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DISTINCT PATTERNS OF ATTENTION IMPAIRMENT IN ASD AND ADHD: A CROSS-SECTIONAL STUDY USING CPT-3 AND TEA-CH

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Abstract

Background:
Autism Spectrum Disorder (ASD) and Attention-Deficit/Hyperactivity Disorder (ADHD) are common neurodevelopmental disorders with overlapping yet distinct cognitive profiles, particularly in the domain of attention. Differentiating their attentional characteristics is critical for improving diagnostic precision and tailoring interventions.

Objectives:
To compare attentional profiles among children with ASD, ADHD, and typically developing children (TDC) using Conners' Continuous Performance Test-3 (CPT-3) and Test of Everyday Attention for Children (TEA-Ch), and to assess the relationship between attention metrics and symptom severity.

Methods:
A comparative cross-sectional study was conducted at Saveetha Medical College involving 120 children aged 6–12 years, equally divided into ASD, ADHD, and TDC groups (n = 40 each). Standardized tools including CPT-3, TEA-Ch, ADHD Rating Scale-5 (ADHD-RS-5), and Social Responsiveness Scale-2 (SRS-2) were administered. Between-group comparisons were analysed using ANOVA and post hoc Tukey tests. Pearson correlation was used to evaluate associations between attention measures and symptom severity.

Results:
Children with ADHD showed significantly higher commission errors (25.2 ± 6.8%) and reaction time variability (64.5 ± 16.8 ms), indicating deficits in inhibitory control. The ASD group exhibited the highest omission errors (18.6 ± 6.1%), reflecting sustained attention deficits. On TEA-Ch, ASD participants were most impaired in selective attention (Sky Search $z = -1.8 \pm 0.6$), while ADHD participants showed the greatest difficulties in sustained attention (Code Transmission $z = -2.3 \pm 0.5$) and shifting (Creature Counting $z = -2.0 \pm 0.6$). Symptom severity was significantly correlated with attention metrics—SRS-2 with omission errors in ASD ($r = 0.61$) and ADHD-RS-5 with commission errors in ADHD ($r = 0.70$). All differences were statistically significant ($p < 0.001$).

Conclusions:
ASD and ADHD are associated with distinct patterns of attention dysfunction. ADHD is characterized by impaired inhibitory control and attentional variability, while ASD exhibits deficits in sustained and selective attention. These attentional impairments are strongly linked to symptom severity and functional outcomes. Standardized tools such as CPT-3 and TEA-Ch can aid in differentiating these neurodevelopmental conditions and guiding individualized intervention strategies.

Keywords:
ASD, ADHD, attention deficits, CPT-3, TEA-Ch, sustained attention, executive dysfunction, symptom severity

INTRODUCTION

Autism Spectrum Disorder (ASD) and Attention-Deficit/Hyperactivity Disorder (ADHD) are two of the most prevalent neurodevelopmental disorders in childhood. According to the Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (DSM-5), ASD is defined by persistent deficits in social communication and interaction, along with restricted and repetitive patterns of behavior, interests, or activities (1–3). In contrast, ADHD is characterized by developmentally inappropriate levels of inattention, hyperactivity, and impulsivity (4).

The co-occurrence of ASD and ADHD is increasingly recognized in clinical and research settings. Approximately 30–60% of children diagnosed with ASD also meet the criteria for ADHD, significantly higher than the 5–7% prevalence reported in the general pediatric population (5). This frequent comorbidity underscores the potential overlap in the neurocognitive profiles of the two conditions, particularly in domains related to executive function and attention regulation.

Empirical studies have consistently reported shared impairments in response inhibition and sustained attention across both disorders. A large-scale comparative study involving children with ASD, ADHD, and typically developing controls demonstrated significant deficits in these domains among both clinical groups. Notably, attentional impairments in the ASD cohort were largely attributable to co-occurring ADHD traits, indicating a high degree of functional overlap in attentional control mechanisms (6).

Despite this convergence, differential patterns of executive dysfunction have been observed. While both conditions are associated with challenges in attentional shifting and inhibitory control, children with ASD more commonly exhibit deficits in cognitive flexibility, whereas those with ADHD tend to have greater impairments in inhibition, working memory, and planning abilities (7). These findings suggest the existence of both shared and syndrome-specific neurocognitive profiles, which may influence clinical presentation and intervention responsiveness.

