**Reporting on Diversity in Concussion-Focused Neurocognitive Research: A Demographic Review**

Adam C. Raikes, Ph.D., ATC1, Lillian Durán, Ph.D.2, Sydney Y. Schaefer, Ph.D.3

1 Social, Cognitive and Affective Neuroscience Lab, The University of Arizona

2 The University of Oregon

3 Arizona State University

**Abstract**

Clinical diagnoses of concussions involve a multi-faceted approach, including assessments of symptoms, neurocognitive status, posture, behavior and sleep. The purpose of this literature review was to determine the prevalence of demographic reporting with respect to race, ethnicity/culture, and language in the context of concussion-related neurocognitive testing. Healthy and concussed concussed individuals, from culturally and linguistically diverse populations demonstrate performance at levels lower than similar White, English-speaking cohorts on common neurocognitive tests. A systematic search of the literature yielded 768 unique citations reporting concussion-related neurocognitive outcomes. Of these, 36.07% (n = 277 articles) included at least one participant demographic distribution for race, culture/ethnicity, or language. However, only 1.8% (14 articles) included one or more demographics in the data analyses. These findings indicate limited external generalizability for the majority of the included articles. Additionally, differences between racial, cultural/ethnic, and linguistic groups are not fully explored and caution is warranted for clinical interpretation of neurocognitive test outcomes when used with diverse populations.

**Keywords:** *concussion, neurocognitive testing, cultural and linguistic diversity, minority populations*

**Word count:** 4101

**1 Introduction**

The diagnosis and management of concussion is currently an issue of social and medical emphasis. An estimated 1.7 to 3.8 million mild traumatic brain injuries (mTBI), of which concussions are a subset in the mild end of the spectrum, require hospitalization each year and countless numbers of concussions are managed clinically or go undiagnosed [1–3]. Furthermore, sports related concussion is a cross-sports and a cross-competition level issue. Individuals participating in all sports at all levels of competition are potentially at risk for concussion [4], with the highest degree of risk found for collision/contact sports (i.e. football, hockey soccer) [4]. The diagnosis and management of both short- and long-term effects of concussion is also a research emphasis for the military, as both blast-related and blunt-trauma related concussions are prevalent for deployed military personnel [5]. Although sports- and military-related concussions receive much of the media coverage, the majority of diagnosed mTBIs are the result of motor vehicle accidents [1,6,7]. Therefore, concussion is not merely a sports and military issue, but one that affects all members of society.

In the current recommendations for the diagnosis and management of concussions, a multidisciplinary team is responsible for evaluating the concussed individual for symptoms and functional deficits [8,9]. Within each of these disciplines, one or multiple measures may be employed to inform this clinical team. These measures may include but are not limited to symptom report, neurocognitive testing, behavioral assessment, postural stability evaluation, and sleep quantification. Given that individuals from all cultural and linguistic backgrounds are at risk for concussion, the need for clinically- and culturally-relevant and valid measures for evaluating the concussed individual is imperative.

This is especially true for neurocognitive testing in light of several facts. First, many commonly utilized neurocognitive tests were developed for, and validated on, White, English-speaking individuals in the United States [10,11]. As such, test performance by other racial, cultural, and ethnic groups may differ from the expected outcomes based on original validation and norms for reasons other than cognitive impairment, such as education, cultural salience, and acculturation [12–14]. Consequently, there is reasonable evidence indicating that neuropsychological tests contain cultural biases [12,13,15,16], resulting in potential misdiagnoses [17–20]. These issues are further exacerbated when considering the difficulties that might also arise when examiners do not share a language with their client [12,14,20–22]. Finally, global immigration trends indicate that, as of 2015, 244 million individuals worldwide reside outside their country of birth. Thus, in both research and clinical practice, the issue of cross-cultural neuropsychological testing is one that potentially affects clinicians, patients, and participants regardless of the country in which testing occurs.

**1.1 Purpose and Organization**

The purpose of this literature review is, therefore, to determine the extent to which cultural and linguistic demographic data are being reported in concussion-related research, specifically with respect to neurocognitive testing. To do so, first a definition and brief overview of the effects and symptoms of concussions will be provided along with characteristics and features of common testing methods. Second, a brief overview of the evidence for the impact of race, culture/ethnicity, and language in cognitive function will be presented. Third, an overview of the literature regarding racial, cultural, and linguistic differences in neurocognitive testing in the context of concussion diagnosis and management will be given. Finally, conclusions will be offered along with recommendations for future research and considerations in the clinical context.

**1.2 Concussion Overview**

Concussion is a consequence of direct force (applied to the head itself) or indirect force (applied to the body and transferred biomechanically to the head) that result in a disruption of brain function [8,23,24]. Broadly, these disruptions include impairments or changes in cognitive status, behavior, balance, sleep and the presence of somatic symptoms [8,9,23,24]. The most commonly reported symptoms include headache, photo- and phonosensitivity, nausea, and vomiting, confusion or fogginess, and dizziness. These symptoms often present uniquely between individuals, such that the same incident can yield a number of severe symptoms in some and seemingly no symptoms in others. Therefore, the diagnosis and management of a concussion is confounded by the multitude of ways in which symptoms may present in the individual.

To further confound this issue, concussion is a clinical diagnosis [8,9,23,24]. For example, brain imaging generally fails to reveal structural insults to the brain in the acute phase, and is therefore not commonly used unless clinical presentation suggests structural damage [8,25]. Accordingly, injury mechanism, clinical presentation and formal testing are the current centerpieces of the concussion diagnosis [8,23,26,27]. Symptom scales, neurocognitive tests, and balance assessments are commonly utilized to provide a comprehensive evaluation of the individual [28–34]. Many of these tools have previously demonstrated validity and reliability in multiple samples in the United States [34–36]. Additionally these tools are proven to have both sensitivity and specificity to deficits related to concussion [34,37,38].

The most common neurocognitive tests for post-concussion assessment are either paper-and-pencil or computerized tests [39–41]. These tests – including ImPACT, CNS Vital Signs, as well as more traditional tests including Trail Making Test and Stroop tests – evaluate the domains of cognition most commonly affected by a concussive event. These domains include memory, concentration, executive function, information processing and reaction speed [28,42,43]. Decrements in these domains are reported in the literature acutely after injury and generally return to pre-injury performance levels within 3 weeks of injury [28,42,44,45]. However, persistent functional deficits have been reported in some individuals long after the clinical resolution of symptoms [46–48].

These tests are often used to measure an athlete’s baseline ability prior to a competitive season or series of seasons. In the event of a concussive injury, data are then used for comparison with post-concussion data collected at specific time points. In the absence of baseline measures, normative values exist for many of these various measures. However, these normative values are generally based on predominantly White, middle-to-upper class English-speaking high school and college students in the United States and may lack sensitivity to racial, cultural/ethnic or linguistic differences when applied to other populations [49–52]. This is undoubtedly problematic when attempting to establish return to “baseline” after injury for individuals not captured in the normative datasets.

**1.3 Racial, Cultural/Ethnic and Linguistic Impacts on Cognitive Tests**

Very few studies have examined the specific effects of race, culture/ethnicity, or language on neurocognitive testing for concussion management. Kontos et al. (2010) compared African American and White athletes’ performance on the Immediate Post-Concussion Assessment and Cognitive Testing (ImPACT, [53]) at baseline, two, and seven days post-injury [39]. The authors noted that African Americans were more likely to demonstrate a significant decline in cognitive function at one week post-injury with a similar trend at two days post-injury. Specifically, the authors observed decreased motor processing speed in the African American group and a lack of practice effect from baseline to seven days post-injury. The authors suggest that the lack of differences at baseline between the groups, coupled with the fact that differences were observed in only one measure, does not merit a separate normative baseline for African Americans. However, the participants in this study were all English-speaking high school and college students from similarly performing academic institutions. Consequently, these participants may not represent the breadth of educational, acculturation, linguistic, and socioeconomic conditions, which may impact individuals’ pre- and post-injury performance on this test.

Likewise, Shuttleworth-Edwards et al. (2009) compared white, English-speaking football players in the US to predominantly white English-speaking rugby players in South Africa on the ImPACT [52]. The authors showed that while the South African players tended to report higher symptom scores, the cognitive task outcomes were similar. However, the authors acknowledge that the athletes in both groups were predominantly White and well-educated [52]. The similarity of these results may not persist outside of this narrow scope.

Some cross-lingual comparisons have additionally been conducted. Ott et al. (2014) compared English-speaking athletes to Spanish-English (native Spanish speakers with English as a second language) bilingual athletes taking the ImPACT in either Spanish or English [51]. They demonstrated that these bilingual athletes completing the ImPACT in Spanish performed more poorly than both bilingual and English-speaking individuals taking the test in English. Furthermore, bilingual athletes administered the test in English performed more poorly than English-speaking athletes. The authors note that this study highlights the need for caution when administering the ImPACT to Spanish- and English-speaking Hispanics [51].

In short, racial and ethnic background, cultural heritage, and primary language likely influence neurocognitive testing outcomes following concussion [12–20,22,39,51,52]. The purpose of this review is therefore to determine whether these important demographic features (e.g. race, culture/ethnicity, and language) are being reported in conjunction with concussion-related neurocognitive testing, and then identify to what extent they are factored into the analysis and interpretation of concussion-related neurocognitive outcomes.

**2 Methods**

**2.1 Search strategy**

Literature reporting neurocognitive outcomes related to concussion diagnosis and management procedures was identified in the following manner. A multiple database search was conducted on the following databases: Academic Search Premier, PsycInfo, CINAHL, MEDLINE, SportDiscus, and Psychology and Behavioral Science Collection (all available through EBSCOHost at Utah State University) in March, 2016. Search terms for all databases included terms related to concussion (“concuss\*” OR “mTBI” OR “mild traumatic brain injury” OR “closed head injury”) and terms related to neurocognitive testing (“\*cognitive” OR “\*cognitive test”). Only articles published in English were considered. No restrictions on year of publication were imposed.

