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A Review of the Validity of Laboratory Cognitive Tasks Used to Assess Symptoms of ADHD

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ABSTRACT: Reviewed the validity of frequently used laboratory assessment measures of ADHD symptoms using research published since 1991. Emphasized examining the validity of the tasks as they are commonly used by clinicians and researchers. Tasks evaluated included the Continuous Performance Test (CPT) and the Gordon Diagnostic System (GDS), the Children's Checking Task (CCT), Delay of Gratification Tasks, the Choice-Delay Task, (C-DT), and the Stop Signal Task (SST). Results showed that the CPT, C-DT, and the SST had the most support, yet further efforts to evaluate the validity of these measures are needed before they can be used for more than experimental purposes.

KEY WORDS: attention-deficit/hyperactivity disorder; ADHD; validity; laboratory measures.

Attention-deficit/hyperactivity disorder (ADHD) is a mental health problem characterized by difficulties with inattention and impulsivity/hyperactivity.[1] These characteristics are typically assessed using clinical interviews and behavior rating scales but there has long been interest in developing laboratory-based measures that could be used in their place.[2] This interest originates from the potential advantages that laboratory based measures have over more traditional measures of ADHD. First, laboratory measures of ADHD hold the promise to be extremely cost effective when contrasted with the time and effort required to complete a comprehensive diagnostic evaluation. Second,

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lab measures may be relatively free from bias, whereas both ratings scales and structured interviews can be influenced by a number of extraneous factors.[3–5] Third, laboratory measures hold the promise of providing immediate information about change in ADHD symptoms in response to manipulations, whereas the same is not true for interview and rating scale measures of ADHD. Other potential advantages of laboratory measures of ADHD include ease of administration, reliance only on the individual being evaluated (thereby eliminating demands on teachers and others to complete an assessment), and the ability to administer the measures in a variety of settings.

These potential advantages have led to the development of a number of lab-based measures of ADHD. Many of these measures have become widely used and have provided valuable empirical data.[6,7] As a result, there is considerable interest in using laboratory measures for diagnostic or clinical purposes. However, as others have noted, demonstrating that a measure is valid for one purpose does not ensure that it is valid for all purposes.[8] Thus, if laboratory measures of ADHD are to be used for clinically, then the validity of these measures must be established for these purposes.

The purpose of this article is to review recent research (i.e., published between 1991 and 2001) on common laboratory measures of ADHD to evaluate their validity with respect to three potential clinical uses. The first question we will address is whether the laboratory measure can be used as an index of ADHD behavior. We conceptualized this as a question of convergent validity. To address this question, we will examine whether the laboratory measure is related to other, well-validated measures of ADHD behaviors; specifically, behavior ratings and observations. The second question we will address is whether the laboratory measure can be used to identify children with ADHD. We conceptualized this as a question of discriminant validity of the laboratory measure. To address this question, we will examine whether performance on the laboratory measure accurately distinguishes children with ADHD from other children. The third question is whether the laboratory measure can be used as an indicator of response to treatment. We conceptualized this as a question of predictive validity. To address this question, we will examine whether performance on the laboratory measure changes in expected ways in response to treatment.

We believe a review covering these areas is warranted at this time for the following reasons: (1) the recent theoretical shift toward a lack

of behavioural inhibition as the primary deficit associated with ADHD[9] has lead to the development of new lab tasks, such as the stop-signal task; (2) interest in objective measures of psychopathology that could be used in both research and clinical contexts is substantial, as evidenced by the recent task force focused on this topic that was established by Division 12 of the American Psychological Association,[10] and (3) it has been over a decade since the publication of an early, seminal report of laboratory tasks of ADHD[11] and conducting an updated review will help determine whether the evaluation of validity has improved over time.

