., 2022) found that about one-half of parents of children with SCT had a negative reaction to the term "sluggish cognitive tempo." A common reason for their negative reaction was that SCT inaccurately implies (to some) laziness or low intelligence. Likewise, SCT may be a misnomer in that studies show a very weak significant or nonsignificant association between SCT and slow performance and processing speed, despite what the term implies (Bauermeister et al., 2012; Baytunca et al., 2018; Callan et al., 2020; Creque & Willcutt, 2021; Jacobson et al., 2018; Kofler et al., 2019; Mayes et al., 2021c, in press; Reinvall et al., 2017; Tamm et al., 2018; Willard et al., 2013; Willcutt et al., 2014; Wood et al., 2017; for a review, see Barkley, Jacobson, & Willcutt, 2022). Slower reaction time, another possibly presumed correlate of SCT, was weakly but significantly correlated with SCT in one study (Camprodon-Rosanas et al., 2020) but not in three other studies (Baytunca et al., 2018; Creque & Willcutt, 2021; Skirbeck, Hansen, Oerbeck, & Kristensen, 2011).

Aside from the apparent inaccuracy of the term SCT, the SCT Work Group (Becker et al., in press) determined that cognitive disengagement syndrome (CDS) was a better term than SCT using the following criteria: the new term (1) broadly describes the constellation of symptoms, is observable, is indicative of impairment when present at clinically significant levels, and has face validity for the general public and (2) does not seem perjorative, does not overlap with existing terminology or imply it is an official established disorder, and does not over-pathologize typical behaviors. CDS includes two domains: cognitive disengagement and hypoactivity. Cognitive disengagement is a broad term that encompasses a number of behaviors related to daydreaming (e.g., daydreams, gets lost in thoughts, appears lost in a fog, stares blankly) and mental confusion (e.g., loses train of thought, forgets what was going to say, easily confused). The hypoactivity dimension is more focused on slow motor behavior (e.g., low activity level, easily tired, drowsy/sleepy during the day) (Becker et al., in press).

Research to date has not specifically examined if SCT symptoms are represented by distinct cognitive and motor dimensions (as the SCT Work Group maintains) and if SCT subdimensions are consistent across clinical and community groups, which are the primary goals of our study. Factor analytic studies of the components of SCT items are few. In one study (Penny et al., 2009), factor analysis of 14 SCT items rated by parents of 335 elementary school children yielded three subfactors (slow, sleepy, daydreamer) with sizable cross-loading, whereas teacher ratings suggested a unitary SCT factor with some support for two subfactors (sleepy/daydreamer, slow). Another study with 131 children with ADHD found support for separate SCT factors representing inconsistent alertness (i.e., cognitive disengagement) and slowness (i.e., hypoactivity) (Fenollar Cortés et al., 2017). Factor analysis of teacher ratings of 15 SCT items for 7,613 elementary school students (Becker et al., 2020) was most supportive of a unitary SCT factor, with some support for three subfactors (daydreaming, mental confusion, and underarousal). Similarly, parent and teacher ratings of 15 SCT items in 165 children with ADHD-Inattentive presentation yielded three subfactors representing daydreaming, mental confusion, and sleepy/low energy (McBurnett et al., 2014). Arguably, subfactors identified in these studies can be construed under the headings of cognitive disengagement and hypoactivity. Our study aims to either support or refute this supposition, as well as to determine if differences in factor structures are found between diagnostic groups, which has not previously been investigated.

Purpose

The purposes of our study were (1) to determine if two dimensions (cognitive disengagement and hypoactivity) were found when SCT items were factor analyzed in general population and clinical samples and (2) to examine correlations between cognitive disengagement and hypoactivity scores and differences in the prevalence and severity of cognitive disengagement and hypoactivity symptoms within four groups of children (autism, ADHD-Combined, ADHD-Inattentive, and a population-based elementary school sample). Studies examining SCT in autism and ADHD samples are important because SCT is very common in these children, with estimates ranging from 30%-49% for autism (Brewe et al., 2020; Duncan et al., 2019; Mayes et al., 2020; Reinvall et al., 2017) and 27%-40% for ADHD (Barkley, 2013; Burns & Becker, 2021; Ekinci et al., 2021; Mayes et al., 2020; Servera et al., 2018). In contrast, SCT is present in approximately 5% to 7% of elementary school children (Burns & Becker, 2021; Mayes et al., 2021b).

