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Pediatrics; originally published online March 10, 2014;
DOI: 10.1542/peds.2013-3195

Postconcussive Symptom Exaggeration After Pediatric Mild Traumatic Brain Injury

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KEY WORDS

mild TBI, concussion, postconcussive symptoms, postconcussion syndrome, symptom exaggeration, feigning, neuropsychological, validity testing, pediatrics

ABBREVIATIONS

ADHD—attention-deficit/hyperactivity disorder
CSI—Concussion Symptom Inventory
MSVT—Medical Symptom Validity Test
mTBI—mild traumatic brain injury
PVT—performance validity test

Dr Kirkwood conceptualized and designed the project and study, coordinated aspects of data collection, and drafted the initial manuscript; Dr Peterson assisted in study design, conducted the initial analyses, drafted the results section, and reviewed and revised the entire manuscript; Dr Connery contributed to the conceptualization of the project, coordinated portions of data collection, and reviewed and revised the manuscript; Drs Baker and Grubenhoff reviewed and revised the manuscript; and all authors approved the final manuscript as submitted.

www.pediatrics.org/cgi/doi/10.1542/peds.2013-3195

doi:10.1542/peds.2013-3195

Accepted for publication Jan 9, 2014

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PEDIATRICS (ISSN Numbers: Print, 0031-4005; Online, 1098-4275).

FINANCIAL DISCLOSURE: Dr Kirkwood receives royalties from a book cited in the article; the other authors have indicated they have no financial relationships relevant to this article to disclose.

FUNDING: No external funding.

POTENTIAL CONFLICT OF INTEREST: The authors have indicated they have no potential conflicts of interest to disclose.

WHAT'S KNOWN ON THIS SUBJECT: After mild traumatic brain injury, most youth recover well. A minority of patients report persistent symptoms, which relate to both injury and noninjury factors. In adult studies, validity test performance is 1 noninjury factor that relates to persistent symptoms.

WHAT THIS STUDY ADDS: This is the first pediatric study to demonstrate that validity test failure is associated with increased symptoms after mild traumatic brain injury. The findings suggest that some symptoms conceptualized as injury-related "postconcussive" problems are better explained by exaggeration or feigning.

abstract

BACKGROUND: A minority of pediatric patients who have mild traumatic brain injury (mTBI) report persistent postconcussive symptoms. In adults, failure on validity tests, which help to detect exaggerated or feigned problems, is associated with symptom complaints. No pediatric studies have examined the relationship between validity test performance and symptom report. We hypothesized that children failing a validity test would report significantly more postconcussive symptoms than those passing.

METHODS: Using a consecutive clinical case series design, we examined 191 patients aged 8 to 17 years seen for neuropsychological evaluation after mTBI. Participants were administered a validity test (Medical Symptom Validity Test; MSVT) and completed a graded symptom scale as part of a neuropsychological battery.

RESULTS: A total of 23 participants (12%) failed the MSVT. The Fail group endorsed significantly more postconcussive symptoms than the Pass group, with a large effect size ($P < .001$; $d = 1.1$). MSVT performance remained a robust unique predictor of symptom report even after controlling for other influential factors (eg, female gender, premorbid psychiatric problems).

CONCLUSIONS: A subset of children who had persistent complaints after mTBI may be exaggerating or feigning symptoms. If such negative response bias remains undetected, errors in etiologic statements and less than optimal treatment may occur. Because the detection of invalid responding is well established in neuropsychology, clinical neuropsychologists should be incorporated routinely into clinical care for patients who have persistent complaints. To better control for noninjury effects in future pediatric mTBI studies, researchers should add validity tests to neurobehavioral outcome batteries. *Pediatrics* 2014;133:643–650

After uncomplicated pediatric mild traumatic brain injury (mTBI), methodologically rigorous studies using performance-based tests provide little evidence that difficulties persist beyond the initial days to weeks.[1–6] This finding corresponds with the general conclusions of several critical reviews,[7–9] as well as meta-analytic studies with both pediatric and adult samples.[10–17] In contrast, when examining outcomes by using subjectively reported symptoms, a minority of pediatric patients endorse more persistent problems.[18] One factor that has been found to increase the risk for persistent symptoms is more severe mTBI, such as injury associated with intracranial pathology on neuroimaging.[19–22] However, the effect of injury-related factors tends to diminish over time[23] and not all "postconcussive" symptoms are driven by injury-related neurologic factors. Postconcussive symptoms are nonspecific, occurring often in normal samples.[24–28] Symptoms after pediatric mTBI are also associated with multiple other noninjury factors, including premorbid symptom ratings,[23] premorbid learning and behavioral problems,[29,30] demographic factors,[23] maladaptive coping,[31] comorbid bodily injury and pain,[32] and parental anxiety and family stress.[6,33]