These search procedures yielded 4961 citations, of which there were 2541 unique citations. Titles and abstracts were then screened for inclusion based on the following guidelines:

1. Articles reported on original (no systematic reviews, meta-analyses, book chapters, or consensus statements), peer-reviewed (no dissertations or theses) manuscripts. Articles published ahead of print were included.
2. Articles reported on human participants.
3. Articles reported on specific neurocognitive or neuropsychological tests. Articles were included if specific test outcomes were reported, if test scores were used to stratify individuals into groups (e.g., post-concussion syndrome (PCS) or no PCS), or if test scores were entered into a model and reported as coefficients rather than specific values.
4. Articles reported on participants in a concussion context. Concussion context included studies reporting on not only acutely concussed individuals, but also the long-term effects of previous concussions, as well as test-retest reliability for concussion-specific cognitive tests (e.g., one-year test-retest reliability, repeat baseline assessment) within non-concussed populations, and subconcussive effects (e.g., repetitive head impacts from boxing or soccer without formal concussion diagnosis). This wide range of contexts was chosen to ensure a broad range of cognitive testing applications within the typical applications for concussion.
5. Articles were excluded if individuals were only diagnosed with moderate, severe, or moderate-to-severe traumatic brain injuries.

After applying inclusion criteria, 1254 articles remained and full texts were available for 1253 of these. The same inclusion criteria were applied to the available full texts. Additionally, however, articles were excluded if, in the presence of traumatic brain injury, there was not a clearly defined mild TBI or concussion group (e.g., articles were excluded when the sample included individuals with varying degrees of severity who were not separated into distinct groups). A total of 768 articles met the guidelines for inclusion. Please see Figure 1 for a flowsheet of the inclusion/exclusion process.

The methods and results sections of each included article were coded by two independent coders. Variables coded included 1) tests used, 2) whether or not the authors reported racial, ethnic, country of origin, or 3) primary language distribution for the participants, and 4) whether or not racial, cultural/ethnic, country of origin, or linguistic characteristics were considered in the analyses, and 5) the reported number of individuals identifying with various racial, ethnic, or linguistic groups. Race and culture/ethnicity were defined as any explicit indication of the distribution of racial or cultural/ethnic background. When this information was not provided in the manuscript, country of recruitment was not taken as an implicit identification (e.g., participants recruited in South Korea were not assumed to be South Korean). Primary language was defined as any explicit indication of the languages spoken by the participants. Again, country of recruitment was not taken as implicit identification of the primary language of the participants.

Coded articles were then sorted to determine the frequency of reporting various racial, ethnic and linguistic participant characteristics. Due to the varied ways that authors reported race and cultural/ethnic distributions, these two categories are combined into a single category. For example, Macciochi et al. (2013) reported African American as “race” [54] whereas Cole et al. (2013) reported African American as “ethnicity” [55]. Data are presented as percentages of the total sample of articles.

**3 Results**

**3.1 Article characteristics**

On the basis of this systematic search, 768 group-design articles published between January 1976 and March, 2016 were identified that used neurocognitive tests within a concussion context (baseline testing, test-retest reliability, or post-injury follow up). Of these articles, the majority (n = 489, 63.67%) were published by researchers or groups recruiting participants in the United States. See Figure 2 for a more detailed view of articles by country.

**3.2 Reporting demographics**

Demographic variables of interest were reported in 36.07% (n = 277 articles) of the included articles. Race, culture, ethnicity, or country of origin were reported in 20.01% (n = 164 articles) of these articles (Supplementary Table 1). Participants’ preferred or spoken language was reported in 21.88% (n = 168 articles; Supplementary Table 2). Furthermore, of the 277 reporting any of these distributions, 55 articles (19.86%; 7.16% of all included articles) reported both language and race, culture/ethnicity, or country of origin. Finally, 14 articles (5.05%; 1.82% of all included articles) included these categories in the data analyses or stratified outcomes based on these demographic characteristics [39,51,52,54,56–65].

<Insert Supplementary Table 1 approximately here>

<Insert Supplementary Table 2 approximately here>

**3.3 Articles reporting race, culture, ethnicity, or country of origin.**

Of the 164 articles reporting demographic distributions related to race, culture, ethnicity, or country of origin, 150 reported participants in terms related to race, culture, or ethnicity and six reported participants in terms of their country of origin, with four articles reporting participants in terms of both race, culture or ethnicity and in terms of country of origin. Two articles referred to the majority of the participants being Caucasian or White without reporting actual values [299,321], while one simply noted “comparable… ethnic backgrounds” between groups [322]. One further article reported individuals in terms of race, culture, or ethnicity, however it was unclear in the text whether the distributional percentages reflected the entire sample including control participants, the entire sample prior to exclusionary criteria being applied, or only those individuals with mTBI [260]. Therefore, for the purposes of this review, the distributions of participants in these four studies will not be included in subsequent descriptions (*n* = 160 articles).

Among those articles reporting race, culture, or ethnicity demographics, a total of 73 descriptors are used, many of which overlap each other but are not reported consistently. For example, there are seven different descriptors applied to individuals traditionally described as “White,” including: White, Caucasian, Caucasian/White, White (non-Hispanic), White or European-American, White (non-Latino), and White Latino. See Table 1 for frequencies of these descriptors. Of the 10 articles reporting country of origin, 24 different descriptors are used. See Table 2 for frequencies of these descriptors.

<Insert Table 1 approximately here>

<Insert Table 2 approximately here>

Across all of the studies reporting race, or ethnicity demographics, individuals identified as “White” (n = 26037, 35.00%) or “Caucasian” (n = 8816, 11.85%) accounted for 46.53% of all participants, with individuals identified as “Hispanic” (n = 12903, 17.34%) or African-American (n = 3772, 5.07%) accounting for the next largest proportions of the participants (Table 1). Furthermore individuals identified as “White” or “Caucasian” accounted for more than 50% of the participants in 66.25% (n = 106) of the 160 articles (Table 1).Participants specifically identified as being from the United States were the majority of all participants across the 10 articles reporting country of origin (n = 31793, 92.04%; Table 2).

Authors made direct comparisons between racial/cultural groups in six of the 160 articles. These articles produced mixed results. No cognitive differences were observed between White, English-speaking South African rugby players and English-speaking American football players [52] or between multiple groups (Caucasian, African American, Other) [59]. Furthermore, while White individuals were more likely to report amnesia than individuals identified as “other”, there were no difference between amnesia and non-amnesia groups on ImPACT subscales [64].

By contrast, concussed African Americans had lower visual motor processing speed as well as a greater likelihood to demonstrate at least one cognitive impairment on ImPACT at seven days post injury [39]. Additionally, boxers were shown to have a significant decrease in processing speed with increasing fight exposure, used as a proxy for concussion risk, after adjusting for age, race, and education [57]. Furthermore, non-European New Zealanders tended to perform less well on CNS Vital Signs at 12-months post injury than European New Zealanders [56]. However, the authors are careful to note that there is some evidence of poorer neuropsychological test performance by New Zealanders in comparison to European New Zealanders on traditional neuropsychological testing and therefore cultural bias, rather than true differences in test outcomes, may be partially explanatory in this case as well.

Lower test-retest reliability on ImPACT for American college students compared to Irish students was reported in one article [65]. However, the groups did not complete the second and third administrations on the same time scale. The Irish students completed tests on days seven and fourteen from baseline whereas the US students completed them on days 45 and 50 [65]. While these timeframes inform about the long-term stability of the test, the dissimilarity does not permit cross-cultural comparison.

**3.4 Articles reporting language.**

Across the 168 articles reporting participant languages, 27 descriptors were reported. One article specified that most participants spoke French without giving an exact breakdown [321] and is not included in subsequent analyses. Out of 167 articles reporting participant language distributions, a total of 88.62% (n = 148) identified a single language for all participants (see Table 3), with English as the most common language (n = 122). English-only speaking participants were identified in 80.24% (*n* = 134 articles) of these articles, with French-speaking participants being the next most common group (*n* = 8 articles). Additionally, English-only speaking individuals represented the majority of the participants (> 50%) in 79.04% (n = 132) of these articles. Furthermore, English-only speaking individuals accounted for 83.50% (n = 79714) of all participants across the 167 articles.

<Insert Table 3 approximately here>

Fourteen articles reported participants from two or more language groups. However, only four articles provided comparisons between multiple language groups in the data analyses. These articles identified clear differences on neurocognitive test performance between language groups. Spanish-English bilinguals demonstrated lower performance on ImPACT, when taking the test in their preferred language (either English or Spanish), than monolingual English-speaking individuals [51,58,61]. Additionally, those bilinguals taking the test in English performed better than those taking it in Spanish. Furthermore varying test-retest reliability within language groups (English, French, Czech, and Swedish) on ImPACT composite scores at baseline and a one-year follow up were observed [60]. However, no between-group comparisons were made to determine whether there were systematic differences.

**4 Summary**

Concussion is a public health crisis. The demand for objective, quantifiable measures of impairment and recovery are essential not only to diagnosing the individual but documenting recovery and making return-to-learn, -play, and -work decisions as well as a means to track functioning over time. Among the many documented effects of concussion, impairments in memory, executive function, emotional control, decision-making, concentration and attention, and reaction time are frequently observed. Given global patterns of immigration and the subsequent increase in cultural and linguistic diversity in destination countries, such as the United States [323], there is the reasonable necessity for measures that are sensitive to these neurocognitive deficits while accounting for racial, cultural/ethnic, and linguistic characteristics of the participant or patient.

Despite such diversity, fewer than 40% of the articles identified in this review reported participant characteristics with respect to race, culture/ethnicity, or language. Of these articles, White or English-speaking participants are the majority of, or only, participants in approximately 80%. Furthermore, approximately 2% of all of the articles account for these demographics in the data analyses. Consequently, the external generalizability of the results of the majority of the articles identified here is limited. Furthermore, the effects of concussion on neurocognitive test outcomes in diverse populations is unclear.

