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The license plate test performance in Canadian adolescents with learning disabilities: A preliminary study

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ABSTRACT

Accurate identification of symptom exaggeration is essential when determining whether data obtained in pediatric evaluations are valid or interpretable. Performance validity measures identify performance patterns that are implausible if the test taker is investing full effort; however, it is unclear whether or not persons with preexisting cognitive difficulties such as Specific Learning Disabilities (SLD) might be falsely accused of poor test motivation due to actual but impaired reading, processing or memory skills. The purpose of this study was to evaluate the newly developed License Plate Test (LPT) performance in students with identified SLD providing good effort, to examine the influence of severe reading or learning problems on LPT performance. Participants were 29 students with SLDs aged 11–14 years ($M=12.1$), who completed psycho-educational assessments as part of a transition program to secondary school. Results indicate that recognition memory measures on the LPT were insensitive to cognitive impairments in these children; all students achieved scores of 80% or higher on these tasks. Performance was more variable as test demands of the LPT increased, and the difference between performance on easy and hard subtests was related to greater difficulties with working memory. These results provide preliminary data regarding how children with SLD perform on the LPT, allowing for development of appropriate cut scores to maximize sensitivity and specificity of this test for use with child and adolescent populations.

KEYWORDS

Adolescents; assessment;
learning disabilities;
validity tests

It is now expected practice to include symptom and performance validity tests (SVTs & PVTs) when completing a neuropsychological assessment with adults (Bush et al., 2005; Heilbronner et al., 2009). While the majority of neuropsychologists now typically include measures of effort and motivation in their adult assessments (Martin et al., 2015; Sharland & Gfeller, 2007), it is only recently that clinicians have been encouraged to include such measures in assessment of children and adolescents (Green & Flaro, 2003; Heilbronner et al., 2009; Salekin et al., 2007). Despite past research showing that low effort or avoidance of disliked tasks could negatively influence children's performance on achievement tests and result in inaccurate diagnoses (e.g. Adelman et al., 1989), clinicians often assumed that the children they tested were always fully engaged in psychological or neuropsychological assessment tasks (Kirkwood et al., 2012; Salekin et al., 2007). Many recent studies, however, have demonstrated that children are indeed capable of feigning cognitive impairment during a neuropsychological evaluation (e.g. Flaro & Boone, 2009; Kirkwood et al., 2011; Kirkwood et al., 2010; McCaffrey & Lynch, 2009), and that parental coaching or persuasion can also produce false or exaggerated symptoms in such assessments (e.g. Lu & Boone, 2002). Given that clinicians are not able to accurately identify suboptimal effort using clinical judgment alone

(Guilmette, 2013) psychologists are now beginning to include PVTs in their evaluation of children and adolescents.

Very little research has been published regarding accurate identification of noncredible performance in this age group (DeRight & Carone, 2015). Furthermore, since the use of PVTs and SVTs is “virtually non-existent among school psychologists” (DeRight & Carone, 2015, p. 3), no objective data exist regarding the percentage of children who may feign or exaggerate during psychoeducational assessments. This is unfortunate, as we know that a large percentage of normal children engage in some type of lying or deception on a regular basis (e.g. see Peterson & Peterson, 2015) and the U.S. College admissions scandal of 2019 demonstrated how easily adolescents could feign Specific Learning Disabilities (SLD) in order to obtain academic accommodations (Taylor, 2019).

It is therefore essential to investigate methods to accurately identify children and adolescents who are not investing maximal effort in testing, while also minimizing the risk of misattributing poor but honest performance to low motivation/effort in those with developmental or acquired disabilities.

Relatively few existing PVTs have been shown to demonstrate good sensitivity and specificity to noncredible

performance in children and adolescents (Harrison, 2015); the Word Memory Test (WMT; Green, 2003) and the Medical Symptom Validity Test (MSVT; Green, 2004) are two exceptions (e.g., Carone et al., 2014; Green & Flaro, 2003; Kirkwood & Kirk, 2010). Research suggests that the WMT and MSVT are relatively unaffected by reading impairments in children and adolescents so long as overall word decoding skills are better than the 1st percentile and word reading skills are at a grade 3 level or higher (Green & Flaro, 2003; Larochette & Harrison, 2012). Research also shows that these two tests return low false positive rates in assessment of children and adolescents with severe ADHD (Harrison et al., 2015). Other PVTs have been shown to have relatively weaker sensitivity to noncredible performance in children or have an unacceptably high false positive diagnosis rate in those with learning or attention problems (see Harrison & Armstrong, 2018; Harrison et al., 2015). As such, there is a need to develop additional PVTs that can be used in child and adolescent assessments, with normative data to ensure that those with developmental disorders are not falsely accused of symptom exaggeration.