Another noninjury factor that likely helps to account for some postconcussive problems is symptom exaggeration and/or feigning, which has been neglected almost entirely in the pediatric mTBI literature. In compensation-seeking mTBI adult samples, malingering is found surprisingly often, in 40% to 50% of cases.[34–37] Outright malingering is apt to occur less frequently in children, although multiple case reports and case series have documented that children provide noncredible responses at least occasionally during health care examinations.[38–50] Only 1 identified study has focused on how frequently noncredible responding occurs after pediatric mTBI specifically. A consecutive neuropsychological case series of ours consisting of 193 school-aged children found that 17% of the sample failed a performance validity test (PVT).[51]

PVTs are designed to appear difficult but in actuality are easy and can be performed well with little effort or ability.[52] In adults after mTBI, ~50% of the variance in neuropsychological ability-based test performance is accounted for by whether examinees exert adequate effort as measured by PVTs.[53–56] We found that nearly 40% of the ability-based variance was accounted for by PVT performance in children after mTBI,[57] supporting the idea that some of the cognitive effects that are attributed to pediatric mTBI in clinical and research contexts are likely better explained by noncredible effort.

In adult mTBI samples, performance on PVTs has also been found to be strongly associated with increased self-reported postconcussive symptomatology.[55,58,59] No identified pediatric study has examined the relationship between PVT performance and postconcussive symptoms. The current study was designed to examine the relationship between PVT failure and self-reported symptoms in a pediatric mTBI sample. We hypothesized that children failing a PVT would report significantly more symptoms than those passing the PVT and that PVT pass/fail status would independently contribute to overall level of reported symptomatology.

METHODS

Participants

The project was approved by the university-affiliated Institutional Review Board. Participants were drawn from consecutive clinical cases referred to an outpatient pediatric concussion program. Patients were considered eligible if they were aged 8 to 17 years at the time of evaluation. Subgroups or earlier versions of this same case series have been presented elsewhere.[51,57,60,61] All patients had sustained blunt head trauma within the previous 12 months with evidence of altered mental/neurologic status. Children who had complicated mTBI (defined as depressed skull fractures or any intracranial pathology on neuroimaging) were included if Glasgow Coma Scale score was never <13. Children who underwent neurosurgical intervention or who were referred forensically were excluded. Sample characteristics are provided in Table 1.

Measures

Background information for all participants was collected using a standardized questionnaire completed by the parents. Data were confirmed and clarified during clinical interviews conducted by board certified neuropsychologists. A participant was considered to have a positive history of the psychiatric and developmental disorders presented in Table 1 (eg, anxiety, attention-deficit/hyperactivity disorder [ADHD]) if the child had ever been diagnosed or treated by a health care provider. The conditions were not considered mutually exclusive. Injury-related information was gathered during interviews with parents and participants, as well as from available medical records.

The Medical Symptom Validity Test (MSVT)[63] is a computerized forced-choice verbal memory test designed to evaluate response validity. Examinees are presented with 10 semantically related word pairs twice on a computer screen. They are then asked to choose the correct word from pairs consisting of the target and a foil, during immediate and delayed recognition conditions. Examinees receive auditory and visual feedback about the correctness of each response. The actuarial criteria proposed by Green[63] were considered indicative of invalid responding. Data from independent studies and the publisher indicate

