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The Correlation Between Distractor Incorporated Continuous Performance Test and Neuropsychological Test Battery Results of Children With ADHD

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OBJECTIVES

To assess correlation of MOXO d-CPT test results and Neuropsychological Test Battery results of children with ADHD (Attention Deficit Hyperactivity Disorders).

BACKGROUND

Children with Attention Deficit Hyperactivity Disorder (ADHD) have deficits in executive functions, working memory, selective and sustained attention and inhibitory control. Neuropsychological tests, despite not being diagnostic, provides helpful contributory data (1). Although the clinical utility of continous performance tests has been controversial, a large meta-analysis of 26 studies revealed that children with ADHD made significantly more errors of omission and commission than normal children (2). Studies also highlight the importance and effectiveness of incorporating distractors (auditory, visual and combined) in CPT to better distinguish ADHD from non-ADHD children (3,4). These tests involve execution of a predetermined reaction to target and non-target stimuli. Omission errors may be linked to problems with attention, and some subtypes of commission errors may be associated with “inadequate control”, or impulsivity. Incorporation of distractors to CPT simulate real-life settings and measure selective and sustained attention and distractibility (5). In the current study, our aim was to assess correlation of d-CPT to other neuropsychological tests which evaluate different areas of functioning.

MATERIAL AND METHODS

Study sample consisted of 29 children (mean age 9.17) with a diagnosis of ADHD according to DSM 5 criteria. Sample was based on consecutive referrals to two specialty clinics between January to September 2015. Characteristics of the sample is provided in Table 1.

MPH was washed out 24 hours prior to testing. Each patient performed d-CPT on Day 1 and a Neuropsychological Test (NPT) battery on day two. Our NPT battery covered a broad spectrum of cognitive functions as listed in Table 2. d-CPT test included Attention (omission errors), impulsivity (commission errors), reaction time and hyperactivity (inappropriate response to target stimuli) indices.

This study was approved by the appropriate ethics committees and all participants provided written informed consent. Spearman’s Correlation was used for statistical analysis.