Recently, Green's Publishing developed a novel measure of performance validity called the License Plate Test (LPT). The License Plate Test is a computerized PVT developed to help identify instances of noncredible test performance in those undergoing neuropsychological or psychoeducational assessments, while also including a genuine learning and retention component. The test presents a combination of 10 imaginary license plates from actual American states, each with different background images, a state name at the bottom, and an additional word pair in the upper section of the license plate. Examinees are shown these 10 images twice via a computer screen while also being asked to name aloud all three components of the license plate (word pair, state name, background picture). In the immediate forced-choice recognition trials, subjects must choose between two options for each of the three variables previously presented (words, state name, and background pictures) both individually and then in pairs. In the image recognition trial the original images are paired with foils not previously seen by the subject. Finally, examinees must recall as many words, states and background images as possible. Portions of this task are meant to be difficult whereas others are designed to capitalize on recognition memory, a type of memory skill that is resistant to all but the most severe forms of neurological injury (Green & Merten, 2013). As a result, it is hoped that this test can identify not only when an examinee is performing non-credibly relative to most other individuals, but to also identify performance decrements typical of those with genuine neurological disorders.

At present, no normative data have been obtained for performance on this test by children or adolescents, including those with developmental disabilities that might interfere with accurate performance on the LPT. The present study therefore aimed to assess LPT performances in a group of grade 7 students with identified SLDs and current academic accommodations, to assess the influence of severe reading and learning difficulties on LPT performance. These

Table 1. Demographic information.

Sex	%Female	24.1		
	N	Mean	SD	Range
Age (y)	29	12.1	0.37	11.0–13.0
WISC FSIQ	6	93.8	6.9	88–106
WJ IV GIA	22	96.2	11.4	81–124

students were participating in a transition program, a component of which involved updated psycho-educational testing to identify their specific learning needs as they made the transition to secondary school. Given that these students already had accommodations in place within their schools, and given that each student had a documented history of learning problems dating back to the early grades, it was felt that they were an ideal group from whom to obtain normative data as they had little external incentive to feign or exaggerate their learning problems.

The purpose of the present study was therefore to gather preliminary data on the LPT performance of young adolescents with specific reading disorders, to develop baseline scores against which exaggerated performance in other populations might be determined. Further, we were interested in determining whether some aspects of this complex PVT might be more difficult for those with reading difficulties, and if specific cognitive impairments in memory or reading might be associated with lower scores on specific recognition or memory sections of the LPT.

Method

Participants

Participants were 29 young adolescents (24.1% female) aged 11–13 y (Mean = 12.1, SD = 0.37) who completed psycho-educational assessments at a university assessment center between 2015 and 2019. These students were referred by their schools to participate in a comprehensive program designed to assist students with SLD in their transition from elementary to secondary school. Psycho-educational assessments were performed by clinical psychologists or graduate students supervised by licensed clinicians. All students had been assessed and identified under the Ontario Ministry of Education criteria for exceptionality as “learning disabled”¹ some time prior to fifth grade. As shown in Table 1, the young adolescents in the current sample were of average intelligence. Most students participated in three testing

¹The Ontario Ministry of Education classifies individuals as Learning Disabled as “having a learning disorder evident in both academic and social situations that involves one or more of the processes necessary for the proper use of spoken language or the symbols of communication, and that is characterized by a condition that: (1) Is not primarily the result of impairment of vision, impairment of hearing, physical disability, developmental disability, primary emotional disturbance, or cultural difference; (2) results in a significant discrepancy between academic achievement and assessed intellectual ability, with deficits in one or more of the following: receptive language (listening, reading), language processing (thinking, conceptualizing, integrating), expressive language (talking, spelling, writing), or mathematical computations; and (3) may be associated with one or more conditions diagnosed as: a perceptual handicap, a brain injury, minimal brain dysfunction, dyslexia, developmental aphasia.” (Taken from http://www.oise.utoronto.ca/adaptivetech/Special_Ed/Communication_Exceptionality/Learning_Disability/index.html.)

sessions lasting approximately three hours each over the course of two to three weeks, and were administered two stand-alone PVTs as well as this new measure. The current sample did not include students with any other known neurological or behavioral problems apart from possible comorbid Attention Deficit Hyperactivity Disorder.