However, on the basis of this review, there is reason for caution when interpreting the results of neurocognitive tests, particularly ImPACT, of individuals from non-English speaking populations as well as individuals who do not identify as “White,” or “Caucasian.” Specifically, there is evidence that Spanish-English bilinguals demonstrate lower performance under non-concussed conditions regardless of the test language (Spanish or English) than their English-only counterparts, though taking the test in English consistently yields higher scores [51,58,61]. This is true even when these bilingual individuals take the test in the language that they prefer [51]. The mechanisms for such differences remain unclear, though education, acculturation, cultural bias, and test translation are all plausible explanations [13,17,22,51,58,61]. There is also an indication that long-term test-retest reliability may vary on the ImPACT between multiple cultural and linguistic groups on the basis of different within-group intraclass correlation coefficients [60,65]. However, no between-group statistics have been calculated to fully explore this. Additionally, there is evidence of increased symptom-reporting [52] and increased likelihood of cognitive impairment [39] in non-American and non-White samples, respectively.

The lack of reporting of race, culture/ethnicity, and languages spoken by the participants is problematic in three ways. First, it does not permit the reader to gauge the representativeness of the samples drawn. Second, it does not permit the reader to judge the populations on whom the results are valid and generalizable. Third, it does not allow for testing and evaluating outcomes for differences across racial, cultural/ethnic, and linguistic populations.

**4.1 Recommendations for Research**

In light of these findings, two recommendations for future research emerge. First, researchers should begin to obtain and document the race, culture/ethnicity, and language (primary, bilingual status) of participants. Doing so, will allow for better external generalizability and facilitate comparisons between articles. Furthermore, reporting these demographic variables may enable researchers to identify correlates and etiology of performance differences on neurocognitive tests when participant outcomes are not homogenous or conflict with reported normative data. Additionally, researchers should endeavor to recruit country-specific representative samples, given the global trend toward immigration [323]. This will help to ensure greater applicability of the findings to the general population.

Second, future research should investigate differences in neurocognitive outcomes of various populations with respect to concussion. There is limited yet emerging evidence, for differences between English-speaking White Americans and those from other backgrounds [51,61]. Thus, it is necessary to more fully explain these differences to determine whether there are in fact systematic differences between various groups. Doing so will allow for the development of racially-, culturally/ethnically-, and linguistically-sensitive interpretations.

**4.2 Recommendations for Practice**

Recent work has highlighted the fact that cross-cultural neurocognitive testing with tests validated for White, English-speaking individuals introduces issues of cultural bias and misdiagnosis, even in healthy populations [11,15,16,20,324]. In light of these concerns and findings here [39,51,52,58,61], clinical interpretation of neurocognitive outcomes with respect to concussion merits caution with diverse populations. Concussion remains a multi-faceted clinical diagnosis, with neurocognitive testing as only one component. It is important to recognize that neurocognitive outcomes at baseline and post-injury may not reflect the true capacity of the individual if the commonly used tests do indeed contain racial, cultural/ethnic, or linguistic biases. Until further research more clearly identifies the role of these demographic variables, no other specific recommendations can be made for the clinician in this area.

**4.3 Limitations**

The systematic search terms used may have excluded some literature due to the narrow focus of the wording. Additionally, no ancestral or descendent searches were conducted. However, the results from this limited search are striking in the magnitude to which these demographic characteristics are not being reported and not being systematically investigated. While there may be articles not captured by this search, it is reasonable to view the proportions within this sample (n = 768 articles) as representative.

**5 Conclusion**

Current practices for reporting race, culture/ethnicity, and language demographics in concussion-oriented neurocognitive research are inconsistent and insufficient for determining both sample representativeness and generalizability. While some evidence suggests differences between groups, such differences are not fully clarified. Further research and more complete reporting of these demographic variables are required in order to fully evaluate the utility and interpretation of the scores achieved on these tests with diverse populations, particularly when comparing individual performance with normative data. In doing so, both researchers and clinicians can more thoroughly document the magnitude of neurocognitive impairment following concussion and the time-course and trajectory of recovery.

**References**

1. Langlois JA, Rutland-Brown W, Wald MM. The epidemiology and impact of traumatic brain injury: a brief overview. J. Head Trauma Rehabil. 2006;21:375–8.

2. McCrea M, Hammeke T, Olsen G, Leo P, Guskiewicz KM. Unreported concussion in high school football players: implications for prevention. Clin. J. Sport Med. 2004;14:13–17.

3. Meehan WP, Mannix RC, O’Brien MJ, Collins MW. The prevalence of undiagnosed concussions in athletes. Clin. J. Sport Med. Off. J. Can. Acad. Sport Med. 2013;23:339–42.

4. Zuckerman SL, Kerr ZY, Yengo-Kahn A, Wasserman E, Covassin T, Solomon GS. Epidemiology of sports-related concussion in NCAA athletes from 2009-2010 to 2013-2014 incidence, recurrence, and mechanisms. Am. J. Sports Med. 2015;43:2654–62.

5. Hoge CW, McGurk D, Thomas JL, Cox AL, Engel CC, Castro CA. Mild traumatic brain injury in US soldiers returning from Iraq. N. Engl. J. Med. 2008;358:453–463.

6. Cassidy JD, Carroll LJ, Peloso PM, Borg J, von Holst H, Holm L, et al. Incidence, risk factors and prevention of mild traumatic brain injury: results of the WHO Collaborating Centre Task Force on Mild Traumatic Brain Injury. J. Rehabil. Med. 2004;28–60.

7. Faul M, Xu L, Wald MM, Coronado VG. Traumatic Brain Injury in the United States: Emergency Department Visits, Hospitalizations and Deaths 2002-2006 [Internet]. Atlanta (GA): Centers for Disease Control and Prevention, National Center for Injury Prevention and Control; 2010 [cited 2015 Apr 25]. Available from: http://origin.glb.cdc.gov/traumaticbraininjury/pdf/blue\_book.docx

8. McCrory P, Meeuwisse WH, Aubry M, Cantu RC, Dvořák J, Echemendia RJ, et al. Consensus statement on concussion in sport: The 4th International Conference on Concussion in Sport held in Zurich, November 2012. Br. J. Sports Med. 2013;47:1–12.

9. McCrory P, Meeuwisse W, Dvorak J, Aubry M, Bailes J, Broglio S, et al. Consensus statement on concussion in sport—the 5th international conference on concussion in sport held in Berlin, October 2016. Br. J. Sports Med. 2017;51:838–47.

10. Manly JJ, Jacobs DM, Ferraro FR. Future directions in neuropsychological assessment with African Americans. Minor. Cross-Cult. Asp. Neuropsychol. Assess. 2002;79–96.

11. Manly JJ. Critical issues in cultural neuropsychology: profit from diversity. Neuropsychol. Rev. 2008;18:179–83.

12. Ardila A. Directions of research in cross-cultural neuropsychology. J. Clin. Exp. Neuropsychol. 1995;17:143–150.

13. Ardila A. Cultural values underlying psychometric cognitive testing. Neuropsychol. Rev. 2005;15:185–195.

14. Brickman AM, Cabo R, Manly JJ. Ethical issues in cross-cultural neuropsychology. Appl. Neuropsychol. 2006;13:91–100.

15. Fernández AL, Abe J. Bias in cross-cultural neuropsychological testing: problems and possible solutions. Cult. Brain. 2017;1–35.

16. Puente AE, Perez-Garcia M, Vilar-Lopez R, Hidalgo-Ruzzante N, Fasfous AF. Neuropsychological assessment of culturally and educationally dissimilar individuals. Handb. Multicult. Ment. Health Assess. Treat. Diverse Popul. 2013;225–241.

17. Jacobs DM, Sano M, Albert S, Schofield P, Dooneief G, Stern Y. Cross-cultural neuropsychological assessment: A comparison of randomly selected, demographically matched cohorts of English-and Spanish-speaking older adults. J. Clin. Exp. Neuropsychol. 1997;19:331–9.

18. Norman MA, Evans JD, Miller WS, Heaton RK. Demographically corrected norms for the California Verbal Learning Test. J. Clin. Exp. Neuropsychol. 2000;22:80–94.

19. Norman MA, Moore DJ, Taylor M, Jr DF, Cysique L, Ake C, et al. Demographically corrected norms for African Americans and Caucasians on the Hopkins Verbal Learning Test–Revised, Brief Visuospatial Memory Test–Revised, Stroop Color and Word Test, and Wisconsin Card Sorting Test 64-Card Version. J. Clin. Exp. Neuropsychol. 2011;33:793–804.

20. Daugherty JC, Puente AE, Fasfous AF, Hidalgo-Ruzzante N, Pérez-Garcia M. Diagnostic mistakes of culturally diverse individuals when using North American neuropsychological tests. Appl. Neuropsychol. Adult. 2017;24:16–22.

21. Candelaria MA, Llorente AM. The assessment of the Hispanic child. Handb. Clin. Child Neuropsychol. [Internet]. Springer; 2009. p. 401–424. Available from: http://link.springer.com/chapter/10.1007/978-0-387-78867-8\_18

22. Echemendia RJ, Harris JG, Congett SM, Diaz ML, Puente AE. Neuropsychological training and practices with Hispanics: A national survey. Clin. Neuropsychol. 1997;11:229–43.

23. Giza CC, Kutcher JS, Ashwal S, Barth J, Getchius TSD, Gioia GA, et al. Summary of evidence-based guideline update: Evaluation and management of concussion in sports: Report of the Guideline Development Subcommittee of the American Academy of Neurology. Neurology. 2013;80:2250–7.

24. Jha N, Cantu R, Gennarelli TA, Tator CH, Bailes JE, Giza C, et al. International concussion consensus 2015. Curr. Res. Concussion. 2015;2:68–80.