Method

Studies were included in this review if (1) they used laboratory measures to evaluate the performance of children with ADHD in areas reflective of ADHD symptomatology, and (2) they were published between 1991 and early 2001. Studies were identified through comprehensive PsycInfo and Medline searches. Review of those studies generated additional references. Rather than evaluate all possible laboratory measures, we focused on those most commonly used in research or assessment of ADHD so that we could comprehensively review the research published on them over the past decade. The tasks selected for review included the Continuous Performance Test (including the Gordon Diagnostic System), the Children's Checking Task, Delay of Gratification Tasks, Delay Aversion Paradigms (Choice-Delay Task), and the recently developed Stop Signal Task (See Table 1).

We organized the review around tasks, with the following subsections used for each task:

1. *Description*—the basic parameters and theoretical basis of the task are briefly described;
2. *Convergent Validity*—studies evaluating whether the task relates to other measures of ADHD, namely behavior ratings and observations, are summarized;
3. *Discriminant Validity*—studies that evaluate whether children with ADHD differ from other children (both typically developing children and children with non-ADHD psychopathology) are reviewed. Included are studies that report data on mean differences (e.g., ADHD children have higher scores than controls on the task) and studies that report data on categorical classification (e.g., percent of ADHD vs. control children that were correctly classified using the task);
4. *Predictive Validity*—studies that examine whether the performance of children with ADHD changes in response to treatment are reviewed;

When no relevant data was found for a particular subsection it was omitted from the review.

Results

The Continuous Performance Test

Task Description. The Continuous Performance Test (CPT) is one of the most frequently used laboratory tasks in the clinical assessment of ADHD.[2,12] The most common CPT paradigm currently in use is the A-X version in which participants monitor stimuli presented on a computer screen, responding only when they detect a predetermined letter (example X) *after* seeing another predetermined letter (example A). Other variations of the CPT require the participant to respond to a single letter or a pair of letters, presented simultaneously or sequentially, or instead of responding to letters as stimuli, participants respond to digits, pictures or nonsense symbols. Auditory CPTs are also commonly used in research. Two types of errors are typically analyzed in the CPT: (1) misses, or omission errors, which are considered to be a measure of inattention; and (2) false alarms, or commission errors, which are considered to be a measure of impulsivity. Of special note is a version of the CPT called the Gordon Diagnostic System GDS:.[13] This version is significant because it is well known, is used clinically, and includes three different tasks: (1) a Standard Delay Task measuring inhibition of responding; (2) a Standard Vigilance Task measuring sustained attention; and (3) a Distractibility Task measuring selective attention.

Convergent Validity. One study examined the association between CPT performance and observational data. Nigg and colleagues[14] examined the relationship between CPT scores and behaviour observations of classroom and play-yard activity measured in the context of a summer camp. Significant, yet modest, correlations were found between observed aggression and CPT Inattention ($r = .38$), but not for CPT Impulsivity ($r = .22$). However, correlations between CPT Impulsivity and observed aggression were marginally different for children with ADHD ($r = .33$) compared to children in the control group ($r = -.18$).

More common are studies examining whether CPT scores relate to parent and teacher ratings of behavior. In the study described above,[14] CPT performance was correlated not only with observations, but also with parent ratings. Results mirrored data from behavioral observations, with significant correlations emerging between parent ratings of inattention and CPT Inattention ($r = .41$) but not between parent-

rated impulsivity and CPT impulsivity. Studies using teacher ratings have shown that teacher report of externalizing behavior is significantly correlated with CPT inattention (r = .23),[15] CPT response variability (r = .55)[16] and GDS Vigilance Omissions scores (r = .46).[17] However, not all reports find significant associations. For example, one study examined relationships between GDS scores and parent and teacher ratings of ADHD symptoms and failed to find any significant associations (all r's ranging from .01 to .24).[12] The same data examined another way showed low agreement between diagnoses from parent and teacher ratings and measures from the GDS (classification rates ranged from 13% to 44%).