Measures

Students in the transition program were administered a comprehensive test battery that included: a measure of general intellectual ability (either the Wechsler Intelligence Scale for Children—Fourth Edition subtests (WISC-IV; Wechsler, 2003) or the Woodcock–Johnson-IV Test of Cognitive Abilities (WJ-IV; Schrank et al., 2014); measures of academic achievement (the Woodcock Johnson IV Test of Achievement-IV (WJ-IV; Schrank et al., 2014) or the WIAT-III (Wechsler, 2009); and phonological awareness (Comprehensive Test of Phonological Processing (CTOPP; Wagner et al., 1999). Memory was assessed using either the Wide Range Assessment of Memory and Learning-2 (WRAML-2; Sheslow & Adams, 2003) or the Child and Adolescent Memory Profile (ChAMP; Sherman & Brooks, 2015), a recently developed memory test for children and young adults aged 5 through 21 years.

All participants were also given the LPT, the Medical Symptom Validity Test (MSVT; Green, 2004) and another validity test to identify exaggerated reading problems (The Dyslexia Assessment of Simulation or Honesty [DASH]; Harrison et al., 2008).

As noted above, the LPT is a brief computer-administered test of learning and memory. It requires the examinee to learn information from 10 imaginary license plates. Each license plate consists of a word pair at the top of the plate, a name of an American state at the bottom of the plate, and a background picture. Typical time for completion is said to be between 7 and 9 minutes.

The measures included in the LPT are complex; they consist of eight separate tasks or subtests that result in eight corresponding scale scores. These subtests are as follows: Word Recognition (WR), State Recognition (SR), Image Recognition (IR), Paired-Associate Words (PAW), Paired-Associate States (PAS), Free Recall Words (FRW), Free Recall States (FRS), and Free Recall Images (FRI). All subtest scores are based on percentage correct. With respect to the three recognition scales, WR, SR, and IR, each scale is based on the examinee's ability to correctly choose between a stimulus from the original list and a foil stimulus (e.g. choosing the correct word, state, or image from the original list for each respective task). The next two scales, PAW and PAS, are paired associate tasks in which a cue is given to the participant for the response. For PAW, the participant is given the first word of the word pair from the original image and must provide the second word which went with it. In the PAS scale, the participant is provided a word pair and then must say the correct state on which the word pair appeared (e.g. which state license plate had this word pair?).

Finally, the free recall scales, FRW, FRS, and FRI, are based on the participant's ability to name as many of the

stimuli as possible without forced choice or paired options (e.g. "Tell me all of the states you can remember from the original list"). Also recorded is the total time taken, and a comparison of performance difference between "easy" versus "hard" subtests.

Procedure

Adolescents with a previous identification of a specific SLD were referred by their schools to participate in an ethics-approved research project designed to assist in their successful transition from elementary to secondary school. An updated psycho-educational assessment was provided as part of the research program to help the students better understand their specific learning needs, and where appropriate, to inform school personnel regarding the interventions and supports suggested for each student once they began high school. The assessment did not occur within the school, and so the results were not shared with school personnel without the express permission of the student and his/her family.

Two local school boards disseminated application forms to students in grade 7 with a longstanding SLD identification. Students came with their parents for an initial screening interview to determine if their child met the criteria for program participation, and informed consent to participate in the study was obtained at this time. All participants agreed to allow their test data to be used for research purposes.

Each assessment consisted of a core battery of intellectual, cognitive, and academic tests plus any additional testing required to evaluate the difficulties of specific students. The assessment sought not only to examine the reasons for experienced reading difficulties, but to also evaluate cognitive strengths and determine if other co-morbid conditions might be affecting learning. While all students were administered the PVTs, some students were not administered the full test battery due to time constraints (where tests not relevant to their specific complaints were not administered if time was limited) or (rarely) the need to maintain rapport by avoiding tasks that were clearly too difficult. Additionally, the academic test battery changed after the first and second years, meaning that different achievement and memory tests were administered to different cohorts of students.