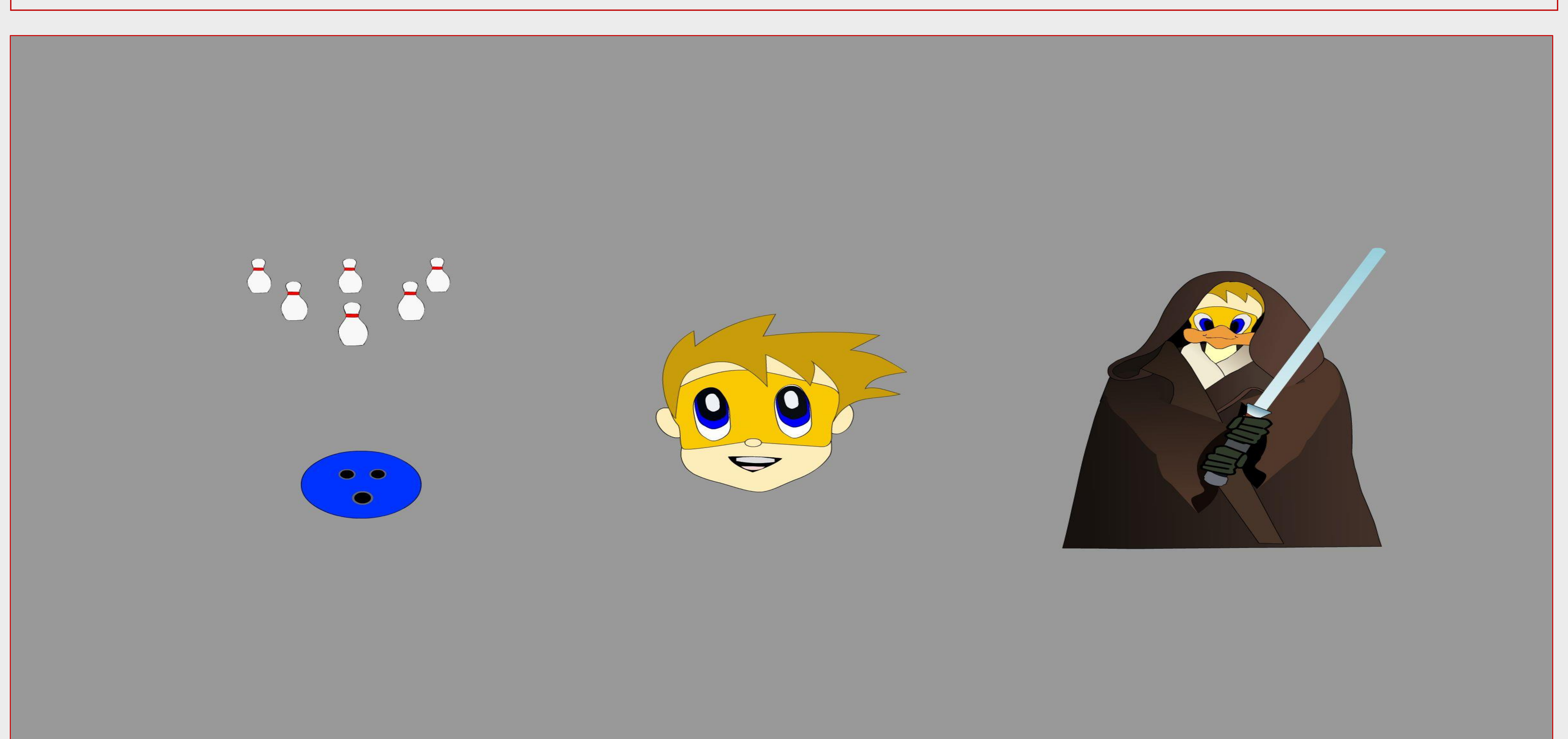

Table 1: Sample Characteristics

	n	%
Gender (n,%)		
Male	25	86%
Female	4	14%
Comorbidity (n,%)		
ODD	11	38%
DMDD	7	24%
Anxiety Disorders	5	17%
Medication (n, %)		
Methylphenidate	24	83%
Atomoxetine	9	31%
Atypical Antipsychotics	10	35%
SSRIs	3	10%

ODD: Oppositional defiant disorder, DMDD: Disruptive mood dysregulation disorder, SSRIs: Selective serotonin re-uptake inhibitors

Table 2: Neuropsychological Tests used in Correlation Study

Neuropsychological Test	Area of Assessment	Anatomic Localization
Digit Span Learning	short term memory and learning	temporal lobe, mainly hippocampal regions
Benton Judgement of Line Orientation Test	visuo-spatial perception and orientation	right parietal lobe
Complex Figure Test	visuospatial/constructional ability, long-term visual memory functions, planning, organization and fine motor skills	frontal lobe
Letter Cancellation test	for visual scanning, selective attention, psychomotor skills, rapid response activation and inhibition	right perietal/ frontal lobe functioning
Symbol Cancellation Task	visuo-spatial perception, sustained and selective attention	right parietal/frontal lobe functioning
Stroop Color Word Test	sustained attention, information processing speed, distractor effect and selective attention	frontal lobe
Trail Making Test	graphomotor skills, visual search, scanning, and speed of processing, mental flexibility, and executive functions	frontal lobe
Wisconsin Card Sorting Test	executive function, perseveration, working memory, and categorical thinking	frontal lobe

RESULTS

Significant correlations were found for Attentional index with DSL (r = .662, p ≤.001), JLO (r = .649, p ≤.001), CFT (r = .467, p ≤.05), LCT (r = .039, p ≤.05), SCT (r = .031, p ≤.05), Stoop (r = .046, p ≤.05) and WCST (r = .482, p ≤.05). The correlations were also significant when visual distractors were introduced but were lost with auditory distractors.

Timing index without any distractor was associated with only DSL test (r = .476, p ≤.05). The correlations with JLO (r=.449 , p ≤.05), CFT (r=.449 , p ≤.05), LCT (r=.422 , p ≤.05) and SCT (r=.436 , p ≤.05) became significant when visual and combined distractors were added.