Importantly, attentional deficits in these populations are not merely diagnostic features but have significant implications for adaptive functioning. Comparative analyses have revealed that children with co-occurring ASD and ADHD present with more severe impairments in communication, socialization, and daily living skills than those with either condition alone, suggesting additive or synergistic effects on functional outcomes (8). To objectively assess the multidimensional nature of attention dysfunction, standardized neuropsychological tools such as the Conners' Continuous Performance Test – Third Edition (CPT-3) and the Test of Everyday Attention for Children (TEA-Ch) are commonly employed. These instruments have demonstrated high sensitivity and specificity in evaluating sustained attention, selective focus, and attentional control, making them well-suited for distinguishing between clinical and non-clinical populations (9).

Attention dysfunction in both ASD and ADHD contributes substantially to academic underachievement, behavioural dysregulation, and impaired social adaptation. Moreover, the presence of ADHD symptoms in children with ASD has been linked to increased autism symptom severity and poorer long-term outcomes (10). Elucidating the attentional profiles associated with each condition, as well as their overlap, is therefore critical for refining diagnostic distinctions and developing targeted intervention strategies.

Objective:
The present study aims to (i) compare the attention profiles of children diagnosed with ASD, ADHD, and typically developing controls using validated neuropsychological instruments (CPT-3 and TEA-Ch), and (ii) explore associations between attention performance and symptom severity across groups, utilizing standardized behavioural rating scales.

METHODOLOGY

Study Design and Setting

This comparative cross-sectional study was conducted over a 12-month period at the Child Development and Neuropsychiatry Clinic, Saveetha Medical College and Hospital, Chennai, India. The primary objective was to evaluate and compare attention profiles among children diagnosed with Autism Spectrum Disorder (ASD) and Attention-Deficit/Hyperactivity Disorder (ADHD), in comparison to typically developing children (TDC), using standardized neuropsychological assessments.

Participants

A total of 120 children aged 6 to 12 years were enrolled in the study, comprising three groups: ASD (n = 40), ADHD (n = 40), and TDC (n = 40). Participants in the clinical groups were recruited from the outpatient neurodevelopmental and psychiatry clinics, while typically developing controls were recruited from local schools and community referrals, matched for age and sex.

Inclusion Criteria

- Children diagnosed with ASD or ADHD according to DSM-5 criteria.
- Intelligence quotient (IQ) ≥ 70 as assessed by the Wechsler Intelligence Scale for Children–Fourth Edition (WISC-IV).
- Stable medication status for at least four weeks prior to participation (if applicable).

Exclusion Criteria

- Presence of comorbid neurological conditions (e.g., epilepsy, cerebral palsy).
- Uncorrected hearing or visual impairments.
- History of traumatic brain injury or other major medical illnesses.

Ethical Considerations

The study protocol was reviewed and approved by the Institutional Ethics Committee of Saveetha Medical College and Hospital. Informed written consent was obtained from parents or legal guardians of all participants.

Assessment Measures

The following standardized tools were used to assess neurocognitive and behavioral parameters:

1. **Conners' Continuous Performance Test – Third Edition (CPT-3):** Used to assess sustained attention, vigilance, and response inhibition through computerized testing.
2. **Test of Everyday Attention for Children (TEA-Ch):** Evaluated selective attention, sustained attention, and attentional control/shifting using subtests such as Sky Search, Code Transmission, and Creature Counting.
3. **Child Behaviour Checklist (CBCL):** Captured parent-reported behavioral and attentional concerns using standardized age-specific scales.
4. **Social Responsiveness Scale – Second Edition (SRS-2):** Measured ASD symptom severity and social communication deficits.
5. **ADHD Rating Scale – 5 (ADHD-RS-5):** Quantified core symptoms of ADHD based on parent and teacher input.

Study Procedure

Screening and Diagnostic Confirmation

Participants were initially screened based on DSM-5 criteria for ASD or ADHD by trained clinicians. Diagnostic confirmation was performed using the Autism Diagnostic Observation Schedule – Second Edition (ADOS-2) for ASD and the Vanderbilt ADHD Diagnostic Rating Scale for ADHD. Eligible participants underwent cognitive and neuropsychological assessments within two weeks of diagnostic confirmation.