Results

All students passed both the MSVT and the DASH. As such, and given that they had already been identified as SLD in their schools, it seemed reasonable to assume that all students were investing acceptable effort in the assessment process.

Table 2 shows the achievement, memory and processing scores of the students. As may be seen, many students had weak rapid naming abilities, and some continued to have phonological processing difficulties. While the average scores for reading tasks fell in the broad average range, the distribution was significant and half or more of the students

Table 2. Mean, SD and range of reading and memory tests administered.

Test	N	Mean	SD	Range	% <SS 85
Reading					
WIAT					
Word reading	7	88.4	15.3	67–111	57.1
Reading comprehension	7	92.0	3.9	85–97	0
WJ IV					
Broad reading	22	87.8	11.3	73–112	50.0
Passage comprehension	23	89.2	12.1	70–127	34.8
Sentence reading fluency	23	89.3	13.2	68–121	43.5
Letter word identification	20	90.2	12.0	70–112	35.0
Word attack	20	92.0	11.5	69–114	25.0
CTOPP					
Phonological awareness	8	88.8	17.4	71–122	37.5
Rapid naming	8	78.4	9.5	67–92	62.5
Memory					
WJ IV					
Short term working memory	23	95.1	10.4	72–121	13.0
Long term retrieval	23	99.4	9.7	84–116	4.3
WRAML					
Story memory	6	9.83	3.7	5–15	16.7
Story memory delayed	6	8.17	4.0	1–12	33.4
Verbal memory	4	97.0	6.0	88–100	0
Visual memory	4	105.3	18.6	85–126	0
ChAMP					
Verbal memory	14	107.7	9.7	92–123	0
Visual memory	14	99.1	13.4	76–120	14.3
Total memory	14	103.9	10.2	84–117	7.1

Note: WIAT: Wechsler Individual Achievement Test; WJ IV: Woodcock Johnson IV; WRAML: wide range assessment of memory and learning; ChAMP: child and adolescent memory profile.

performed below the 16th percentile on measures of broad reading ability. In general, memory scores were average, although again there were a number of subjects with below average scores.

Mean LPT performance may be seen in Table 3. Recall that LPT scores (except easy-hard difference and total time) represent a percentage score with 100% being the maximum. As may be seen, the word, state and image recognition subtests appeared relatively easy for these students, all students scoring at least 80%.

By contrast, the PAS and FRS tasks were the most difficult, with the average student achieving less than 50% accuracy. Free recall words, FRI, and PAW also proved to be difficult for many students, averaging 77% or lower accuracy on these subtests. Further, on each of the subtests FRS and FRI one student was unable to answer any questions correctly and two students could not get any PAS pairs correct. The easy-hard question difference averaged 21.25 points, with a range of 0 to 41.7. As predicted by the test author, total time taken to complete this test averaged just over 7 minutes, with a range of 4.3–16.3.

While the overall difference between easy and hard items was 21.3, it is also useful to consider the mean differences between the three recognition subtests. The absolute differences are statistically different from one another: the WR-SR and WR-IR differences are of similar size ($m = 4.66$, $sd = 6.1$, and $m = 4.31$, $sd = 5.5$ for those differences, respectively), while the SR-IR difference was quite small by comparison ($m = 1.38$, $sd = 3.5$). A comparison of these three scores using a repeated measures ANOVA found significant differences ($F(2,56) = 6.62$, $p = .003$).

Table 3. Mean, SD and range of LPT subscales.

LPT subscale	N	Mean	SD	Range
Word recognition	29	95.3	6.1	80–100
State recognition	29	98.6	3.5	90–100
Image recognition	29	99.3	2.6	90–100
Word paired associates	29	77.1	18.8	40–100
State paired associates	29	45.6	22.9	0–100
Free recall word	29	67.6	16.8	40–100
Free recall state	29	47.9	19.0	0–100
Free recall image	29	70.3	19.9	0–100
Easy/hard difference	29	21.3	9.0	0–41.7
Total test time	29	7.5	2.3	4.3–16.3

We were interested to see whether any cognitive or memory skills might be associated with level of LPT subtest performance. Table 4 outlines the significant correlations identified in the present study. As may be seen, few variables were correlated with LPT performance on the easier recognition tasks. Notably, no relationship was found between the LPT subtests and any measure of overall intellectual functioning.