Method

Samples

The elementary school sample comprised 665 children who participated in a population-based epidemiological study of the prevalence of sleep disorders in children (Bixler et al., 2009). Children in the clinical samples included 1,177 with autism, 725 with ADHD-Combined (ADHD-C), and 307 with ADHD-Inattentive (ADHD-I) referred to a department of psychiatry and behavioral health diagnostic clinic. All referred children underwent a diagnostic evaluation by a licensed PhD psychologist that included a diagnostic interview with the parents, parent and teacher questionnaires and rating scales (Pediatric Behavior Scale, PBS, Lindgren & Koeppl, 1987), review of records, administration of psychological tests, and clinical observations of the child during the evaluation. All children in the ADHD group had a DSM-IV or DSM-5 (whichever version was current when the child was evaluated) diagnosis of ADHD and fulfilled the following criteria: (1) PBS ratings of short attention span or distractible as often or very often a problem by at least two raters (mother, father, and/or teacher) and (2) symptoms of ADHD observed during psychological testing. Children were classified with ADHD-C if the median mother, father, and teacher rating on the PBS hyperactive/impulsive items was "often" or "very often" a problem. Children were classified with ADHD-I if the median hyperactive/impulsive rating was less than often a problem.

Children in the autism sample had a DSM-IV or DSM-5 diagnosis of autism (i.e., autistic disorder, Asperger's disorder, or autism spectrum disorder) and a score in the autism range on the Checklist for Autism Spectrum Disorder (CASD, Mayes, 2012). The CASD is a 30-item diagnostic measure completed by a clinician based on a semi-structured parent interview, teacher and child care provider report, and clinical observations of the child during the evaluation. In the nationally representative standardization study, the CASD identified children with and without autism with 99.5% accuracy, and studies show the CASD differentiates children with autism from children who have other disorders (Mayes, 2012; Mayes et al., 2012, 2017; Tierney et al., 2015). Diagnostic agreement between the CASD and the Childhood Autism Rating Scale, the Gilliam Asperger's Disorder Scale, and the Autism Diagnostic Interview-R ranged from 93%-98% (Mayes et al., 2009; Murray et al., 2011). Children with autism who also had ADHD symptoms were only included in the autism sample in our study. These children were not given an additional clinical diagnosis of ADHD if they were evaluated at the time of the DSM-IV because the DSM-IV did not permit an ADHD diagnosis with autism. In the autism sample, 79.5% had clinically elevated maternal ratings on the total ADHD subscale (ADHD-C) and 9.1% had elevated ratings on attention deficit but not on impulsivity/hyperactivity (ADHD-I), so almost 90% of the autism sample might be considered to have autism plus ADHD-C or ADHD-I. Sample demographic data are presented in Table 1. The Penn State College of Medicine Institutional Review Board waived informed consent for the retrospective analysis of existing clinical data for the autism and ADHD groups. Parent written consent and child assent were obtained for the elementary school children.

Table 1 Demographic Data for Children in the Autism, ADHD-C, ADHD-I, and Elementary School Samples

	Autism	ADHD-C	ADHD-I	Elementary
N	1177	725	307	665
Age range	4–17	4–16	4–17	6–12
Age *M* (*SD*)	7.5 (3.0)	8.4 (2.6)	9.2 (2.8)	8.7 (1.7)
IQ range	9–147	42–149	50–142	71–147
IQ *M*	93.6 (24.1)	102.7 (17.0)	103.2 (16.3)	106.5 (12.9)
Male %	79.4	72.3	56.0	52.6
SES %[a]	34.8	36.8	48.5	48.9
White %	91.7	90.2	92.8	80.5
SCT *n*/%	381/32.4%	134/18.5%	83/27.0%	46/6.9%

[a]One or both parents have a professional or managerial occupation

Significant ($p < .001$) demographic differences were found between two or more groups comparing the lowest and highest mean scores and percentages for age ($d = 0.6$), IQ ($d = 0.7$), sex ($z = 12.0$), SES ($z = 5.9$), and race ($z = 4.9$)

Pediatric Behavior Scale

The 165 items on the PBS (Lindgren & Koeppl, 1987) were rated by mothers on a 4-point scale from "never" to "very often" a problem during the past 2 months. The PBS corresponds well with established measures of psychopathology (Bixler et al., 2009; Mayes Gordon, Calhoun, & Bixler, 2014) and has been used to diagnose and differentiate psychological problems in multiple studies (e.g., Conrad et al., 2010; Mattison & Mayes, 2012; Mayes et al., 2017, 2021a; Nichols et al., 2000; Waxmonsky et al., 2017). PBS items were factor analyzed in clinical and population-based samples (Mayes et al., 2021a, b) yielding an SCT factor distinct from other factors (e.g., inattention, impulsivity, hyperactivity, oppositional defiant disorder/ODD, anxiety, depression, and cognitive problems). The SCT factor comprises five items (sluggish/slow moving/low energy, drowsy/sleepy/not alert, tires easily, in a fog/confused, and stares/preoccupied/in own world). The SCT factor composition is consistent with the results of published factor analytic studies (Becker et al., 2016) and has been utilized to assess SCT in previous publications (Mayes et al., 2020, 2021a, b, c; Mayes, Seebeck, & Waschbusch, 2021d).