25. McCrory P. Summary and agreement statement of the 2nd International Conference on Concussion in Sport, Prague 2004. Br. J. Sports Med. 2005;39:i78–86.

26. Harmon KG, Drezner JA, Gammons M, Guskiewicz KM, Halstead M, Herring SA, et al. American Medical Society for Sports Medicine position statement: concussion in sport. Br. J. Sports Med. 2013;47:15–26.

27. McCrea MA, Nelson LD, Guskiewicz K. Diagnosis and Management of Acute Concussion. Phys. Med. Rehabil. Clin. N. Am. 2017;28:271–86.

28. Broglio SP, Puetz TW. The effect of sport concussion on neurocognitive function, self-report symptoms and postural control. Sports Med. 2008;38:53–67.

29. Collins MW, Grindel SH, Lovell MR, Dede DE, Moser DJ, Phalin BR, et al. Relationship between concussion and neuropsychological performance in college football players. JAMA J. Am. Med. Assoc. 1999;282:964–70.

30. Collins MW, Iverson GL, Lovell MR, McKeag DB, Norwig J, Maroon J. On-field predictors of neuropsychological and symptom deficit following sports-related concussion. Clin. J. Sport Med. 2003;13:222–229.

31. Covassin T, Elbin RJ, Harris W, Parker T, Kontos AP. The role of age and sex in symptoms, neurocognitive performance, and postural stability in athletes after concussion. Am. J. Sports Med. 2012;40:1303–12.

32. Guskiewicz KM. Balance assessment in the management of sport-related concussion. Clin. Sports Med. 2011;30:89–102.

33. Peterson CL, Ferrara MS, Mrazik M, Piland S, Elliott R. Evaluation of neuropsychological domain scores and postural stability following cerebral concussion in sports. Clin. J. Sport Med. 2003;13:230–237.

34. Schatz P, Pardini JE, Lovell MR, Collins MW, Podell K. Sensitivity and specificity of the ImPACT test battery for concussion in athletes. Arch. Clin. Neuropsychol. 2006;21:91–9.

35. Valovich McLeod TC, Barr WB, McCrea M, Guskiewicz KM. Psychometric and measurement properties of concussion assessment tools in youth sports. J. Athl. Train. 2006;41:399–408.

36. Sady MD, Vaughan CG, Gioia GA. Psychometric characteristics of the Postconcussion Symptom Inventory in children and adolescents. Arch. Clin. Neuropsychol. 2014;29:348–63.

37. Schatz P, Sandel N. Sensitivity and specificity of the online version of ImPACT in high school and collegiate athletes. Am. J. Sports Med. 2013;41:321–6.

38. Barr WB, McCrea M. Sensitivity and specificity of standardized neurocognitive testing immediately following sports concussion. J. Int. Neuropsychol. Soc. 2001;7:693–702.

39. Kontos AP, Elbin RJ, Covassin T, Larson E. Exploring differences in computerized neurocognitive concussion testing between African American and White athletes. Arch. Clin. Neuropsychol. 2010;25:734–44.

40. McCrea M, Kelly JP, Randolph C, Kluge J, Bartolic E, Finn G, et al. Standardized Assessment of Concussion (SAC): on-site mental status evaluation of the athlete. J. Head Trauma Rehabil. 1998;13:27–35.

41. Collie A, Maruff P, Makdissi M, McCrory P, McStephen M, Darby D. CogSport: reliability and correlation with conventional cognitive tests used in postconcussion medical evaluations. Clin. J. Sport Med. 2003;13:28–32.

42. McCrea M, Guskiewicz KM, Marshall SW, Barr W, Randolph C, Cantu RC, et al. Acute effects and recovery time following concussion in collegiate football players: The NCAA Concussion Study. JAMA J. Am. Med. Assoc. 2003;290:2556–63.

43. McCrea M, Kelly JP, Randolph C, Cisler R, Berger L. Immediate neurocognitive effects of concussion. Neurosurgery. 2002;50:1032–1042.

44. Belanger HG, Vanderploeg RD. The neuropsychological impact of sports-related concussion: a meta-analysis. J. Int. Neuropsychol. Soc. 2005;11:345–357.

45. Schneider KJ, Iverson GL, Emery CA, McCrory P, Herring SA, Meeuwisse WH. The effects of rest and treatment following sport-related concussion: a systematic review of the literature. Br. J. Sports Med. 2013;47:304–7.

46. Chen J-K, Johnston KM, Frey S, Petrides M, Worsley K, Ptito A. Functional abnormalities in symptomatic concussed athletes: an fMRI study. NeuroImage. 2004;22:68–82.

47. Gosselin N, Bottari C, Chen J-K, Petrides M, Tinawi S, de Guise É, et al. Electrophysiology and functional MRI in post-acute mild traumatic brain injury. J. Neurotrauma. 2011;28:329–41.

48. McAllister TW, Sparling MB, Flashman LA, Guerin SJ, Mamourian AC, Saykin AJ. Differential working memory load effects after mild traumatic brain injury. NeuroImage. 2001;14:1004–1012.

49. Tsushima WT, Siu AM. Neuropsychological test performance of Hawai’i high school athletes: updated Hawai’i immediate post-concussion assessment and cognitive testing data. Hawaii J. Med. Public Health. 2014;73:208–11.

50. Tsushima WT, Oshiro R, Zimbra D. Neuropsychological test performance of Hawai’i high school athletes: Hawai’i ImPACT normative data. Hawaii Med. J. 2008;67:93–5.

51. Ott S, Schatz P, Solomon G, Ryan JJ. Neurocognitive performance and symptom profiles of Spanish-speaking Hispanic athletes on the ImPACT Test. Arch. Clin. Neuropsychol. 2014;29:152–63.

52. Shuttleworth-Edwards AB, Whitefield-Alexander VJ, Radloff SE, Taylor AM, Lovell MR. Computerized neuropsychological profiles of South African versus US athletes: a basis for commentary on cross-cultural norming issues in the sports concussion arena. Phys. Sportsmed. 2009;37:45–52.

53. Maroon JC, Lovell MR, Norwig J, Podell K, Powell JW, Hartl R. Cerebral concussion in athletes: Evaluation and neuropsychological testing. Neurosurgery. 2000;47:659–672.

54. Macciocchi SN, Seel RT, Thompson N. The impact of mild traumatic brain injury on cognitive functioning following co-occurring spinal cord injury. Arch. Clin. Neuropsychol. 2013;28:684–91.

55. Cole WR, Arrieux JP, Schwab K, Ivins BJ, Qashu FM, Lewis SC. Test–retest reliability of four computerized neurocognitive assessment tools in an active duty military population. Arch. Clin. Neuropsychol. 2013;28:732–42.

56. Barker-Collo S, Jones K, Theadom A, Starkey N, Dowell A, McPherson K, et al. Neuropsychological outcome and its correlates in the first year after adult mild traumatic brain injury: A population-based New Zealand study. Brain Inj. 2015;29:1604–16.

57. Bernick C, Banks SJ, Shin W, Obuchowski N, Butler S, Noback M, et al. Repeated head trauma is associated with smaller thalamic volumes and slower processing speed: the Professional Fighters’ Brain Health Study. Br. J. Sports Med. 2015;49:1007–11.

58. Blake ML, Ott S, Villanyi E, Kazhuro K, Schatz P. Influence of language of administration on ImPACT performance by bilingual Spanish–English college students. Arch. Clin. Neuropsychol. 2015;30:302–9.

59. Broshek DK, Kaushik T, Freeman JR, Erlanger D, Webbe F, Barth JT. Sex differences in outcome following sports-related concussion. J. Neurosurg. 2005;102:856–863.

60. Bruce JM, Echemendia R, Meeuwisse W, Comper P, Sisco A. 1 year test–retest reliability of ImPACT in professional ice hockey players. Clin. Neuropsychol. 2014;28:14–25.

61. Jones NS, Walter KD, Caplinger R, Wright D, Raasch WG, Young C. Effect of education and language on baseline concussion screening tests in professional baseball players. Clin. J. Sport Med. 2014;24:284–8.

62. Larson EB, Kondiles BR, Starr CR, Zollman FS. Postconcussive complaints, cognition, symptom attribution and effort among veterans. J. Int. Neuropsychol. Soc. 2013;19:88–95.

63. Rabinowitz AR, Li X, McCauley SR, Wilde EA, Barnes A, Hanten G, et al. Prevalence and predictors of poor recovery from mild traumatic brain injury. J. Neurotrauma. 2015;32:1488–96.

64. Register-Mihalik JK, De Maio VJ, Tibbo-Valeriote HL, Wooten JD. Characteristics of pediatric and adolescent concussion clinic patients with postconcussion amnesia. Clin. J. Sport Med. 2015;25:502–8.

65. Resch JE, Driscoll A, McCaffrey N, Brown C, Ferrara MS, Macciocchi S, et al. ImPact test-retest reliability: Reliably unreliable? J. Athl. Train. 2013;48:506–11.

66. Allen BJ, Gfeller JD. The Immediate Post-Concussion Assessment and Cognitive Testing battery and traditional neuropsychological measures: A construct and concurrent validity study. Brain Inj. 2011;25:179–91.

67. Amick MM, Clark A, Fortier CB, Esterman M, Rasmusson AM, Kenna A, et al. PTSD modifies performance on a task of affective executive control among deployed OEF/OIF veterans with mild traumatic brain injury. J. Int. Neuropsychol. Soc. 2013;19:792–801.

68. Araujo GC, Antonini TN, Monahan K, Gelfius C, Klamar K, Potts M, et al. The relationship between suboptimal effort and post-concussion symptoms in children and adolescents with mild traumatic brain injury. Clin. Neuropsychol. 2014;28:786–801.

69. Armistead-Jehle P, Cooper DB, Vanderploeg RD. The role of performance validity tests in the assessment of cognitive functioning after military concussion: A replication and extension. Appl. Neuropsychol. Adult. 2016;23:264–73.