As may be seen, SR was positively associated with sentence reading fluency. On the WRAML, there is a negative correlation between WR and story memory (immediate and delayed). This seemingly incongruous finding occurred because four of the six participants obtained a perfect score on the LPT word recognition task, but the two others who obtained scores of 90 and 95% on this LPT task obtained higher scores on the WRAML story memory tasks than did the other four. So, while there is a negative correlation it is, in actuality, a meaningless association as all of these students performed well on both the WRAML memory and the LPT word recognition tasks. Looking at the larger number of students who completed the WJ-IV there is a positive relationship between LPT WR score and long-term retrieval abilities. Notably, the lowest score on this LPT recognition task was 80% and this was achieved by the student with the lowest long term retrieval score on the WJ-IV.

A relatively larger number of significant relationships were identified between the non-recognition LPT subtests and measured academic and memory skills. Table 5 shows only the significant correlations between LPT non-recognition tasks and measured reading and memory skills. As may be seen, those with better overall memory scores took less time on the LPT, as did those with better passage comprehension. Long-term memory retrieval skills were significantly and positively associated with performance on the PAW subtest ($p < .001$), and short term working memory skills were associated with FRW ($p = .041$). Recall for states (both paired associates and free recall) were positively associated with ChAMP scores: with PAS being associated with both verbal memory ($p = .013$) and delayed recall of lists ($p = .047$), and state free recall being associated with object memory ($p = .044$). For this latter test, the correlation is likely due to the small sample size because one child obtained a score of zero on state free recall and yet had the highest score on ChAMP objects. Another child returned a perfect score on FRS but achieved only a standard score of 9 (37th percentile) on ChAMP objects. Excluding these two scores there is no significant association.

Table 4. Significant Spearman Rho correlations among LPT recognition variables versus reading and memory measures.

LPT recognition Subscales	Reading skills									
	Woodcock Johnson IV									
	Sentence reading fluency									
	Rho	<i>p</i>			<i>n</i>					
State Rec	0.478	.021			23					

LPT recognition Subscales	Memory skills											
	WRAML						Woodcock Johnson IV					
	Story memory			Story delay			Long term retrieval					
	Rho	<i>p</i>		<i>n</i>	Rho	<i>p</i>		<i>n</i>	Rho	<i>p</i>		<i>n</i>
Word Rec	-0.857	.029		6	-0.845	0.034		6	0.482	.020		23

Table 5. Significant Spearman Rho correlations among LPT non-recognition variables versus reading and memory measures.

LPT non-recognition subscales	Reading skills									
	Woodcock Johnson IV									
	Sentence reading fluency			Passage comprehension						
	Rho	<i>p</i>		<i>n</i>	Rho	<i>p</i>		<i>n</i>		
Word PA	0.437	.037		23	0.545	.007		23		
Image FR	0.442	.035		23						
Total time					-0.447	.032		23		

LPT non-recognition subscales	Memory skills									
	WRAML									
	Story memory									
	Rho	<i>p</i>		<i>n</i>						
Total time	-0.812				.05					

LPT non-recognition subscales	Woodcock Johnson IV									
	Short term WM			Long term retrieval						
	Rho	<i>p</i>		<i>n</i>	Rho	<i>p</i>		<i>n</i>		
	Word PA					0.716	<.001		23	
Word FR					0.428	.041		23		
State FR	-0.477	.021		23						
Easy/Hard difference	0.483	.020		23						

LPT non-recognition subscales	ChAMP											
	Lists delayed			Objects			Instructions			Verbal memory		
	Rho	<i>p</i>		<i>n</i>	Rho	<i>p</i>		<i>n</i>	Rho	<i>p</i>		<i>n</i>
	State PA	0.538	.047		14					.642	.013	
State FR					-0.545	.044		14				
Total Time									-0.548	.042		14

Note: WJIV: Woodcock Johnson IV; WRAML: wide range assessment of memory and learning; LPT: License Plate Test; PA: paired associates; FR: free recall; WM: working memory.