TABLE 1 Background and Injury Characteristics of All Participants

Participants, *N*	191
Age in years, mean (SD)	14.53 (2.28)
Grade level, mean (SD)	8.68 (2.28)
Male, *n* (%)	114 (59.7)
Caucasian, *n* (%)	146 (76.4)
Estimated FSIQ, mean (SD)[a]	103.16 (11.30)
Maternal years of education, mean (SD)	15.05 (2.48)
Paternal years of education, mean (SD)	14.69 (3.58)
Premorbid history of psychiatric diagnosis or treatment, *n* (%)	68 (35.6)
Anxiety, *n* (%)	37 (19.4)
Depression, *n* (%)	33 (17.3)
Conduct problems, *n* (%)	9 (4.7)
ADHD, *n* (%)	37 (19.4)
Premorbid history of diagnosed learning disability, *n* (%)	37 (19.4)
Premorbid history of special education services, *n* (%)	28 (14.7)
History of previous traumatic brain injury, *n* (%)	90 (47.1)
Number of previous traumatic brain injury, mean (SD); range	0.88 (1.21); 0 to 6
Weeks since injury, median (SD)	6.0 (9.72)
Loss of consciousness, *n* (%)	33 (17.3)
Injury cause, *n* (%)	
Sport	118 (61.8)
Fall	32 (16.8)
Recreational vehicle	15 (7.9)
Motor vehicle collision	9 (4.7)
Auto versus pedestrian	5 (2.6)
Assault	3 (1.6)
Other	9 (4.7)
Neuroimaging conducted, *n* (%)	129 (67.5)
Intracranial findings for those who underwent neuroimaging, *n* (%)	10 (7.8)
Families in or planning on litigation, *n* (%)	7 (3.8)
Families seeking disability compensation, *n* (%)	0 (0)
Participants charged with a crime, *n* (%)	2 (1.1)

[a] Based on performance on the 2 subtest version of the WASI.[62]

that children with a second- to third-grade reading level score above the recommended pass/fail cutoffs.[64–67]

Postconcussive symptoms were rated using a graded symptom scale. The scale included 11 of 12 items from the Concussion Symptom Inventory (CSI).[68] The CSI was developed by using stringent psychometric techniques applied to postconcussive ratings from 16 350 high school and college athletes followed prospectively, as well as from 641 athletes who were subsequently concussed. The CSI items are rated on a 7-point Guttman scale. To help ensure understanding for our pediatric patients, we simplified the response choices to a 3-point scale (0 = "never," 1 = "some," and 2 = "a lot") and modified the wording of several items (eg, "nausea" to "sick to stomach"). We also combined the items "drowsiness" and "fatigue" into a single item, "feeling tired." In the current sample, the modified version of the scale demonstrated high internal consistency (Cronbach's α = 0.87).

Procedure

Patients underwent testing no earlier than 1 week post-injury and no later than 52 weeks post-injury. Median testing time was 6 weeks post-injury. As part of the neuropsychological test battery, all children were administered the MSVT. All children completed the modified CSI, with <1% of item ratings missing.

Data Preparation

Data were examined for departures from normality and extreme outliers. All but 2 variables had acceptable skew and kurtosis (absolute value <2). Time since injury was positively skewed, with 4 individuals falling more than 3 SD from the mean. These outliers were trimmed to +3 SD, resulting in acceptable skew and kurtosis. Parent education was kurtotic because of a disproportionate number of individuals with 16 years of education, but skew was acceptable.

Analyses

First, we explored associations between self-reported symptoms and background and injury characteristics by using independent samples *t* tests and Pearson correlations. Second, we tested whether these characteristics had a relation to MSVT failure by using independent samples *t* tests and χ^2 analyses. Third, we examined the relationship between MSVT failure and overall postconcussive symptom report with an independent-samples *t* test. We then compared the 2 groups' mean responses to each of the 11 individual items. Because of nonnormality at the item level, we compared responses using the Mann-Whitney *U* test. We used a Bonferroni correction to conservatively control the family-wise error rate. The resultant $P < .004$ was used to indicate significance.

Next, we conducted hierarchical regression analyses to explore the independent effect of MSVT failure on self-reported symptoms. Assumptions for multiple regression analysis were met. In the first step, we entered age, gender, and history of psychiatric problems. We then entered weeks since injury and presence of neuroimaging pathology. Lastly, we entered MSVT pass/fail status. We first completed this analysis in the full sample. In a follow-up analysis, we considered just those who had sport-related injuries.

Finally, to better understand the meaning of MSVT failure for reported symptomatology, we compared the percentages of the MSVT Pass and Fail groups who endorsed differing total number of symptoms. We considered an individual

symptom endorsed if the participant responded either 1 ("some") or 2 ("a lot").