Discriminant Validity. Studies conducted within the last decade consistently show that the CPT effectively discriminates school-aged children with ADHD from normal controls.[7,14,18–21] This conclusion is true for studies reporting mean comparisons and for studies reporting categorical classifications. For example, one study correctly classified 62.5% of ADHD children and 94.4% of normal children using their CPT performance scores in a discriminant function analysis.[21] Using an auditory CPT, Doyle and colleagues[22] found high specificity (89–91%) yet considerably low sensitivity (7–15%) with a cut-off of 1.5 SDs. PPP ranged from 42–66%, while NPP was generally lower at 44–47%. A modified version of the CPT has also been shown to accurately distinguish preschool children with ADHD from normal control preschoolers.[23,24] A recent study suggests that fluctuations in speed of responding, rather than the more typical measures derived from the CPT, may be a key variable in discriminating the performance of ADHD and normal control children.[25]

The ability of the GDS to discriminate children with ADHD from typical controls has also been examined. Using conditional probabilities, Barkley and colleagues[26] examined classification rates of the GDS and other neuropsychological tests for children with ADHD and typical controls. Of all the measures, GDS scores were found to be most useful, particularly the commission errors score. However, this was only true when both subtypes of ADHD were considered as a single diagnostic group: 100% PPP for number of commission errors, 92% for number of omission errors. For NPP, scores were considerably less: 59% for commissions, and 63% for omissions. For the ADD+H alone group, the PPP of commission errors was 63% and 33% for omission errors, while the NPP was 82% for commission errors and 77% for

omissions. These results suggest that while abnormal scores may indicate the presence of ADD (though not specific to subtype), normal scores do not rule out the disorder.

In a follow-up study using a larger sample size and a broader range of diagnostic statistics, the same authors[27] found comparable classification rates using the GDS. PPP was above 80%, but only moderate NPP levels (59–61%) were found. The other diagnostic statistics yielded an average sensitivity of 40%, and an overall classification rate of approximately 66%. In contrast to these findings, another study[17] found that none of the GDS measures discriminated school-aged children with and without ADHD (defined using a median split on the Teacher Report Form).

Three studies conducted by Halperin and colleagues evaluate whether the CPT discriminates ADHD children from psychiatric controls and these studies yield mixed results. In one study children with ADHD were more impulsive and inattentive than psychiatric controls on the CPT,[20] whereas there were no differences on the same measures in a second study.[28] A third report by this same group found that CPT impulsivity discriminated children with ADHD from children with reading disability, but CPT inattention did not.[29] Other authors have also examined whether the CPT discriminates ADHD children from psychiatric controls, with correct classification rates ranging from only 60% to 67% for both ADHD and psychiatric control groups.[21,25] A comparison of children with ADHD and psychiatric controls using the GDS[30] found that the ability of the GDS to correctly identify children with ADHD was low (positive predictive values ranged from 20% to 37%), but it was adequately able to correctly identify children who did not have ADHD (negative predictive values ranges from 72%–88%).

A related set of studies are those that compare CPT performance of ADHD children with and without comorbid disorders. Results from these studies suggest that: (1) ADHD children with comorbid anxiety make fewer inattention errors than ADHD-only children[31]; and (2) ADHD children with and without co-occurring conduct problems make significantly more inattention errors than do children with conduct problems only.[25,32]

Predictive Validity. Numerous studies have examined CPT performance before and after administering stimulant medication and these studies consistently show that CPT performance (including performance on the GDS) improves following methylphenidate administra-

tion.[7,14,23,33,34] More limited evidence suggests that this effect might be specific to CPT commission (i.e., impulsivity) errors.[7,35]

Children's Checking Task

Task Description. The Children's Checking Task (CCT) is a paper and pencil measure that requires speeded checking of numbers as a tape recorder presents numerical stimuli.[36] The child is instructed to circle a number any time the number presented by the tape-recorder differs from the one listed on a page in front of them. This task is designed as a measure of impulsivity (commission errors) and inattention (omission errors).

Discriminant Validity. One study has used a modified version of the CCT[24] with preschool children ages 3 to 5 years old.[37] Results showed that children with ADHD made significantly more commission errors on the modified CCT than did normal children, but did not differ in the number of omission errors, indicating that mean difference scores on the CCT discriminate preschool children with ADHD from normal control children.

Predictive Validity. In the same study described above, Byrne and colleagues[37] also found that the difference in commission errors between children with ADHD and typical preschoolers disappeared when the ADHD children received stimulant medication.