Impulsivity index without distractors, was not correlated with any of the NPT batteries. When auditory distractors added CFT (r=.474, p ≤.05) and LTF (r=.422, p ≤.05) found to be significant. JLO (r = .424, p ≤.05), SCT (r = .390, p ≤.05), TMT (r=.491, p ≤.05) significant correlations were also observed when combined distractors were introduced.

Hyperactivity index was found to be highly correlated with DSL (r =.571, p ≤.05), JLOB (r =.549, p ≤.05), CFT (r = .716, p ≤.001), LCT (r = .769, p ≤.001), (r = .769, p ≤.001), Stoop test (r = .508, p ≤.05), and WCST (r = .535, p ≤.05) and significant correlations were also observed when auditory, visual and combined distractors were introduced. Details of the correlation analysis can be found on Table 3.

Table 3. Relation between d-CPT test (Moxo) and Neuropsychiatric Battery Test Results

d-CPT Test (Moxo)	Neuropsychiatric Battery Tests							
	DSL	JLOB	CFT	LCT	SCT	SCWT	TMT	WCST
Attention								
No distractor	**.662****	**.649****	**.467***	-.316	**-.423***	**-.420***	-.081	**.491***
Visual distractor	**.416***	.364	**.417***	**-.408***	-.368	-.206	-.100	.372
Auditory distractor	.379	.366	**.380***	-.259	-.276	-.237	.151	.340
Combination of distractors	.609**	.526*	**.530****	**-.542****	-.343	**-.448***	-.127	**.510***
Timing								
No distractor	**.467***	.349	.369	-.349	-.353	-.325	.049	.539
Visual distractor	**.445***	**.449***	**.449***	**-.453***	**-.436***	-.309	.166	.032
Auditory distractor	**.404***	.329	.309	-.238	-.233	-.320	.056	.124
Combination of distractors	**.583****	**.470***	**.421***	-.359	-.329	**-.441***	-.043	.126
Impulsiveness								
No distractor	.225	.170	.252	-.261	-.081	.040	.037	.228
Visual distractor	.271	.111	.225	-.145	-.187	.156	.058	.171
Auditory distractor	.338	.348	**.474***	**-.422***	-.318	.035	.263	.347
Combination of distractors	.278	**.424***	.357	-.270	**-.390***	.129	**.491***	.204
Hyperactivity								
No distractor	**.571****	**.549****	**.716****	**-.796****	**-.623****	**-.508***	-.056	**.535***
Visual distractor	**.599****	**.608****	**.664****	**-.569****	**-.514****	**-.428***	-.049	.347
Auditory distractor	**.600****	**.661****	**.753****	**-.715****	**-.655****	**-.465***	-.186	**.519***
Combination of distractors	**.559****	**.607****	**.721****	**-.738****	**-.655****	**-.455***	.078	.465

* p≤.05, **p≤.001, DSL: Digit Span Learning Test, JLO: Judgment of Line Orientation Test, CFT: Complex Figure Test, LCT: Letter Cancellation Test, SCT: Symbol Cancellation Test, SCWT: Stroop Color Word Test, TMT: Trail Making Test, WCST: Wisconsin Card Sorting Test

DISCUSSION

1. **Attention index** is correlated with tests that measure selective and sustained attention as well as tests that measure short term memory (STM) and executive functioning. Incorporation of auditory distractors decrease correlations to an insignificant level.
2. The correlation of **Timing index** was strongest with tests for STM and learning among NPTs. It could be inferred that children with low processing speed also have more problems with STM. Addition of visual distractors increase correlation with tests that measure selective and sustained attention.
3. **Impulsivity index** was surprisingly less correlated with other NPTs. Addition of combined distractors increase correlation.
4. **Hyperactivity index** was the most correlated with other NPTs among all other indices. We conclude that H index may inform about sustained and selective attention as well as executive functioning. Response inhibition difficulties and better captured by the H as opposed to I index, as highly significant correlations were obtained with other NPTs that measure response inhibition.

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