Data Analyses

The five PBS SCT items were factor analyzed in each of the diagnostic groups using principal axis factoring with an oblique rotation specifying a two-factor solution. Internal consistency was assessed with Cronbach's alpha. Children were classified as having SCT and the two components of SCT (cognitive disengagement and hypoactivity) if their PBS score in each area was > 1.5 standard deviations above the general population mean (*T*-score > 65). McNemar's test was used to compare differences between cognitive disengagement and hypoactivity prevalence rates within each of the four diagnostic groups (autism, ADHD-C, ADHD-I, and elementary school). Differences between cognitive disengagement and hypoactivity scores within the four groups were analyzed with paired *t*-tests and Cohen's *d*. Pearson correlations and explained variance examined the degree of linear relationship between cognitive disengagement and hypoactivity scores. Analyses were performed on both the total sample and the subgroup of children with SCT (*T*-score > 65). A Bonferroni correction was used to control for the number of comparisons.

Results

For all four diagnostic groups (autism, ADHD-C, ADHD-I, and general population), factor analysis yielded two factors: cognitive disengagement and hypoactivity (Table 2). The cognitive disengagement and hypoactivity factors had strong internal consistency in all four groups, with Cronbach's alpha ranging from 0.72 to 0.80 for cognitive disengagement and 0.68 to 0.77 for hypoactivity. The two factors were distinct from but highly correlated with each other (0.54 to 0.67) across the four groups. Factor analytic results were similar for the subgroup of 130 children with autism who were not significantly elevated on maternal ratings of ADHD and again yielded two factors: cognitive disengagement (factor loadings were in a fog/confused 0.92 and stares/preoccupied/in own world 0.54) and hypoactivity (sluggish/slow moving/lacks energy 0.94, drowsy/sleepy/not alert 0.63, and tires easily 0.70) without cross loading (0.02-0.10).

In the subset of children with SCT, the co-occurrence of cognitive disengagement and hypoactivity was more likely than either occurring alone (Table 3). As shown in Table 4, correlations between cognitive disengagement and hypoactivity scores were all significant in the total autism, ADHD-C, ADHD-I, and elementary school samples, but in the subsamples of children with SCT in each diagnostic group, cognitive disengagement and hypoactivity were independent constructs not significantly correlated with each other.

In the autism and ADHD-C total groups and SCT subgroups, cognitive disengagement prevalence rates and mean scores were significantly higher than hypoactivity prevalence rates and mean scores. Effect sizes were medium and small in the total group ($d = 0.5$ for autism and 0.2 for ADHD-C) and were large and medium in the SCT subgroup ($d = 0.8$ for autism and 0.5 for ADHD-C). In contrast, differences were nonsignificant (Bonferroni $p > 0.05$) in the ADHD-I and elementary school groups, with very small effect sizes of 0.0-0.1 (Table 4).

Discussion

Support for the Cognitive Disengagement and Hypoactivity Components of SCT

Factor analysis of Pediatric Behavior Scale items in both our ADHD/autism sample (Mayes et al., 2021a) and general population sample (Mayes et al., 2021b) previously yielded an SCT factor that was related to but distinct from other factors (e.g., inattention, anxiety, depression, somatic complaints, and cognitive problems) without cross-loading. This is consistent with other studies reporting strong convergent and divergent validity for SCT (Becker et al., 2016; Dvorsky et al., 2019; Hartman et al., 2004; Lee et al., 2014; Mayes et al., 2020, 2021a, b; Penny et al., 2009; Saez et al., 2019; Willcutt et al., 2014). Factor analysis of the five SCT items in the current study yielded two factors: cognitive disengagement (in a fog/confused and stares/preoccupied/in own world) and hypoactivity (sluggish/slow moving/low energy, drowsy/sleepy/not alert, and tires easily). The two factors demonstrated high internal consistency and were significantly related to each other. Importantly, the factor structure was the same across diverse diagnostic groups that differed significantly in demographics and comorbid symptoms (e.g., autism with and without ADHD). Results support the SCT Work Group's position that SCT comprises symptoms representing both cognitive disengagement and hypoactivity. The SCT Work Group has recommended that SCT be renamed "cognitive disengagement syndrome" to more accurately describe SCT. As noted in our Introduction, the term SCT has been criticized for multiple reasons and research shows that SCT may be a misnomer in that it is only weakly and often not significantly associated with slow performance and processing speed, despite what the term SCT implies (Barkley, 2014; Waschbusch, 2021).