70. Babikian T, Satz P, Zaucha K, Light R, Lewis RS, Asarnow RF. The UCLA longitudinal study of neurocognitive outcomes following mild pediatric traumatic brain injury. J. Int. Neuropsychol. Soc. 2011;17:886–95.

71. Barrow IM, Hough M, Rastatter MP, Walker M, Holbert D, Rotondo MF. Can within-category naming identify subtle cognitive deficits in the mild traumatic brain-injured patient? J. Trauma Acute Care Surg. 2003;54:888–897.

72. Barwick F, Arnett P, Slobounov S. EEG correlates of fatigue during administration of a neuropsychological test battery. Clin. Neurophysiol. 2012;123:278–84.

73. Barwood CHS, Murdoch BE. Unravelling the influence of mild traumatic brain injury (MTBI) on cognitive-linguistic processing: A comparative group analysis. Brain Inj. 2013;27:671–6.

74. Beers SR, Goldstein G, Katz LJ. Neuropsychological differences between college students with learning disabilities and those with mild head injury. J. Learn. Disabil. 1994;27:315–24.

75. Biederman J, Feinberg L, Chan J, Adeyemo BO, Woodworth KY, Panis W, et al. Mild traumatic brain injury and attention-deficit hyperactivity disorder in young student athletes. J. Nerv. Ment. Dis. 2015;203:813–9.

76. Bigler ED, Jantz PB, Farrer TJ, Abildskov TJ, Dennis M, Gerhardt CA, et al. Day of injury CT and late MRI findings: Cognitive outcome in a paediatric sample with complicated mild traumatic brain injury. Brain Inj. 2015;29:1062–70.

77. Boake C, McCauley SR, Levin HS, Contant CF, Song JX, Brown SA, et al. Limited agreement between criteria-based diagnoses of postconcussional syndrome. J. Neuropsychiatry Clin. Neurosci. 2004;16:493–9.

78. Bolzenius JD, Roskos PT, Salminen LE, Paul RH, Bucholz RD. Cognitive and self-reported psychological outcomes of blast-induced mild traumatic brain injury in veterans: a preliminary study. Appl. Neuropsychol. Adult. 2015;22:79–87.

79. Brooks BL, Daya H, Khan S, Carlson HL, Mikrogianakis A, Barlow KM. Cognition in the emergency department as a predictor of recovery after pediatric mild traumatic brain injury. J. Int. Neuropsychol. Soc. 2016;22:379–87.

80. Brooks BL, Khan S, Daya H, Mikrogianakis A, Barlow KM. Neurocognition in the emergency department after a mild traumatic brain injury in youth. J. Neurotrauma. 2014;31:1744–9.

81. Clark AL, Sorg SF, Schiehser DM, Bigler ED, Bondi MW, Jacobson MW, et al. White matter associations with performance validity testing in veterans with mild traumatic brain injury: the utility of biomarkers in complicated assessment. J. Head Trauma Rehabil. 2016;31:346–59.

82. Classen S, Levy C, Meyer DL, Bewernitz M, Lanford DN, Mann WC. Simulated driving performance of combat veterans with mild traumatic brain injury and posttraumatic stress disorder: A pilot study. Am. J. Occup. Ther. 2011;65:41–427.

83. Cole MA, Muir JJ, Gans JJ, Shin LM, D’Esposito M, Harel BT, et al. Simultaneous treatment of neurocognitive and psychiatric symptoms in veterans with post-traumatic stress disorder and history of mild traumatic brain injury: A pilot study of mindfulness-based stress reduction. Mil. Med. 2015;180:956–63.

84. Combs HL, Berry DTR, Pape T, Babcock-Parziale J, Smith B, Schleenbaker R, et al. The effects of mild traumatic brain injury, post-traumatic stress disorder, and combined mild traumatic brain injury/post-traumatic stress disorder on returning veterans. J. Neurotrauma. 2015;32:956–66.

85. Coughlin JM, Wang Y, Munro CA, Ma S, Yue C, Chen S, et al. Neuroinflammation and brain atrophy in former NFL players: An in vivo multimodal imaging pilot study. Neurobiol. Dis. 2015;74:58–65.

86. Daniel JC, Olesniewicz MH, Reeves DL, Tam D, Bleiberg J, Thatcher R, et al. Repeated measures of cognitive processing efficiency in adolescent athletes: Implications for monitoring recovery from concussion. Neuropsychiatry. Neuropsychol. Behav. Neurol. 1999;12:167–9.

87. De Beaumont L, Tremblay S, Henry LC, Poirier J, Lassonde M, Théoret H. Motor system alterations in retired former athletes: The role of aging and concussion history. BMC Neurol. 2013;13:1–10.

88. Didehbani N, Cullum CM, Mansinghani S, Conover H, Hart JJ. Depressive symptoms and concussions in aging retired NFL players. Arch. Clin. Neuropsychol. 2013;28:418–24.

89. Dretsch MN, Kelly MP, Coldren RL, Parish RV, Russell ML. No significant acute and subacute differences between blast and blunt concussions across multiple neurocognitive measures and symptoms in deployed soldiers. J. Neurotrauma. 2015;32:1217–22.

90. Dretsch MN, Parish R, Kelly M, Coldren R, Russell M. Eight-Day Temporal Stability of the Automated Neuropsychological Assessment Metric (ANAM) in a Deployment Environment. Appl. Neuropsychol. Adult. 2015;22:304–10.

91. Dretsch MN, Silverberg ND, Iverson GL. Multiple past concussions are associated with ongoing post-concussive symptoms but not cognitive impairment in active-duty army soldiers. J. Neurotrauma. 2015;32:1301–6.

92. Durazzo TC, Abadjian L, Kincaid A, Bilovsky-Muniz T, Boreta L, Gauger GE. The Influence of Chronic Cigarette Smoking on Neurocognitive Recovery after Mild Traumatic Brain Injury. J. Neurotrauma. 2013;30:1013–22.

93. Echemendia RJ, Putukian M, Mackin RS, Julian L, Shoss N. Neuropsychological test performance prior to and following sports-related mild traumatic brain injury. Clin. J. Sport Med. 2001;11:23–31.

94. Erlanger D, Feldman D, Kutner K, Kaushik T, Kroger H, Festa J, et al. Development and validation of a web-based neuropsychological test protocol for sports-related return-to-play decision-making. Arch. Clin. Neuropsychol. 2003;18:293–316.

95. Ettenhofer ML, Abeles N. The significance of mild traumatic brain injury to cognition and self-reported symptoms in long-term recovery from injury. J. Clin. Exp. Neuropsychol. 2008;31:363–72.

96. Fann JR, Uomoto JM, Katon WJ. Cognitive improvement with treatment of depression following mild traumatic brain injury. Psychosomatics. 2001;42:48–54.

97. Fay TB, Yeates KO, Taylor HG, Bangert B, Dietrich A, Nuss K, et al. Cognitive reserve as a moderator of postconcussive symptoms in children with complicated and uncomplicated mild traumatic brain injury. J. Int. Neuropsychol. Soc. 2010;16:94–105.

98. Fisher DC, Ledbetter MF, Cohen NJ, Marmor D, Tulsky DS. WAIS-III and WMS-III profiles of mildly to severely brain-injured patients. Appl. Neuropsychol. 2000;7:126–132.

99. Franke LM, Czarnota JN, Ketchum JM, Walker WC. Factor analysis of persistent postconcussive symptoms within a military sample with blast exposure. J. Head Trauma Rehabil. 2015;30:E34–46.

100. Gill J, Merchant-Borna K, Lee H, Livingston WS, Olivera A, Cashion A, et al. Sports-related concussion results in differential expression of nuclear factor-κb pathway genes in peripheral blood during the acute and subacute periods. J. Head Trauma Rehabil. 2016;31:269–76.

101. Gordon SN, Fitzpatrick PJ, Hilsabeck RC. No effect of PTSD and other psychiatric disorders on cognitive functioning in veterans with mild TBI. Clin. Neuropsychol. 2011;25:337–47.

102. Greiffenstein MF, Baker WJ. Premorbid clues? Preinjury scholastic performance and present neuropsychological functioning in late postconcussion syndrome. Clin. Neuropsychol. 2003;17:561–73.

103. Grills CE, Armistead-Jehle PJ. Performance validity test and neuropsychological assessment battery screening module performances in an active-duty sample with a history of concussion. Appl. Neuropsychol. Adult. 2016;23:295–301.

104. Hänninen T, Tuominen M, Parkkari J, Vartiainen M, Öhman J, Iverson GL, et al. Sport concussion assessment tool - 3rd edition - normative reference values for professional ice hockey players. J. Sci. Med. Sport. 2016;19:636–41.

105. Hanna-Pladdy B, Berry ZM, Bennett T, Phillips HL, Gouvier WD. Stress as a diagnostic challenge for postconcussive symptoms: Sequelae of mild traumatic brain injury or physiological stress response. Clin. Neuropsychol. 2001;15:289–304.

106. Hart JJ, Kraut MA, Womack KB, Strain J, Didehbani N, Bartz E, et al. Neuroimaging of cognitive dysfunction and depression in aging retired national football league players: A cross-sectional study. JAMA Neurol. 2013;70:326–35.

107. Hess DW, Marwitz JH, Kreutzer JS. Neuropsychological impairments after spinal cord injury: A comparative study with mild traumatic brain injury. Rehabil. Psychol. 2003;48:151–6.

108. Hill BD, Rohling ML, Boettcher AC, Meyers JE. Cognitive intra-individual variability has a positive association with traumatic brain injury severity and suboptimal effort. Arch. Clin. Neuropsychol. 2013;28:640–8.

109. Hill BD, Womble MN, Rohling ML. Logistic regression function for detection of suspicious performance during baseline evaluations using concussion vital signs. Appl. Neuropsychol. Adult. 2015;22:233–40.