Delay of Gratification Tasks

Task Description. Delay of gratification paradigms (DGP) typically consist of presenting children with an attractive toy or snack and instructing them to wait until the experimenter gives them permission to play with / eat the "off-limits" target.[38] However, the specific procedures vary considerably across studies. For example, children may be provided with alternatives to the forbidden toys or snacks in order to examine strategies children use for coping with the waiting period. Delay of gratification paradigms are designed to measure inhibitory or self-regulatory control.

Discriminant Validity. One study[37] examined delay of gratification in preschool children with and without ADHD. Children were allowed to play with one group of toys, but another group of toys was "off-

limits," ostensibly because they belonged to another child. A significant difference was found between preschoolers with and without ADHD, with 77% of the ADHD children but none of the normal controls, playing with the "off-limits" toys.

Delay Aversion Paradigm (Choice-Delay Task)

Task Description. The Delay Aversion Hypothesis conceptualizes impulsive behaviour within a motivational framework; impulsivity results from a *choice* to avoid a delay, rather than a difficulty in inhibiting one's behaviour.[39] This hypothesis has been measured using the Choice-Delay Task (C-DT), in which children repeatedly choose between a large delayed reward and a smaller immediate reward. While similar to the delay of gratification task discussed above, the Choice-Delay paradigm differs such that once the child chooses the delayed reward, they cannot switch their choice to the more immediate option. Preference for the larger but delayed reward thus involves an active choice, rather than inhibiting the response involving selection of the smaller reward.

Criterion Validity. One study examined the association between performance on the C-DT and naturalistic behaviours as measured through ratings and observations.[40] Of a possible 11 correlations, 8 were significant. Scores on the C-DT were negatively associated with SNAP-IV teacher ratings of impulsivity (–.37) and hyperactivity (–.27), and Conners teacher ratings on the Hyperkinesis Index (–.30) and the Conduct problem index (–.26). C-DT scores were also significantly associated with measures from the Classroom Observation Code, including the AD/HD composite (–.28), the Interference composite (–.37), Gross Motor (–.35), and Physical aggression (–.39).

Discriminant Validity. Sonuga-Barke and colleagues[39] found that when presented with a limited numbers of trials on which to choose, a community based group of hyperactive children chose the larger delayed reward only 18% of the time while the typical controls chose the larger reward 48% of the time. Reward parameters such as magnitude or rate did not impact the hyperactive children's choice of reward. A later study of the C-DT added an additional condition that allowed children to determine the rate at which trials were presented.[41] Results showed that ADHD and non-ADHD girls differed in the self-presentation condition—hyperactive girls chose a shorter presenta-

tion and remembered fewer picture cards than did controls—but no difference emerged in performance when the viewing time was predetermined for them. Other studies have investigated performance on the C-DT from the perspective of assessment and discriminating children with ADHD from typical controls. Solanto and colleagues[40] found that C-DT scores classified 71.6% of their sample into either the ADHD group or the control group, with a specificity of 64.3% and a sensitivity of 76.9%. Kuntsai, Oosterlaan and Stevenson[42] also found that the C-DT significantly discriminated ADHD and control children, but specific classification rates were not reported.

The Stop-Signal Task (SST)

Task Description. A recently developed laboratory measure of inhibitory control is the stop signal task.[43–45] The stop signal paradigm provides a laboratory analogue of everyday situations requiring quick execution of a thought or action and, on occasion, inhibition of this behaviour.[46,47] The SST is operationalized through a computerized task in which participants are required to respond as fast as they can to symbols (usually letters) presented on a computer screen (a forced-choice reaction time task). On 25% of the trials, an auditory tone presented by the computer indicates to the participant that they are to try to withhold their response to the current letter on the screen. The tone occurs only occasionally, is unpredictable, and importantly, occurs at various latencies after the appearance of the letter on the computer screen, ranging from a few milliseconds to the actual reaction time of the participant. This is essential for the calculation of the primary dependent variable, the Stop Signal Reaction Time (SSRT), which is an estimation of the time the individual needs to stop their usual behavior (i.e., pressing a key every time they see the symbol) in response to the stop signal. A participant's SSRT is determined using the latency of the stop signal and their primary "go" response time.[48]