Cognitive and Attention Assessment

All assessments were conducted in a distraction-free, quiet room by trained clinical psychologists. The CPT-3 and TEA-Ch were administered in a standardized order across two separate 45-minute sessions on non-consecutive days to minimize fatigue effects.

Data Management

Raw scores obtained from CPT-3 and TEA-Ch subtests were converted to standardized z-scores using age-matched normative data. All participant data were anonymized, coded, and stored securely for statistical processing.

Statistical Analysis

Descriptive statistics were calculated for demographic and clinical variables, including means and standard deviations. Between-group differences in attention-related variables were analysed using one-way analysis of variance (ANOVA), followed by post hoc Tukey's Honestly Significant Difference (HSD) tests for pairwise comparisons. Pearson correlation coefficients were computed to examine the relationship between symptom severity scores (SRS-2 and ADHD-RS-5) and attention metrics. A p-value of less than 0.05 was considered statistically significant. All statistical analyses were conducted using IBM SPSS Statistics, Version 25.0 (IBM Corp., Armonk, NY).

RESULTS

Demographic and Clinical Characteristics

A total of 120 participants were equally distributed among the three study groups: children with Autism Spectrum Disorder (ASD), Attention-Deficit/Hyperactivity Disorder (ADHD), and Typically Developing Children (TDC), with 40 children in each group. As shown in Table 1, the groups were comparable in terms of mean age, sex distribution, and IQ ($p > 0.05$), indicating effective matching across demographic variables. However, significant group differences were noted in symptom severity indices. The ADHD group had the highest scores on the ADHD Rating Scale-5 (21.4 ± 4.3), while the ASD group demonstrated elevated scores on the Social Responsiveness Scale-2 (76.2 ± 9.4), consistent with their diagnostic profiles ($p < 0.001$).

Table 1. Demographic and Clinical Characteristics of Study Groups (N=120)

Characteristic	ASD (n=40)	ADHD (n=40)	TDC (n=40)	*p*-value
Mean age (years)	8.6 ± 1.5	8.7 ± 1.4	8.5 ± 1.6	0.83
Male (%)	75%	80%	70%	0.42
Mean IQ (WISC-IV)	92.3 ± 10.1	95.5 ± 9.8	97.8 ± 9.2	0.07
ADHD-RS-5 score	12.1 ± 3.6	21.4 ± 4.3	5.3 ± 1.7	<0.001*
SRS-2 T-score	76.2 ± 9.4	54.1 ± 6.5	43.2 ± 5.7	<0.001*

*Note: TDC = typically developing children. $p < 0.05$ considered significant.

CPT-3 Performance Metrics

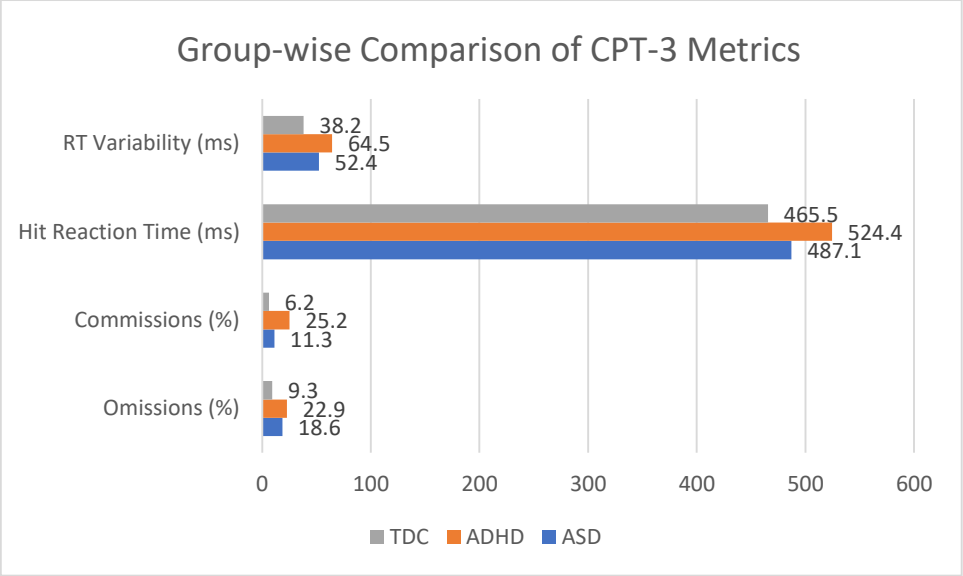
As presented in **Table 2**, significant differences were observed across all CPT-3 performance variables among the three groups. Children with ADHD exhibited the highest mean commission error rate (25.2 ± 6.8%) and the greatest variability in reaction time (64.5 ± 16.8 ms), indicating impaired inhibitory control and fluctuating attention. The ASD group, on the other hand, showed significantly elevated omission errors (18.6 ± 6.1%), suggestive of sustained attention deficits. TDC participants demonstrated optimal performance across all domains. All differences were statistically significant ($p < 0.001$), as confirmed by one-way ANOVA