RESULTS

Relationship Between Symptoms and Background and Injury Factors

Endorsement of symptoms was not significantly associated with age, grade, estimated IQ, parental education, or premorbid learning disability or special education. Girls reported higher levels of symptoms than boys ($P < .001$, $d = 0.56$). In addition, premorbid psychiatric problems were associated with higher postconcussive symptom report ($P = .017$, $d = 0.36$). Premorbid anxiety and depression diagnosis or treatment both predicted higher symptoms (anxiety: $P = .037$, $d = 0.39$; depression: $P = .004$, $d = 0.56$). There was no relationship between symptoms and premorbid conduct problems or ADHD. Significantly more symptoms were apparent for those seen sooner after injury ($r = -0.19$, $P = .007$). Loss of consciousness, mechanism of injury, history of previous TBI, and litigation status had no relationship to reported symptoms. Participants with neuroimaging pathology reported fewer symptoms than participants with normal imaging results ($P = .004$, $d = 1.12$) or participants who did not undergo imaging ($P = .009$, $d = 1.05$).

Differences Between MSVT Pass and MSVT Fail Groups

Of the 191 participants, 23 (12.0%) failed the MSVT. The Pass and Fail groups did not differ in age, grade, gender, race/ethnicity, parental education, premorbid learning disability or special education use, litigation status, mechanism of injury, time since injury, or whether the injury was associated with loss of consciousness or neuroimaging pathology. At the time of evaluation, 2 participants reported being accused of a crime, both of whom passed the MSVT.

Participants who had a premorbid history of psychiatric treatment or diagnosis were significantly more likely to fail the MSVT than those who had no such history (20.6% vs 7.3%; $P = .007$). Among specific diagnoses, only participants who had a premorbid history of anxiety were significantly more likely to fail the MSVT than those who had no such history (24.3% failure for those who had anxiety history compared with 9.1% failure for those who had no such history; $P = .011$). There were no significant differences for the 2 groups for premorbid depression, conduct problems, or ADHD.

Relationship Between MSVT Pass/Fail and Reported Symptoms

The MSVT Fail group endorsed significantly more postconcussive symptoms than the MSVT Pass group, with a large effect size ($P < .001$; $d = 1.1$). Mean responses of the MSVT Pass and Fail groups for individual postconcussive symptoms are provided in Table 2. The MSVT fail group endorsed numerically more symptoms for all individual items, with a mean effect size (Cohen's *d*) of 0.71. Group differences were statistically significant after Bonferroni correction for 7 of 11 items.

Results of hierarchical regression analyses exploring the independent effect of MSVT failure on self-reported symptoms are shown in Table 3. Age, gender, and history of psychiatric problems explained 10% of the variance, with both gender and premorbid psychiatric problems providing significant unique prediction of self-reported postconcussive symptoms. Inclusion of injury-related variables resulted in a significant improvement in the model's predictive ability. Both weeks since injury and presence of neuroimaging pathology provided significant unique prediction of postconcussive symptoms. Finally, MSVT pass/fail resulted in significant improvement in model prediction. In the final model, female gender, shorter time since injury, positive neuroimaging findings, and MSVT failure all provided significant unique prediction of more postconcussive symptoms. A very similar pattern of results was evident in the follow-up regression analysis of just those individuals who had sport-related injuries.

Cumulative percentages of total symptoms endorsed for the MSVT Pass versus Fail groups are shown in Fig 1. As can be seen, the MSVT Fail group endorsed more symptoms at each item level. In the full sample, the median number of items endorsed was 8. In the MSVT Fail group, 81.8% endorsed 8 or more symptoms compared with 49.8% of the MSVT Pass group, a statistically significant difference ($P = .005$).

DISCUSSION

The primary purpose of the current study was to explore the relationship

TABLE 2 Average Scores for Individual Postconcussive Symptoms for Those Passing and Failing the MSVT

Symptom	Pass ($n = 168$)		Fail ($n = 23$)		Mann-Whitney U *P* Value	Cohen's *d*
	Mean	SD	Mean	SD		
Feeling tired	1.32	0.63	1.61	0.50	.038	0.51
Headache[a]	1.11	0.75	1.74	0.54	<.001	0.96
Trouble remembering[a]	0.95	0.68	1.52	0.59	<.001	0.90
Sensitive to bright lights[a]	0.74	0.74	1.39	0.66	<.001	0.93
Dizzy or wobbly[a]	0.71	0.69	1.35	0.78	<.001	0.87
Trouble paying attention[a]	1.10	0.70	1.61	0.58	.001	0.79
Feeling in a fog[a]	0.89	0.72	1.39	0.66	.002	0.72
Blurry or double vision	0.46	0.67	0.87	0.76	.007	0.57
Sensitive loud noises[a]	0.71	0.75	1.27	0.70	.001	0.77
Sick to stomach	0.47	0.68	0.59	0.73	.44	0.17
Feeling slowed down	0.78	0.69	1.22	0.80	.009	0.59

[a] Symptoms for which group differences are statistically significant.