110. Hinton-Bayre AD, Geffen G, McFarland K. Mild head injury and speed of information processing: a prospective study of professional rugby league players. J. Clin. Exp. Neuropsychol. 1997;19:275–89.

111. Hunt TN, Ferrara MS. Age-related differences in neuropsychological testing among high school athletes. J. Athl. Train. 2009;44:405–9.

112. Ivins BJ, Lange RT, Cole WR, Kane R, Schwab KA, Iverson GL. Using base rates of low scores to interpret the ANAM4 TBI-MIL battery following mild traumatic brain injury. Arch. Clin. Neuropsychol. 2015;30:26–38.

113. Jamora CW, Schroeder SC, Ruff RM. Pain and mild traumatic brain injury: The implications of pain severity on emotional and cognitive functioning. Brain Inj. 2013;27:1134–40.

114. Kashluba S, Hanks RA, Casey JE, Millis SR. Neuropsychologic and functional outcome after complicated mild traumatic brain injury. Arch. Phys. Med. Rehabil. 2008;89:904–11.

115. Killam C, Cautin RL, Santucci AC. Assessing the enduring residual neuropsychological effects of head trauma in college athletes who participate in contact sports. Arch. Clin. Neuropsychol. 2005;20:599–611.

116. Krishnan M, Smith N, Donders J. Use of the Tower of London—Drexel University, Second Edition (TOLDX) in adults with traumatic brain injury. Clin. Neuropsychol. 2012;26:951–64.

117. Krivitzky LS, Roebuck-Spencer TM, Roth RM, Blackstone K, Johnson CP, Gioia G. Functional magnetic resonance imaging of working memory and response inhibition in children with mild traumatic brain injury. J. Int. Neuropsychol. Soc. 2011;17:1143–52.

118. Lange RT, Pancholi S, Brickell TA, Sakura S, Bhagwat A, Merritt V, et al. Neuropsychological outcome from blast versus non-blast: Mild traumatic brain injury in U. S. military service members. J. Int. Neuropsychol. Soc. 2012;18:595–605.

119. Lange RT, Iverson GL, Franzen MD. Neuropsychological functioning following complicated vs. uncomplicated mild traumatic brain injury. Brain Inj. 2009;23:83–91.

120. Lange RT, Iverson GL, Brooks BL, Rennison VLA. Influence of poor effort on self-reported symptoms and neurocognitive test performance following mild traumatic brain injury. J. Clin. Exp. Neuropsychol. 2010;32:961–72.

121. Lange RT, Pancholi S, Bhagwat A, Anderson-Barnes V, French LM. Influence of poor effort on neuropsychological test performance in U.S. military personnel following mild traumatic brain injury. J. Clin. Exp. Neuropsychol. 2012;34:453–66.

122. Larson EB, Zollman F, Kondiles B, Starr C. Memory deficits, postconcussive complaints, and posttraumatic stress disorder in a volunteer sample of veterans. Rehabil. Psychol. 2013;58:245–52.

123. Levin HS, Li X, McCauley SR, Hanten G, Wilde EA, Swank P. Neuropsychological outcome of mTBI: A principal component analysis approach. J. Neurotrauma. 2013;30:625–32.

124. Lippa SM, Pastorek NJ, Romesser J, Linck J, Sim AH, Wisdom NM, et al. Ecological validity of performance validity testing. Arch. Clin. Neuropsychol. 2014;29:236–44.

125. Lopez KC, Leary JB, Pham DL, Chou Y-Y, Dsurney J, Chan L. Brain volume, connectivity and neuropsychological performance in mild traumatic brain injury: the impact of post-traumatic stress disorder symptoms. J. Neurotrauma. 2017;34:16–22.

126. Louey AG, Cromer JA, Schembri AJ, Darby DG, Maruff P, Makdissi M, et al. Detecting cognitive impairment after concussion: Sensitivity of change from baseline and normative data methods using the CogSport/Axon Cognitive test battery. Arch. Clin. Neuropsychol. 2014;29:432–41.

127. Lovell MR, Iverson GL, Collins MW, McKeag D, Maroon JC. Does loss of consciousness predict neuropsychological decrements after concussion? Clin. J. Sport Med. 1999;9:193–198.

128. Luethcke CA, Bryan CJ, Morrow CE, Isler WC. Comparison of concussive symptoms, cognitive performance, and psychological symptoms between acute blast-versus nonblast-induced mild traumatic brain injury. J. Int. Neuropsychol. Soc. 2011;17:36–45.

129. Mac Donald CL, Adam OR, Johnson AM, Nelson EC, Werner NJ, Rivet DJ, et al. Acute post-traumatic stress symptoms and age predict outcome in military blast concussion. Brain. 2015;138:1314–26.

130. MacDonald CL, Johnson AM, Nelson EC, Werner NJ, Fang R, Flaherty SF, et al. Functional status after blast-plus-impact complex concussive traumatic brain injury in evacuated United States military personnel. J. Neurotrauma. 2014;31:889–98.

131. Maillard-Wermelinger A, Yeates KO, Taylor HG, Rusin J, Bangert B, Dietrich A, et al. Mild traumatic brain injury and executive functions in school-aged children. Dev. Neurorehabilitation. 2009;12:330–41.

132. Maruff P, Thomas E, Cysique L, Brew B, Collie A, Snyder P, et al. Validity of the CogState Brief Battery: Relationship to standardized tests and sensitivity to cognitive impairment in mild traumatic brain injury, schizophrenia, and AIDS dementia complex. Arch. Clin. Neuropsychol. 2009;24:165–78.

133. Massey JS, Meares S, Batchelor J, Bryant RA. An exploratory study of the association of acute posttraumatic stress, depression, and pain to cognitive functioning in mild traumatic brain injury. Neuropsychology. 2015;29:530–42.

134. Matser EJT, Kessels AGH, Jordan BD, Lezak MD, Troost J. Chronic traumatic brain injury in professional soccer players. Neurology. 1998;51:791–6.

135. Matser JT, Kessels AGH, Lezak MD, Troost J. A dose-response relation of headers and concussions with cognitive impairment in professional soccer players. J. Clin. Exp. Neuropsychol. 2001;23:770–4.

136. Matser EJT, Kessels AG, Lezak MD, Jordan BD, Troost J. Neuropsychological impairment in amateur soccer players. JAMA. 1999;282:971–3.

137. Matser EJT, Kessels AGH, Lezak MD, Troost J, Jordan BD. Acute traumatic brain injury in amateur boxing. Phys. Sportsmed. 2000;28:87–92.

138. McAllister TW, Rhodes CH, Flashman LA, McDonald BC, Belloni D, Saykin AJ. Effect of the dopamine D2 receptor T allele on response latency after mild traumatic brain injury. Am. J. Psychiatry. 2005;162:1749–51.

139. McAllister TW, Tyler AL, Flashman LA, Rhodes CH, McDonald BC, Saykin AJ, et al. Polymorphisms in the brain-derived neurotrophic factor gene influence memory and processing speed one month after brain injury. J. Neurotrauma. 2012;29:1111–8.

140. McCauley SR, Boake C, Pedroza C, Brown SA, Levin HS, Goodman HS, et al. Correlates of persistent postconcussional disorder: DSM-IV criteria versus ICD-10. J. Clin. Exp. Neuropsychol. 2008;30:360–79.

141. McCauley SR, Wilde EA, Barnes A, Hanten G, Hunter JV, Levin HS, et al. Patterns of early emotional and neuropsychological sequelae after mild traumatic brain injury. J. Neurotrauma. 2014;31:914–25.

142. McDonald TW, Franzen MD. A validity study of the WAIT in closed head injury. Brain Inj. 1999;13:331–46.

143. McGlinchey RE, Fortier CB, Venne JR, Maksimovskiy AL, Milberg WP. Effects of OEF/OIF-related physical and emotional co-morbidities on associative learning: concurrent delay and trace eyeblink classical conditioning. Int. J. Environ. Res. Public. Health. 2014;11:3046–73.

144. Merritt VC, Arnett PA. Premorbid predictors of postconcussion symptoms in collegiate athletes. J. Clin. Exp. Neuropsychol. 2014;36:1098–111.

145. Meyer JE, Arnett PA. Validation of the Affective Word List as a measure of verbal learning and memory. J. Clin. Exp. Neuropsychol. 2015;37:316–24.

146. Meyers JE, Rohling ML. Validation of the Meyers Short Battery on mild TBI patients. Arch. Clin. Neuropsychol. 2004;19:637–51.

147. Nakayama Y, Covassin T, Schatz P, Nogle S, Kovan J. Examination of the Test-Retest Reliability of a Computerized Neurocognitive Test Battery. Am. J. Sports Med. 2014;42:2000–5.

148. Nelson NW, Hoelzle JB, Mcguire KA, Ferrier-Auerbach AG, Charlesworth MJ, Sponheim SR. Evaluation context impacts neuropsychological performance of OEF/OIF veterans with reported combat-related concussion. Arch. Clin. Neuropsychol. 2010;25:713–23.

149. Nelson NW, Hoelzle JB, Doane BM, McGuire KA, Ferrier-Auerbach AG, Charlesworth MJ, et al. Neuropsychological outcomes of U. S. veterans with report of remote blast-related concussion and current psychopathology. J. Int. Neuropsychol. Soc. 2012;18:845–55.

150. Nelson LD, LaRoche AA, Pfaller AY, Lerner EB, Hammeke TA, Randolph C, et al. Prospective, head-to-head study of three computerized neurocognitive assessment tools (CNTs): Reliability and validity for the assessment of sport-related concussion. J. Int. Neuropsychol. Soc. 2016;22:24–37.

151. Nelson LD, Guskiewicz KM, Marshall SW, Hammeke T, Barr W, Randolph C, et al. Multiple self-reported concussions are more prevalent in athletes with ADHD and learning disability. Clin. J. Sport Med. 2016;26:120–127.