Table 2. Group Comparison of CPT-3 Performance Metrics

CPT-3 Variable	ASD (Mean ± SD)	ADHD (Mean ± SD)	TDC (Mean ± SD)	*F*-statistic	*p*-value
Omissions (%)	18.6 ± 6.1	22.9 ± 5.4	9.3 ± 3.2	34.2	<0.001*
Commissions (%)	11.3 ± 4.7	25.2 ± 6.8	6.2 ± 2.9	47.1	<0.001*
Hit RT (ms)	487.1 ± 35.2	524.4 ± 42.6	465.5 ± 31.9	19.5	<0.001*
Variability (SD of RT)	52.4 ± 14.2	64.5 ± 16.8	38.2 ± 10.1	31.7	<0.001*

These findings are further illustrated in **Figure 1**, which visually depicts group-wise differences in omission and commission errors, reaction time, and response variability. The graphical representation reinforces the distinct attentional profiles observed in ASD and ADHD compared to typically developing peers.

Figure 1: Group-wise Comparison of CPT-3 Performance Metrics in Children with ASD, ADHD, and Typical Development



TEA-Ch Subtest Scores

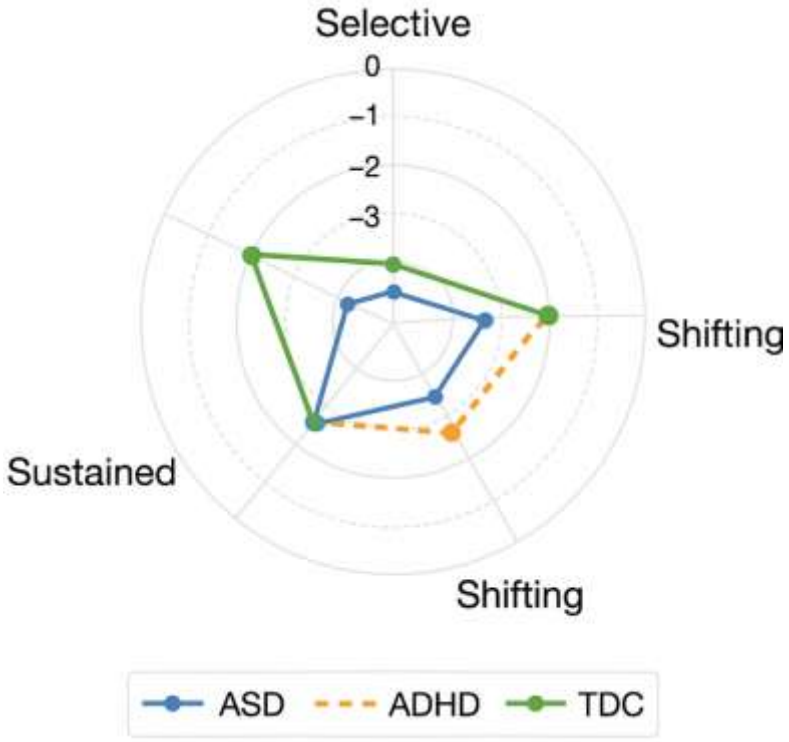
Standardized z-scores from the TEA-Ch subtests are summarized in **Table 3**. Children with ASD demonstrated the greatest impairment in selective attention (Sky Search: $z = -1.8 \pm 0.6$), while the ADHD group showed the most pronounced deficits in sustained attention (Code Transmission: $z = -2.3 \pm 0.5$) and attentional shifting (Creature Counting: $z = -2.0 \pm 0.6$). In contrast, TDC participants exhibited near-normal performance across all subdomains. All group-wise differences were statistically significant ($p < 0.001$).