Table 2 SCT Factor Items and Loadings in the Autism, ADHD-C, ADHD-I, and Elementary School Samples

	Autism $n = 1177$		ADHD-C $n = 725$		ADHD-I $n = 307$		Elementary $n = 665$	
	Cog dis	Hypoactivity	Cog dis	Hypoactivity	Cog dis	Hypoactivity	Cog dis	Hypoactivity
In a fog/confused	0.93	-0.04	0.82	0.00	0.87	0.02	0.77	-0.00
Stares/preoccupied/in own world	0.63	0.05	0.70	0.04	0.77	-0.00	0.79	0.03
Sluggish/slow moving/lacks energy	-0.04	0.89	-0.14	1.04	0.00	0.89	-0.14	1.06
Drowsy/sleepy/not alert	-0.21	0.53	0.14	0.57	-0.19	0.66	0.16	0.61
Tires easily	0.07	0.63	0.13	0.35	0.06	0.60	0.04	0.50

Cog dis = cognitive disengagement

Table 3 Percentages of Children with Cognitive Disengagement Only, Hypoactivity Only, or Both in Children who have SCT (*N* = 644)

	Autism *n* = 381	ADHD-C *n* = 134	ADHD-I *n* = 83	Elementary *n* = 46
Cognitive disengagement and hypoactivity	44.6%	44.8%	47.0%	41.3%
Cognitive disengagement only	41.7%	37.3%	26.5%	21.7%
Hypoactivity only	13.6%	17.9%	26.5%	37.0%

As this table includes only children with SCT, no children had neither cognitive disengagement nor hypoactivity

Correlations between cognitive disengagement and hypoactivity scores were all significant in the total autism, ADHD-C, ADHD-I, and elementary school samples (indicating that the two problems are highly related), but in the subsamples of children with SCT in each of the four diagnostic groups, cognitive disengagement and hypoactivity were not significantly correlated (indicating that these two components are more independent within subgroups of children who have SCT). However, for almost half of children with SCT, cognitive disengagement and hypoactivity occurred together and were both present. The findings that these two components of SCT are independent and related with high co-occurrence also provides empirical support for the SCT Work Group's position that SCT comprises both cognitive and motor dimensions.

Cognitive Disengagement versus Hypoactivity: Differences within Diagnostic Groups

In the total elementary school sample, prevalence rates for cognitive disengagement (9%) and hypoactivity (8%) did not differ significantly from each other and are similar to prevalence rates reported for other conditions including ADHD (CDC, 2005), ODD/conduct disorder (Ghandour et al., 2019), anxiety disorder (Ghandour et al., 2019), learning disability (Pastor & Reuben, 2008), and developmental disability (Zablotsky, Black, & Blumberg, 2017). This suggests that the two components of SCT are equally common in the general population and are consistent with prevalence rates for many other conditions in childhood.

Prevalence rates and mean scores were significantly higher for cognitive disengagement than hypoactivity in the autism and ADHD-C total groups and in the autism and ADHD-C SCT subgroups, with an overall medium effect size. In contrast, differences were nonsignificant in the ADHD-I and elementary school groups, with very small effect sizes. These findings are expected because hyperactivity (vs. hypoactivity) is common in both ADHD-C and autism (i.e., hyperactivity is a core symptom of ADHD-C and 80% of children in the total autism sample in our study had significantly elevated hyperactive-impulsive maternal PBS ratings). In contrast, hyperactivity is not a characteristic of children in ADHD-I and population-based samples. Given these findings, clinicians should be alert to possible differences in how SCT is manifested in children with autism and ADHD-C versus ADHD-I and general population samples. This may have implications for intervention and targeting specific symptoms.