152. Nelson LD, Pfaller AY, Rein LE, McCrea MA. Rates and predictors of invalid baseline test performance in high school and collegiate athletes for 3 computerized neurocognitive tests. Am. J. Sports Med. 2015;43:2018–26.

153. Newman JB, Reesman JH, Vaughan CG, Gioia GA. Assessment of processing speed in children with mild TBI: A “first look” at the validity of pediatric ImPACT. Clin. Neuropsychol. 2013;27:779–93.

154. Ord JS, Boettcher AC, Greve KW, Bianchini KJ. Detection of malingering in mild traumatic brain injury with the Conners’ Continuous Performance Test-II. J. Clin. Exp. Neuropsychol. 2010;32:380–7.

155. Panenka WJ, Lange RT, Bouix S, Shewchuk JR, Heran MKS, Brubacher JR, et al. Neuropsychological outcome and diffusion tensor imaging in complicated versus uncomplicated mild traumatic brain injury. PLoS ONE. 2015;10:e0122746.

156. Paré N, Rabin LA, Fogel J, Pépin M. Mild traumatic brain injury and its sequelae: Characterisation of divided attention deficits. Neuropsychol. Rehabil. 2009;19:110–37.

157. Ponsford JL, Cameron P, Fitzgerald M, Grant M, Mikocka-Walus A. Long-term outcomes after uncomplicated mild traumatic brain injury: A comparison with trauma controls. J. Neurotrauma. 2011;28:937–46.

158. Proto DA, Pastorek NJ, Miller BI, Romesser JM, Sim AH, Linck JF. The dangers of failing one or more performance validity tests in individuals claiming mild traumatic brain injury-related postconcussive symptoms. Arch. Clin. Neuropsychol. 2014;29:614–24.

159. Provance AJ, Terhune EB, Cooley C, Carry PM, Connery AK, Engelman GH, et al. The relationship between initial physical examination findings and failure on objective validity testing during neuropsychological evaluation after pediatric mild traumatic brain injury. Sports Health. 2014;6:410–5.

160. Rabinowitz AR, Arnett PA. Reading based IQ estimates and actual premorbid cognitive performance: Discrepancies in a college athlete sample. J. Int. Neuropsychol. Soc. 2012;18:139–43.

161. Rabinowitz AR, Arnett PA. Intraindividual cognitive variability before and after sports-related concussion. Neuropsychology. 2013;27:481–90.

162. Rabinowitz AR, Merritt VC, Arnett PA. The return-to-play incentive and the effect of motivation on neuropsychological test-performance: Implications for baseline concussion testing. Dev. Neuropsychol. 2015;40:29–33.

163. Ravdin LD, Barr WB, Jordan B, Lathan WE, Relkin NR. Assessment of cognitive recovery following sports related head trauma in boxers. Clin. J. Sport Med. 2003;13:21–7.

164. Rieger BP, Lewandowski LJ, Callahan JM, Spenceley L, Truckenmiller A, Gathje R, et al. A prospective study of symptoms and neurocognitive outcomes in youth with concussion vs orthopaedic injuries. Brain Inj. 2013;27:169–78.

165. Ruocco AC, Swirsky-Sacchetti T. Personality disorder symptomatology and neuropsychological functioning in closed head injury. J. Neuropsychiatry Clin. Neurosci. 2007;19:27–35.

166. Schatz P, Maerlender A. A two-factor theory for concussion assessment using ImPACT: Memory and speed. Arch. Clin. Neuropsychol. 2013;28:791–7.

167. Schnabel R, Kydd R. Neuropsychological assessment of distractibility in mild traumatic brain injury and depression. Clin. Neuropsychol. 2012;26:769–89.

168. Schroeder SC, Ruff RM, Jäncke L. Posttraumatic stress disorder exacerbates emotional complaints but not cognitive impairments in individuals suffering from postconcussional disorder after mild traumatic brain injury. Z. Für Neuropsychol. 2015;26:35–50.

169. Shandera-Ochsner AL, Berry DTR, Harp JP, Edmundson M, Graue LO, Roach A, et al. Neuropsychological effects of self-reported deployment-related mild TBI and current PTSD in OIF/OEF veterans. Clin. Neuropsychol. 2013;27:881–907.

170. Shuttleworth-Edwards AB, Radloff SE, Whitefield-Alexander VJ, Smith IP, Horsman M. Practice effects reveal visuomotor vulnerability in school and university rugby players. Arch. Clin. Neuropsychol. 2014;29:86–99.

171. Shuttleworth-Edwards AB, Smith I, Radloff SE. Neurocognitive vulnerability amongst university rugby players versus noncontact sport controls. J. Clin. Exp. Neuropsychol. 2008;30:870–84.

172. Silverberg ND, Luoto TM, Öhman J, Iverson GL. Assessment of mild traumatic brain injury with the King-Devick Test® in an emergency department sample. Brain Inj. 2014;28:1590–3.

173. Siman R, Giovannone N, Hanten G, Wilde EA, McCauley SR, Hunter JV, et al. Evidence that the blood biomarker SNTF predicts brain imaging changes and persistent cognitive dysfunction in mild TBI patients. Front. Neurol. 2013;4:190.

174. Soble JR, Spanierman LB, Smith JF. Neuropsychological functioning of combat veterans with posttraumatic stress disorder and mild traumatic brain injury. J. Clin. Exp. Neuropsychol. 2013;35:551–61.

175. Sponheim SR, McGuire KA, Kang SS, Davenport ND, Aviyente S, Bernat EM, et al. Evidence of disrupted functional connectivity in the brain after combat-related blast injury. NeuroImage. 2011;54:S21–9.

176. Stamm JM, Bourlas AP, Baugh CM, Fritts NG, Daneshvar DH, Martin BM, et al. Age of first exposure to football and later-life cognitive impairment in former NFL players. Neurology. 2015;84:1114–20.

177. Strain JF, Womack KB, Didehbani N, Spence JS, Conover H, Hart JJ, et al. Imaging correlates of memory and concussion history in retired National Football League athletes. JAMA Neurol. 2015;72:773–80.

178. Straume-Næsheim TM, Andersen TE, K Holme IM, McIntosh AS, Dvorak J, Bahr R. Do minor head impacts in soccer cause concussive injury? A prospective case-control study. Neurosurgery. 2009;64:719–25.

179. Straume-Næsheim TM, Andersen TE, Bahr R. Reproducibility of computer based neuropsychological testing among Norwegian elite football players. Br. J. Sports Med. 2005;39:i64–9.

180. Suchy Y, Euler M, Eastvold A. Exaggerated reaction to novelty as a subclinical consequence of mild traumatic brain injury. Brain Inj. 2014;28:972–9.

181. Tay SY, Ang BT, Lau XY, Meyyappan A, Collinson SL. Chronic impairment of prospective memory after mild traumatic brain injury. J. Neurotrauma. 2010;27:77–83.

182. Taylor HG, Dietrich A, Nuss K, Wright M, Rusin J, Bangert B, et al. Post-concussive symptoms in children with mild traumatic brain injury. Neuropsychology. 2010;24:148–59.

183. Teel E, Gay M, Johnson B, Slobounov S. Determining sensitivity/specificity of virtual reality-based neuropsychological tool for detecting residual abnormalities following sport-related concussion. Neuropsychology. 2016;30:474–83.

184. Terry DP, Faraco CC, Smith D, Diddams MJ, Puente AN, Miller LS. Lack of long-term fMRI differences after multiple sports-related concussions. Brain Inj. 2012;26:1684–96.

185. Thaler NS, Linck JF, Heyanka DJ, Pastorek NJ, Miller B, Romesser J, et al. Heterogeneity in Trail Making Test performance in OEF/OIF/OND veterans with mild traumatic brain injury. Arch. Clin. Neuropsychol. 2013;28:798–807.

186. Theadom A, Mahon S, Barker-Collo S, McPherson K, Rush E, Vandal AC, et al. Enzogenol for cognitive functioning in traumatic brain injury: A pilot placebo‐controlled RCT. Eur. J. Neurol. 2013;20:1135–44.

187. Theadom A, Parag V, Dowell T, McPherson K, Starkey N, Barker-Collo S, et al. Persistent problems 1 year after mild traumatic brain injury: a longitudinal population study in New Zealand. Br. J. Gen. Pract. 2016;66:e16–23.

188. Theadom A, Cropley M, Parmar P, Barker-Collo S, Starkey N, Jones K, et al. Sleep difficulties one year following mild traumatic brain injury in a population-based study. Sleep Med. 2015;16:926–32.

189. Theadom A, Parmar P, Jones K, Barker-Collo S, Starkey NJ, McPherson KM, et al. Frequency and impact of recurrent traumatic brain injury in a population-based sample. J. Neurotrauma. 2015;32:674–81.

190. Trontel HG, Hall S, Ashendorf L, O’Connor MK. Impact of diagnosis threat on academic self-efficacy in mild traumatic brain injury. J. Clin. Exp. Neuropsychol. 2013;35:960–70.

191. Tsushima WT, Shirakawa N, Geling O. Neurocognitive functioning and symptom reporting of high school athletes following a single concussion. Appl. Neuropsychol. Child. 2013;2:13–6.

192. Van Patten R, Keith C, Bertolin M, Wright JD. The effect of premorbid attention-deficit/hyperactivity disorder on neuropsychological functioning in individuals with acute mild traumatic brain injuries. J. Clin. Exp. Neuropsychol. 2016;38:12–22.

193. Vanderploeg RD, Belanger HG, Curtiss G. Mild traumatic brain injury and posttraumatic stress disorder and their associations with health symptoms. Arch. Phys. Med. Rehabil. 2009;90:1084–93.

194. Vanderploeg RD, Curtiss G, Belanger HG. Long-term neuropsychological outcomes following mild traumatic brain injury. J. Int. Neuropsychol. Soc. 2005;11:228–36.