Criterion Validity. Recent work with the stop task has begun to directly examine whether SST performance is related to measures of naturalistic behavior. One study[49] showed a robust correlation between performance on the stop task and behavioural observations of off task and hyperactive behavior during a restricted academic situation ($r = .65$). Inhibitory control measured by the stop task was also related to teacher ratings of inattention and hyperactivity ($r = .37$). These findings indicate that slower inhibitory processes are related to

more hyperactive and impulsive behaviour in both the classroom and the laboratory.[49] Another study[50] found that inhibitory control as measured by the stop signal task was correlated with composite parent (r = .30) and teacher ratings (r = .25) of attention, but not with ratings of hyperactivity, oppositional behaviour, conduct problems, delinquency, or aggression (all r's less than .22). In contrast to these studies, another study[40] found that SST measures were associated with parent and teacher ratings, and only 3 of 11 measures from classroom observations (interference: r = .29; AD/HD composite: r = .26; and physical aggression: r = 30) were significant. Thus, there are currently mixed results regarding the relationship between SST performance and measures of naturalistic functioning.

Discriminant Validity. A recent meta-analysis showed that performance on the SST accurately distinguishes children with ADHD from normal controls.[6] Across seven studies, a moderately large combined effect size (Cohen's d = .64) was found for comparisons of children with ADHD to normal control children, with ADHD children performing an average of 103 msec slower than normal control children on the stop task.

Studies published since the meta-analysis find similar results. One study examined SST performance in children with ADHD-combined type and in normal comparison children (matched on recruitment source, sex, and age) and found a deficit in stop signal reaction time in children with ADHD.[50] This deficit remained significant even when covarying age, IQ, reading ability, aggression, delinquency, conduct problems, and oppositional behaviour. The data were also examined categorically and resulted in a positive predictive power of .67, negative predictive power of .65, sensitivity of .64, and specificity of .68. A discriminant function analysis generated similar results, but the specific percentages correctly classified were not reported. Another recent study[40] found significant differences between ADHD and control children in SSRT and in probability of inhibition, yet a discriminant function analysis yielded only modest discrimination between groups, with correct classification rates ranging from 53.41% to 68.18% and sensitivity and specificity ranging from 44.1% to 82.8%. Not all studies have found differences between children with ADHD and typical controls on the SST.[42,51] The reasons some studies (in contrast to most) fail to find differences remain unclear, but may reflect differences in sample composition. Specifically, each of the studies that failed to dis-

criminate children with ADHD and controls used community-based samples, whereas other studies typically use clinically referred children. If this factor accounts for the difference between studies it would suggest that a slow inhibitory process may be characteristic of clinically referred children with ADHD.

The meta-analysis described above[6] also examined whether the SST could distinguish children with ADHD from children with CD. Results showed that while children with ADHD had (on average) SSRT times that were nearly 100 milliseconds slower than the CD children (indicating more impaired inhibitory behaviour), the combined effect size was small (Cohen's $d = .07$). Most important was the considerable heterogeneity across studies; two of the four studies reviewed reported that children with ADHD had substantially slower SSRTs (i.e. worse inhibitory control) than children with CD, whereas two other studies showed the opposite pattern (although the group differences were smaller). Further research is needed to clarify these discrepancies. The meta-analysis also found that ADHD children with comorbid conduct disorder did not differ from ADHD children without comorbid conduct disorder, indicating that performance on the SST is not moderated by the presence of conduct problems. Studies of the SST published since the meta-analysis report similar findings. For instance, one recent study[52] reported that children with ADHD-only had slower SSRTs than both the normal control group and the comorbid ADHD+CD group, with the CD-only group falling between (but not different than) the ADHD and normal control children.