Sentence reading fluency and passage comprehension were both positively correlated with performance on the PAW subtest ($p = .037$ and $.007$, respectively), and FRI was associated with reading fluency ($p = .035$).

Discussion

Ensuring that the data collected during an assessment is valid and reliable is essential; one cannot make an accurate diagnosis or appropriate treatment recommendations if the

data collected is noncredible. Furthermore, such exaggeration is likely to go undetected by assessing professionals who rely exclusively on clinical judgment to detect noncredible responding in younger patients (Faust, Hart, & Guilmette, 1988; Faust, Hart, Guilmette, & Arkes, 1988). While we know that children and adolescents can exaggerate their problems or invest low effort during testing, few objective measures exist to help clinicians identify such behavior when it occurs. The purpose of the present study was therefore to gather preliminary data on the LPT

performance of young adolescents with SLD, to develop baseline scores against which exaggerated performance in other populations might be determined. Further, we were interested in determining whether some aspects of this complex PVT might be more difficult for those with reading difficulties, and if specific cognitive impairments in memory or reading might be associated with lower scores on specific recognition or memory sections of the LPT.

Consistent with findings from other studies using performance validity tests with children (e.g. Green & Flaro, 2003; Green et al., 2010; Larochette & Harrison, 2012), results from the present study show that children with specific learning disabilities can perform normally on the recognition tasks of the LPT; the average child could achieve 95% accuracy or higher, and even those with severe developmental reading problems could achieve at least 80% or higher on the word recognition task and 90% or higher on the other recognition tasks. As such, the first three recognition tasks of the LPT appear useful in discriminating those investing good effort from those who are exaggerating memory or learning impairments.

It is true that we found a negative correlation found between the six students given the WRAML and the LPT, but this was due to the fact that four of the six achieved perfect scores on the LPT while the other two achieved only 90 or 95% accuracy on the LPT but better memory scores on the WRAML. Overall, none of these six students achieved less than a 90% score on any LPT recognition test, and no correlation was found between performance on other memory measures and LPT recognition measures. As such, it can be concluded that the recognition tasks included on the LPT are virtually insensitive to actual cognitive impairment.

On the other LPT measures that were hypothesized to be more positively associated with cognitive skills, confounds were also noted to cause seemingly negative correlations between two LPT subtests (state free recall and state pair associates) and cognitive skills. Here again, one student received a low score on these two LPT measures and high scores on the ChAMP whereas all other students did less well on the memory tests but better on these LPT tests. Removal of this one student eliminated any correlation between these harder LPT scores and ChAMP memory scores.

Total time taken on the LPT correlated negatively with ability to follow instructions on the ChAMP, which makes sense intuitively; those who have more difficulty following instructions (and hence have a lower score) will take longer to complete a task with complex instructions. Similarly, those who have more difficulty with comprehension and long-term retrieval of information will have more difficulty accessing learned information such as word pairs. Fluency of access also interferes with long-term recall, as seen in the lower recall of word pairs and free recall of images seen on the LPT. Finally, those with worse short-term memory had a larger difference between easy and hard items.

Like most studies of this kind, there were some notable limitations; mainly, the sample size was small. Nevertheless,

the fact that all of these disabled children could pass the recognition tasks easily lends more credence to the notion that these recognition tasks are unlikely to misdiagnose an individual with a true learning disorder as investing low effort. Additionally, given that these students were Canadian, the fact that their worst scores were on free recall and paired associates for state names may be a function of nationality rather than disability status—these are not names that young children in Canada learn from a young age. Further research should be undertaken with children from the United States who have SLD.

Inconsistent use of tests in the assessment battery also made it difficult to know to what extent cognitive abilities may be associated with performance on the LPT subtests. Future research ensure that a consistent test battery is given to a larger sample.

Good effort tests should be as insensitive as possible to actual cognitive impairments. Overall, the LPT shows promise as a measure of both invalid responding while also being sensitive to genuine learning impairments. Children with SLDs in reading or writing were easily able to pass the recognition subtests of the LPT, with more variability in performance found on the harder subtests. The use of the easy-hard difference may assist clinicians in identifying those students who have genuine learning or memory impairments that interfere with performance on the more difficult subtests relative to the easy recognition ones.

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