TABLE 3 Summary of Hierarchical Regression Analyses Examining MSVT Failure as an Independent Predictor of Child-Reported Symptoms

Predictor	Model 1			Model 2			Model 3		
	B	SE b	B	b	SE b	β	B	SE b	β
Age at testing	0.01	0.01	0.04	0.01	0.01	0.04	0.01	0.01	0.05
Gender	0.24	0.07	0.25***	0.18	0.07	0.19**	0.18	0.06	0.19**
History of psychiatric problems	0.14	0.07	0.15*	0.16	0.07	0.17*	0.11	0.07	0.11
Time since injury				−0.01	0.00	−0.20**	−0.01	0.00	−0.16*
Neuroimaging findings				0.40	0.14	0.19**	0.35	0.14	0.17*
MSVT failure							0.40	0.10	0.28***
R^2		0.10		0.16				0.24	
R^2 change		0.10***		0.07**				0.07***	

* $P < .05$; ** $P < .01$; *** $P < .001$.

between performance on a well-validated neuropsychological validity test and child-reported postconcussive symptoms after mTBI. We found support for the idea that some meaningful percentage of school-aged children and adolescents demonstrate noncredible neuropsychological test performance. In this relatively large clinical case series, 12% of the children failed the MSVT.

Consistent with our expectations, participants failing the MSVT endorsed significantly more postconcussive symptoms than those passing, with a large effect size overall, comparable to that seen in studies with compensation-seeking adults.[55,58,59] Even after controlling for other factors that influenced symptom reporting in this sample (eg, female gender, premorbid anxiety/depression, time since injury), MSVT performance remained a robust unique predictor of the level of endorsed symptomatology.

The question of why children failed the MSVT was not the focus of the current study and was explored in a previous paper.[43] In brief, the evaluating neuropsychologists judged the reasons to be varied and to relate to secondary gain issues (eg, getting out of schoolwork or sports), as well as to direct psychological factors (eg, somatization) and indirect ones (eg, depression leading to a "plea for help"). Although children are capable of feigning cognitive problems in pursuit of financial gain,[38,44,45] litigation status did not relate to MSVT failure in this sample.

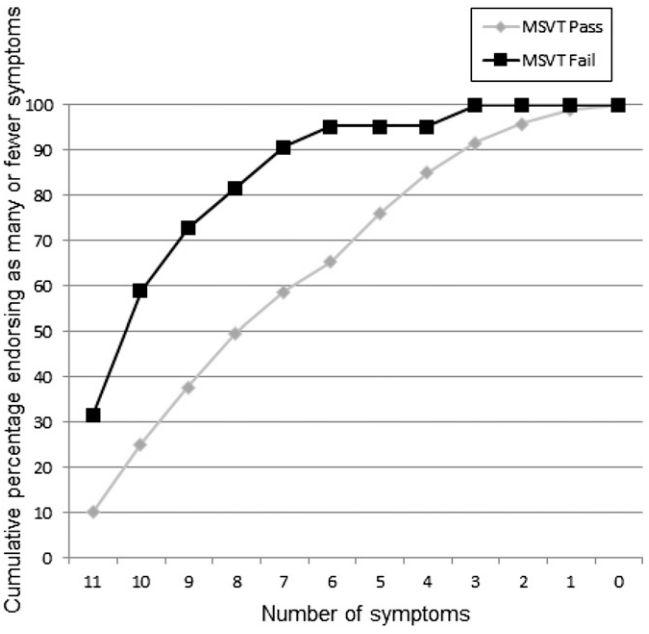

FIGURE 1
Cumulative percentage of total number of postconcussive symptoms endorsed for MSVT Pass and Fail groups.

The current findings have several significant clinical implications. PVT failure was strongly associated with symptom reporting, and therefore provided valuable information to the clinician about the likelihood of symptom exaggeration and/or feigning. Although it is possible that certain children failed the MSVT but still provided valid symptom reports, we believe this is fairly unlikely in most cases given that a strong relationship exists between invalid performance-based test data and invalid self-report data in comparable adult studies.[55,58,59,69–71]

Pediatricians and other primary care providers often manage youth after mTBI, although many do not feel they have adequate training or the tools to care for these patients.[72] Primary care management of mTBI is complicated further by the present findings. A subset of children seen for persistent complaints after mTBI display noncredible test performance and are apt to be exaggerating or feigning some of their symptoms. Yet most primary care and other health care providers do not routinely use any objective methodology to detect such noncredible responding.