Predictive Validity. Performance on the stop task has been demonstrated to be sensitive to the effects of methylphenidate. The most consistent finding is that methylphenidate has been shown to increase response times to the go stimuli in a linear fashion.[53,54] The effects of methylphenidate on inhibitory control are more complex. In some studies, response inhibition improved linearly with increasing dosages. In others, response inhibition showed a curvilinear relationship with methylphenidate doses (increasing at lower doses, then decreasing at higher doses). Thus, methylphenidate appears to produce specific effects on different cognitive processes,[47] with a linear dose-response effect (improvement with increasing doses) on the reaction time task (presumably measuring initiation of action) and with a curvilear dose-reponse effect (improvement then decline as dose increases) on the stop task (presumably measuring response inhibition).

Discussion

The purpose of this review was to evaluate currently used laboratory tasks that are designed to measure symptoms of ADHD for use in answering three clinically-relevant questions: (1) Does the measure relate to other, empirically supported measures of ADHD behavior (criterion validity); (2) Does the measure discriminate children with ADHD from other children (discriminant validity); and (3) Does the measure change in response to treatment? We selected these issues as we believe they represent some of the most important potential clinical uses for the tasks.

The tasks we reviewed were the Continuous Performance Task (CPT), including the Gordon Diagnostic System (GDS), the Children's Checking Task (CCT), Delay of Gratification Tasks, the Choice-Delay Task (C-DT), and the Stop Signal Task (SST). Of these, the CPT (including the GDS) continues to be among the most commonly used, despite mixed evidence regarding its validity. Both the CPT and the GDS appear to consistently discriminate ADHD and typical control groups, and both show expected changes when children are given stimulant medication. However, the evidence is mixed regarding their ability to discriminate children with ADHD from disordered controls and their associations with other measures of ADHD. Thus, the CPT and the GDS continue to be widely used yet both have mixed evidence supporting their validity.

In contrast to these measures, the C-DT and SST appear to have more evidence supporting their validity. Specifically, each of these measures has a demonstrated ability not only to discriminate ADHD children from normal control children, but they also have been demonstrated to be significantly associated with other measures of ADHD behavior. The SST has also been shown to be sensitive to medication. These conclusions should be tempered, however, by the fact that there is relatively little relevant data available, particularly for the C-DT.

Perhaps the safest conclusion from this review is that there continues to be relatively little data that allows for the evaluation of the validity of lab tasks for use in answering clinically important questions (see Table 1). Furthermore, of the data that are available for examining validity, the most common question is whether children with ADHD differ from non-ADHD control children. Very few studies report data necessary to answer other, clinically important questions, such as whether children with ADHD differ from psychiatric controls, whether the tasks are useful measures of response to intervention

(particularly stimulant medication), and whether the tasks correlate with other measures of ADHD (parent ratings, teacher ratings or observations). We found the lack of evidence examining correlations between the lab tasks and ADHD rating scales particularly surprising given that many researchers gather both pieces of information in conducting research.

The limited information on validity is of concern for at least two reasons. First, it raises serious questions for research, theory, and clinical work that rely on these measures. In essence, our review indicates that it is not yet clear whether the measures have any "real life" interpretation when they are used in many of the very ways that are of most interest clinically. Similarly, none of the measures *consistently* discriminated children with ADHD from normal controls or from psychiatric controls, which is critical if these measures are to be used as the basis of a clinical assessment and diagnosis. Until these facts are established, the clinical use of these measures will be limited.

Second, the fact that there is little evidence of the types of validity we reviewed is of concern because it suggests that little new research has been published for some tasks over the past decade[11], despite the apparently increased interest in the tasks. On the other hand, we believe this situation could be quickly reversed if investigators were to begin routinely reporting data that they may be already collecting. For example, knowledge on how lab tasks relate to other measures of ADHD could be dramatically furthered if investigators begin routinely examining the association between the laboratory task and parent/teacher ratings or behaviour observations which they likely already have. Similarly, some clinicians administer lab tasks before, during and treatment. If done correctly, these could be published as useful case studies or even small-sample group studies.