Table 3. TEA-Ch Subtest Scores (Standardized z-scores)

Subtest	ASD	ADHD	TDC	*p*-value
Sky Search (Selective)	-1.8 ± 0.6	-1.2 ± 0.5	0.2 ± 0.4	<0.001*
Code Transmission (Sustained)	-1.6 ± 0.7	-2.3 ± 0.5	0.1 ± 0.3	<0.001*
Creature Counting (Shifting)	-1.2 ± 0.8	-2.0 ± 0.6	0.4 ± 0.5	<0.001*

The distinct attentional profiles observed are graphically presented in **Figure 2** using a radar plot. The TDC group clustered near normative performance ($z \approx 0$) across all dimensions, while the clinical groups showed domain-specific deficits in attention.

Figure 2. Radar Plot of Standardized Attention Scores Across TEA-Ch Subtests in ASD, ADHD, and Typically Developing Children



Correlation of Attention Metrics with Symptom Severity

Pearson correlation analyses are reported in **Table 4**, showing significant associations between attention test parameters and symptom severity scores. In the ASD group, omission errors were moderately correlated with SRS-2 scores (r = 0.61), whereas commission errors were strongly correlated with ADHD-RS-5 scores in the ADHD group (r = 0.70). Sustained attention, as assessed by the TEA-Ch Code Transmission subtest, was inversely correlated with symptom severity in both ASD (r = –0.56) and ADHD (r = –0.62) groups ($p < 0.01$), suggesting that poorer attention performance is linked to greater clinical symptomatology.

Table 4. Correlation of Attention Metrics with Symptom Severity

Attention Metric	SRS-2 (ASD group) *r*	ADHD-RS-5 (ADHD group) *r*	*p*-value
Omissions (%)	0.61	0.45	<0.01*
Commissions (%)	0.48	0.70	<0.01*
Sustained Attention (TEA-Ch)	-0.56	-0.62	<0.01*

Post Hoc Comparisons

Post hoc Tukey's HSD tests were conducted to further explore between-group differences (**Table 5**). ADHD children exhibited significantly more commission errors than those with ASD ($p < 0.01$), whereas ASD participants showed significantly higher omission errors and poorer sustained attention compared to TDC ($p < 0.001$). All comparisons involving the TDC group were statistically significant. These results underscore the distinct and non-overlapping cognitive profiles in ASD and ADHD.

Table 5. Post Hoc Tukey Analysis: Between-Group Differences in Attention Profiles

Comparison	Omissions	Commissions	Sustained Attention
ASD vs ADHD	NS	$p < 0.01$	$p < 0.05$
ASD vs TDC	$p < 0.01$	$p < 0.01$	$p < 0.001$
ADHD vs TDC	$p < 0.001$	$p < 0.001$	$p < 0.001$

Note: NS = Not Significant.

DISCUSSION

This study provides a comprehensive comparison of attentional profiles in children with Autism Spectrum Disorder (ASD), Attention-Deficit/Hyperactivity Disorder (ADHD), and typically developing children (TDC), revealing distinct and statistically significant deficits across multiple domains of attention.

Children with ADHD exhibited the highest rate of commission errors (25.2 ± 6.8%) and the greatest variability in reaction time (64.5 ± 16.8 ms), both of which are markers of impaired inhibitory control and attentional inconsistency. These findings are supported by electrophysiological evidence, which demonstrates reduced error-related negativity (ERN) and error positivity in children with ADHD, reflecting disrupted performance monitoring mechanisms (11,12). Neurocognitive models further suggest that ADHD is characterized by heightened intra-individual variability in response inhibition, contributing to these observed attentional instabilities (11).

In contrast, the ASD group showed the highest omission error rate (18.6 ± 6.1%), indicating deficits in sustained attention. These findings are consistent with literature suggesting that children with ASD exhibit reduced engagement with social stimuli and greater attentional disengagement. Eye-tracking studies have shown a preference for non-social stimuli over faces and social scenes in ASD, contributing to reduced attentional allocation in socially relevant contexts (13,14). These attentional deficits are often associated with the core social-communication difficulties measured by the Autism Diagnostic Observation Schedule (ADOS) (15).