If noncredible effort or symptom report remains undetected, errors in etiologic statements and less than optimal treatment recommendations may occur. For instance, if a child exaggerates memory problems after mTBI because of anxiety-related issues and such exaggeration remains undetected, then health care personnel might assume that the injury reflects more severe neurologic injury and make statements to this effect to the family and unnecessary recommendations for cognitive rehabilitation

or academic remediation, which could have iatrogenic effects. In contrast, if the exaggeration is detected, reassurance from a brain injury perspective and treatments that are targeted at the true underlying etiology (eg, cognitive-behavioral anxiety intervention) can follow, which in turn are apt to minimize inefficient use of limited health care resources and improve the child's long-term health.

Validity testing is well established in the field of neuropsychology, and a variety of methods are now validated to detect noncredible responding in children.[73,74,75] Thus, the study also serves to highlight the importance of incorporating clinical neuropsychologists into mTBI patient care, particularly when symptoms or functional complaints persist beyond the first days to weeks post-injury, when most children would be expected to have recovered naturally. Even when children are not intentionally feigning, neuropsychologists are well equipped to add to clinical care. mTBI is by definition and course a construct with both neurologic and psychological features. Neuropsychologists, who are dually trained in the neurologic principles of brain injury and the psychological principles of emotion and behavior, are uniquely positioned to understand both the injury and noninjury factors that may be contributing to persistent symptomatology. Pediatric neuropsychologists, who have additional specialized expertise in child development, family and school systems, and developmental conditions that can influence post-injury presentations (eg, attentional or learning difficulties) are especially well suited to add to the care of youth who have persistent complaints.

The current findings also have implications for research. The relatively high failure rate on the MSVT raises questions about both performance and symptom data collected from previous mTBI studies. No identified pediatric outcome study has incorporated an objective means to detect noncredible data. As such, previous pediatric studies that have reported persistent postconcussive cognitive deficits or documented cases of "postconcussion syndrome" need to be interpreted cautiously. To better control for noninjury-related effects in future mTBI studies and to increase confidence in any future findings, pediatric researchers should add validity tests to their outcome batteries.

The study results need to be interpreted in the context of several limitations. The participants in this study were drawn from a convenience sample referred clinically to a concussion program. As is the case for any clinical service, referral biases were undoubtedly evident. An example of such a bias was likely apparent in 1 of the study findings. Unexpectedly, participants who had neuroimaging pathology reported fewer symptoms than those who did not have imaging findings. This is likely explained by the fact that those patients who had imaging findings are routinely seen for evaluation in the neuropsychology clinic, whereas most children who do not have neuroimaging findings were being seen specifically because of concerns about persistent symptomatology. Because most youth recover relatively quickly after mTBI, these participants who had persistent symptoms are not representative of the majority of mTBI patients.

Another limitation was that the MSVT was the only stand-alone PVT administered to all patients. Like any classification decision that relies on a single test, decisions about noncredible data based solely on the MSVT may include some false-positive and false-negative errors. Previous case-by-case analysis of an earlier version of this clinical series suggested that these classification errors happen relatively infrequently.[51] An additional limitation is that the sample was skewed toward high functioning adolescent Caucasians who were from well-educated families. Further research will be required to examine whether the results generalize to youth from more varied backgrounds.

CONCLUSIONS

Despite these limitations, the current project is the first published pediatric study to demonstrate that PVT performance is strongly associated with postconcussive symptom reporting after mTBI. The results provide compelling evidence that objective PVTs should be added to the neuropsychological evaluation of school-aged youth after mTBI. Of course, determining whether a child is exaggerating or feigning symptoms not only requires careful examination of performance on objective validity tests, but also a solid understanding of the natural history of the presenting condition; scrutiny of the child's developmental, medical, educational, and environmental background; and thorough consideration of the consistency and plausibility of all examination data.

ACKNOWLEDGMENTS

We gratefully acknowledge Derek Mason and Robert Blaha for their assistance with manuscript preparation.

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Pediatrics; originally published online March 10, 2014;
DOI: 10.1542/peds.2013-3195