Another suggestion for future research is to move beyond examining the validity of individual tasks and toward evaluating the validity of combinations of tasks. Combining multiple tasks is analogous to using a multi-measure assessment strategy, which researchers and methodologists have long demonstrated to be important.[55] Preliminary investigations using combinations of laboratory tasks for ADHD appears to be promising. For example, one study found that by combining the C-DT and the SST as predictors, sensitivity, specificity, and overall correct classification for children with ADHD and typical controls was substantially higher as compared to either measure alone, with overall correct classification rates of 85%.[40] Additional research along these same lines has the potential to provide insight into the validity

Table 1
Summary of the Validity of Laboratory Cognitive Tasks for Assessing ADHD

Task	*Construct Measured*	*Task Description*
Continuous Performance	Attention (omission errors) Impulsivity (commission errors)	participants respond when they detect a predetermined letter *after* seeing another predetermined letter
Gordon Diagnostic System	Attention (omission errors) Impulsivity (commission errors)	3 different tasks: Delay (delay responding for 6 seconds), Vigilance (respond to 1s followed by 9s), Distractibility (ignore distracting stimuli)
Children's Checking	Attention (omission errors) Impulsivity (commission errors)	participants circle discrepancies between numbers presented on a tape recorder and what is written on a page in front of them
Delay of Gratification	Inhibitory control	participants must refrain from playing with / eating a forbidden target stimulus for a certain amount of time
Delay Aversion (Choice-Delay)	Motivation to avoid a delay	participants are presented with a repeated choice between a large delayed reward and a small immediate reward; once choice has been made, it cannot be changed
Stop Signal	Behavioural Inhibition	participants respond as quickly as possible to visual stimuli and try to inhibit their responses when an auditory tone is heard

of current models of ADHD, and may lead to the justifiable inclusion of laboratory measures within an ADHD assessment. This, in turn, could advance our ability to accurately assess ADHD.

In conclusion, we wish to emphasize that our intention in conduct-

Convergent Validity	*Discriminant Validity*	*Predictive Validity*
mixed—generally low to moderate relations with parent and teacher ratings	yes—normal controls mixed—psychiatric controls	yes—performance improves following trials with methylphenidate, particularly for commission errors
mixed—little data low to moderate relations with parent and teacher ratings	some evidence normal controls, yet little data some evidence—psychiatric controls, yet little data	yes—performance improves following trials with stimulant medication
yes—but not recent data	yes—normal controls mixed—psychiatric controls (preschool data)	yes—performance improves following trials with stimulant medication (preschool data)
no data	yes—normal controls no data—psychiatric controls	no data
yes—moderate relations with teacher report and direct observations	yes—normal controls no data—psychiatric controls	no data
yes—strong correlation between the SST and observations during a restricted academic situation in the lab mixed—associations with parent and teacher ratings are moderate	yes—normal controls mixed—psychiatric controls (discriminates between externalizing and internalizing problems)	yes—sensitive to the effects of methylphenidate

ing this review is not to dismiss laboratory tasks for ADHD. In fact, we strongly believe that laboratory tasks hold considerable potential. Among the potential advantages of lab tasks are: (1) they are low cost; (2) they could provide accurate assessments that are free from infor-

mant bias; (3) they could quickly and accurately assess treatment effects, (4) they could provide information about specific mechanisms of action that underlie psychopathology and treatment; and (5) they could provide a method of quickly and accurately discriminate children for screening purposes. However, these potential advantages will not be realized without further work to establish the validity of these measures.

Summary

The current review evaluated the validity of frequently used laboratory assessment methods of ADHD symptoms. We conducted this review because laboratory measures have potential to become very valuable clinical tools, but the validity for each clinical use must first be established. Our review showed that the Continuous Performance Tasks is the most widely used measure, but the Stop Signal Task and the Choice Delay Task are in many ways the most promising. Overall, no lab tasks can yet be recommended as valid for clinical purposes. Suggestions for future research include routine reporting of relationships between laboratory measures and teacher and parent ratings, and moving towards a multi-method assessment approach which would involve evaluating the validity of combinations of tasks.

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