Reaction time analysis further differentiated the groups: children with ADHD showed significantly slower response times (524.4 ± 42.6 ms) compared to ASD (487.1 ± 35.2 ms) and TDC (465.5 ± 31.9 ms), reflecting inefficient processing speed and impulsive response tendencies. The variability in reaction time, which was also higher in the ASD group (52.4 ± 14.2 ms) than in TDCs (38.2 ± 10.1 ms), suggests attentional instability across both clinical groups, albeit to varying degrees. In ADHD, this variability is largely attributed to fluctuations in inhibitory control, as explained by parametric race models (11). In ASD, however, such variability may arise from deficits in attentional shifting and task-switching abilities (7).

Domain-specific assessments using the TEA-Ch battery further clarified the nature of attentional impairments. The ASD group showed the most pronounced difficulty in selective attention, with a mean z-score of –1.8 ± 0.6 on the Sky Search task. This impairment is in line with evidence showing atypical visual scanning strategies and reduced exploration of salient visual cues in children with ASD (13). In contrast, the ADHD group displayed more severe deficits in sustained attention and attentional shifting, with z-scores of –2.3 ± 0.5 and –2.0 ± 0.6 on the Code Transmission and Creature Counting tasks, respectively. These findings reinforce prior reports indicating that ADHD is associated with difficulty maintaining focus over time and shifting attention flexibly across tasks (7).

Correlation analyses highlighted the clinical significance of these attentional profiles. In ASD, omission errors showed a moderate positive correlation with SRS-2 scores ($r = 0.61$), suggesting that greater inattentiveness is linked to more severe social impairment. In ADHD, commission errors correlated strongly with ADHD-RS-5 scores ($r = 0.70$), emphasizing the contribution of inhibitory deficits to the behavioural phenotype. Additionally, poor performance on sustained attention tasks was inversely related to symptom severity in both ASD ($r = –0.56$) and ADHD ($r = –0.62$), confirming the functional relevance of these cognitive impairments.

Post hoc comparisons provided further clarity: ADHD children exhibited significantly more commission errors than those with ASD ($p < 0.01$), while ASD children had higher omission errors and worse sustained attention performance than TDCs ($p < 0.001$). These group-wise differences underscore the presence of distinct attentional mechanisms underlying each disorder, despite some overlapping features.

Overall, these findings highlight the necessity for nuanced, domain-specific evaluation of attention in neurodevelopmental conditions. The observed differences are not only diagnostically informative but also essential for tailoring interventions. Children with ADHD may benefit from executive function training and

interventions aimed at improving impulse control, while those with ASD may require strategies focused on enhancing attentional engagement and flexibility.

Limitations

While the present study offers valuable insights into the differential attentional profiles of children with ASD, ADHD, and typically developing peers, certain limitations must be acknowledged. First, the cross-sectional design precludes any inference of causal relationships between attentional deficits and symptom severity. Longitudinal studies would be necessary to evaluate the developmental trajectory of these cognitive impairments over time. Second, although validated neuropsychological tools (CPT-3 and TEA-Ch) were employed, real-world generalizability may be limited, as laboratory-based assessments do not fully capture attention-related behaviours in naturalistic settings such as classrooms or social environments. Third, the relatively modest sample size, while adequate for detecting group differences, may limit the statistical power to explore nuanced interactions such as the influence of age, comorbidities, or medication status. Additionally, participants were recruited from clinical and educational institutions, potentially introducing selection bias and reducing the broader applicability of findings. Lastly, reliance on parent-reported symptom rating scales may be subject to reporting bias; future studies could benefit from incorporating multi-informant assessments and objective behavioural observations.

CONCLUSION

This study underscores the presence of distinct and measurable attentional impairments in children with ASD and ADHD. While both groups demonstrate executive dysfunction, the nature of the deficits diverges—ADHD is characterized primarily by impaired inhibitory control and response variability, whereas ASD is associated with deficits in sustained and selective attention. These attentional profiles are not only statistically significant but also clinically relevant, as they correlate with symptom severity and functional outcomes. The use of standardized tools such as the CPT-3 and TEA-Ch effectively differentiated between diagnostic groups and highlighted specific areas of cognitive vulnerability. Understanding these domain-specific attentional challenges can inform more targeted and individualized interventions, improve diagnostic precision, and ultimately enhance adaptive functioning in children with neurodevelopmental disorders.

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