Table 4 Percentage of Children with Elevated Parent Cognitive Disengagement and Hypoactivity Ratings ($T > 65$) and Mean Score[a] Differences and Correlations between Cognitive Disengagement and Hypoactivity

	Prevalence rates			Mean score differences and correlations				
	Cognitive disengagement %	Hypoactivity %	McNemar *p*	Cognitive disengagement *M*	Hypoactivity *M*	*t*	*d*	*r*
Total Samples								
Autism	43.3%	20.4%	$< 0.001^b$	0.8	0.4	15.8^b	0.5	0.45^b
ADHD-C	23.4%	14.1%	$< 0.001^b$	0.4	0.3	6.5^b	0.2	0.52^b
ADHD-I	29.6%	22.5%	0.02	0.5	0.4	2.2	0.1	0.47^b
Elementary	8.6%	7.5%	0.47	0.2	0.2	0.9	0.0	0.44^b
SCT subsamples								
Autism	86.4%	58.3%	$< 0.001^b$	1.6	1.1	10.2^b	0.8	-0.03
ADHD-C	82.1%	62,7%	$.003^b$	1.5	1.1	4.7^b	0.5	0.01
ADHD-I	73.5%	73.5%	1.0	1.3	1.2	0.5	0.1	-0.08
Elementary	63.0%	78.3%	0.25	1.2	1.2	0.1	0.0	-.07

[a] 0 = almost never or not at all, 1 = sometimes, 2 = often, 3 = very often
[b] Bonferroni $p < .05$

Limitations and Future Directions

Children in our autism and ADHD samples were referred to a single clinical site, so the samples are likely to have more severe symptoms than nonreferred children with autism and/or ADHD. Findings need to be replicated in other clinical, as well as nonclinical, settings. Future research needs to investigate the impact of disparities related to social determinants of health particularly affecting minoritized groups, which our study did not consider. Further, studies need to use data from other informants (e.g., teacher- and self-report). Studies are also needed to determine the distinct external correlates of cognitive disengagement and hypoactivity, including demographics (sex, age, IQ, race, and SES) and comorbid conditions (e.g., externalizing, internalizing, neurodevelopmental, somatic, sleep, and learning problems). Research at both subfactor and item levels is necessary to further explore differences in SCT symptoms between children with ADHD-C and ADHD-I (with and without autism) and children with autism (with and without ADHD). SCT studies to date have often failed to rule-out autism in ADHD samples, which is important given that most clinically referred children with autism have ADHD (Joshi et al., 2017; Mayes et al., 2020). Further, SCT prevalence rates are similar for autism and ADHD (Barkley, 2013; Brewe et al., 2020; Burns & Becker, 2021; Duncan et al., 2019; Ekinci et al., 2021; Mayes et al., 2020; Reinvall et al., 2017) and children with both autism and ADHD can differ from children with either disorder alone on important dimensions. For example, children with autism plus ADHD have greater social impairment than children with only autism or ADHD (McFayden et al., 2022). Studies also need to distinguish between ADHD-C and ADHD-I given differences in comorbidity between the two subtypes and research showing that SCT is strongly associated with ADHD inattentive symptoms but not with the impulsive and hyperactive components of ADHD (Callan et al., 2020; Dvorsky et al., 2019; Hartman et al., 2004; Lee et al., 2014; Mayes et al., 2021a, b; Penny et al., 2009; Saez et al., 2019; Willcutt et al., 2014). Research is now needed to determine how SCT and its cognitive disengagement and hypoactivity dimensions are related to the specific symptoms and components of autism.

Importantly, the PBS SCT factor comprises only five items, most of which combine components into a single item (e.g., sluggish/slow moving/low energy, in a fog/confused, and stares/preoccupied/in own world). Replication of our factor analytic findings in both clinical and community samples with longer, SCT-specific measures (see Becker, 2021) is needed using a larger item set that does not combine items in order to determine if SCT comprises two factors – cognitive disengagement and hypoactivity – or more than two factors (e.g., does cognitive disengagement represent two factors reflecting daydreaming/blank staring and mental confusion?).

Conclusions

Our findings factor analyzing five SCT items support two SCT subfactors: cognitive disengagement and hypoactivity. This is consistent with an international SCT Work Group's position that SCT comprises symptoms representing a cognitive dimension (e.g., spacey, blank staring, daydreaming, in own world, in a fog, and confused) and a motor dimension (hypoactive, slow moving, lethargic, and drowsy) (Becker et al., in press).

Authors' Contributions All authors contributed to the literature search, analysis and interpretation of the data, and writing of the manuscript.

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Data Availability NA.

Compliance with Ethical Standards

Ethics Approval The study was approved by the Institutional Review Board.

Consent of Interest The Institutional Review Board waived informed consent for the retrospective analysis of existing clinical data for the autism and ADHD groups. Parent written consent and child assent were obtained for the elementary school children.

Competing Interests The authors have no relevant financial or non-financial interests to disclose.

Research Involving Human Participants The research was conducted in accordance with the ethical standards of the authors' Institutional Review Board and with the 1964 Helsinki Declaration and its later amendments.

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