195. Vasterling JJ, Brailey K, Proctor SP, Kane R, Heeren T, Franz M. Neuropsychological outcomes of mild traumatic brain injury, post-traumatic stress disorder and depression in Iraq-deployed US Army soldiers. Br. J. Psychiatry. 2012;201:186–92.

196. Veeramuthu V, Pancharatnam D, Poovindran AR, Musthapha NA, Wong Kum Thong, Mazlan M, et al. Cognitive impairments in mild traumatic brain injury and genetic polymorphism of apolipoprotein E: A preliminary study in a Level I trauma center. Neurol. Asia. 2014;19:69–77.

197. Veeramuthu V, Hariri F, Narayanan V, Kuo TL, Ramli N, Ganesan D. Microstructural change and cognitive alteration in maxillofacial trauma and mild traumatic brain injury: a diffusion tensor imaging study. J. Oral Maxillofac. Surg. 2016;74:1197.e1-1197.e10.

198. Vilar-López R, Santiago-Ramajo S, Gómez-Río M, Verdejo-García A, Llamas JM, Pérez-García M. Detection of malingering in a Spanish population using three specific malingering tests. Arch. Clin. Neuropsychol. 2007;22:379–88.

199. Wäljas M, Iverson GL, Lange RT, Hakulinen U, Dastidar P, Huhtala H, et al. A prospective biopsychosocial study of the persistent post-concussion symptoms following mild traumatic brain injury. J. Neurotrauma. 2015;32:534–47.

200. Waid-Ebbs JK, Daly J, Wu SS, Berg WK, Bauer RM, Perlstein WM, et al. Response to goal management training in veterans with blast-related mild traumatic brain injury. J. Rehabil. Res. Dev. 2014;51:1555–66.

201. Walker WC, Franke LM, Cifu DX, Hart BB. Randomized, sham-controlled, feasibility trial of hyperbaric oxygen for service members with postconcussion syndrome: Cognitive and psychomotor outcomes 1 week postintervention. Neurorehabil. Neural Repair. 2014;28:420–32.

202. Wang Y, Nelson LD, LaRoche AA, Pfaller AY, Nencka AS, Koch KM, et al. Cerebral blood flow alterations in acute sport-related concussion. J. Neurotrauma. 2015;33:1227–36.

203. Whiteside DM, Gaasedelen OJ, Hahn-Ketter AE, Luu H, Miller ML, Persinger V, et al. Derivation of a cross-domain embedded performance validity measure in traumatic brain injury. Clin. Neuropsychol. 2015;29:788–803.

204. Willeumier K, Taylor DV, Amen DG. Elevated body mass in National Football League players linked to cognitive impairment and decreased prefrontal cortex and temporal pole activity. Transl. Psychiatry. 2012;2:e68–e68.

205. Winkler EA, Yue JK, McAllister TW, Temkin NR, Oh SS, Burchard EG, et al. COMT Val (158) Met polymorphism is associated with nonverbal cognition following mild traumatic brain injury. Neurogenetics. 2016;17:31–41.

206. Wisdom NM, Pastorek NJ, Miller BI, Booth JE, Romesser JM, Linck JF, et al. PTSD and cognitive functioning: Importance of including performance validity testing. Clin. Neuropsychol. 2014;28:128–45.

207. Wright MJ, Woo E, Birath JB, Siders CA, Kelly DF, Wang C, et al. An index predictive of cognitive outcome in retired professional American Football players with a history of sports concussion. J. Clin. Exp. Neuropsychol. 2016;38:561–71.

208. Zollman FS, Starr C, Kondiles B, Cyborski C, Larson EB. The Rehabilitation Institute of Chicago Military Traumatic Brain Injury Screening Instrument: Determination of Sensitivity, Specificity, and Predictive Value. J. Head Trauma Rehabil. 2014;29:99–107.

209. Alexander DG, Shuttleworth-Edwards AB, Kidd M, Malcolm CM. Mild traumatic brain injuries in early adolescent rugby players: Long-term neurocognitive and academic outcomes. Brain Inj. 2015;29:1113–25.

210. Alhilali LM, Delic JA, Gumus S, Fakhran S. Evaluation of white matter injury patterns underlying neuropsychiatric symptoms after mild traumatic brain injury. Radiology. 2015;277:793–800.

211. Amyot F, Zimmermann T, Riley J, Kainerstorfer JM, Chernomordik V, Mooshagian E, et al. Normative database of judgment of complexity task with functional near infrared spectroscopy—Application for TBI. NeuroImage. 2012;60:879–83.

212. Barrow IM, Hough M, Rastatter MP, Walker M, Holbert D, Rotondo MF. The effects of mild traumatic brain injury on confrontation naming in adults. Brain Inj. 2006;20:845–55.

213. Beaupré M, De Guise É, McKerral M. The association between pain-related variables, emotional factors, and attentional functioning following mild traumatic brain injury. Rehabil. Res. Pract. 2012;1–10.

214. Bernstein JPK, Mitchell LS, Bazarian JJ, Langfitt JT. The King-Devick test: An indicator of longer-term cognitive effects post-concussion. Acta Neuropsychol. 2015;13:229–36.

215. Blanchet S, Paradis-Giroux A-A, Pépin M, McKerral M. Impact of divided attention during verbal learning in young adults following mild traumatic brain injury. Brain Inj. 2009;23:111–22.

216. Blyth T, Scott A, Bond A, Paul E. A comparison of two assessments of high level cognitive communication disorders in mild traumatic brain injury. Brain Inj. 2012;26:234–40.

217. Borgaro SR, Prigatano GP, Kwasnica C, Rexer JL. Cognitive and affective sequelae in complicated and uncomplicated mild traumatic brain injury. Brain Inj. 2003;17:189–98.

218. Broglio SP, Tomporowski P D, Ferrara MS. Balance performance with a cognitive task: a dual-task testing paradigm. Med. Sci. Sports Exerc. 2005;37:689–95.

219. Brooks BL, McKay CD, Mrazik M, Barlow KM, Meeuwisse WH, Emery CA. Subjective, but not objective, lingering effects of multiple past concussions in adolescents. J. Neurotrauma. 2013;30:1469–75.

220. Brooks BL, Iverson GL, Atkins JE, Zafonte R, Berkner PD. Sex differences and self-reported attention problems during baseline concussion testing. Appl. Neuropsychol. Child. 2016;5:119–26.

221. Brooks BL, Low T, Daya H, Khan S, Mikrogianakis A, Barlow K. Test or rest? Computerized cognitive testing in the emergency department after pediatric mild traumatic brain injury does not delay symptom recovery. J. Neurotrauma. 2016;

222. Brookshire BL, Chapman SB, Song J, Levin HS. Cognitive and linguistic correlates of children’s discourse after closed head injury: A three-year follow-up. J. Int. Neuropsychol. Soc. 2000;6:741–51.

223. Bruce JM, Echemendia RJ. History of multiple self-reported concussions is not associated with reduced cognitive abilities. Neurosurgery. 2009;64:100–6.

224. Catale C, Marique P, Closset A, Meulemans T. Attentional and executive functioning following mild traumatic brain injury in children using the Test for Attentional Performance (TAP) battery. J. Clin. Exp. Neuropsychol. 2008;31:331–8.

225. Clarke LA, Genat RC, Anderson JFI. Long-term cognitive complaint and post-concussive symptoms following mild traumatic brain injury: The role of cognitive and affective factors. Brain Inj. 2012;26:298–307.

226. Cooper DB, Mercado-Couch JM, Critchfield E, Kennedy J, Vanderploeg RD, DeVillibis C, et al. Factors influencing cognitive functioning following mild traumatic brain injury in OIF/OEF burn patients. NeuroRehabilitation. 2010;26:233–8.

227. Cooper DB, Chau PM, Armistead-Jehle P, Vanderploeg RD, Bowles AO. Relationship between mechanism of injury and neurocognitive functioning in OEF/OIF service members with mild traumatic brain injuries. Mil. Med. 2012;177:1157–60.

228. Cooper DB, Vanderploeg RD, Armistead-Jehle P, Lewis JD, Bowles AO. Factors associated with neurocognitive performance in OIF/OEF servicemembers with postconcussive complaints in postdeployment clinical settings. J. Rehabil. Res. Dev. 2014;51:1023–33.

229. De Monte VE, Geffen GM, May CR, McFarland K, Heath P, Neralic M. The acute effects of mild traumatic brain injury on finger tapping with and without word repetition. J. Clin. Exp. Neuropsychol. 2005;27:224–39.

230. De Monte VE, Geffen GM, Massavelli BM. The effects of post-traumatic amnesia on information processing following mild traumatic brain injury. Brain Inj. 2006;20:1345–54.

231. De Monte VE, Geffen GM, May CR, McFarland K. Double cross-validation and improved sensitivity of the rapid screen of mild traumatic brain injury. J. Clin. Exp. Neuropsychol. 2004;26:628–44.

232. De Monte VE, Geffen GM, May CR, McFarland K. Improved sensitivity of the rapid screen of mild traumatic brain injury. J. Clin. Exp. Neuropsychol. 2010;32:28–37.

233. Decq P, Gault N, Blandeau M, Kerdraon T, Berkal M, ElHelou A, et al. Long-term consequences of recurrent sports concussion. Acta Neurochir. (Wien). 2016;158:289–300.

234. Dikmen S, Machamer J, Temkin N. Mild head injury: Facts and artifacts. J. Clin. Exp. Neuropsychol. 2001;23:729–38.

235. Dunkley BT, Da Costa L, Bethune A, Jetly R, Pang EW, Taylor MJ, et al. Low-frequency connectivity is associated with mild traumatic brain injury. NeuroImage Clin. 2015;7:611–621.

236. Echemendia RJ, Bruce JM, Bailey CM, Sanders JF, Arnett P, Vargas G. The utility of post-concussion neuropsychological data in identifying cognitive change following sports-related MTBI in the absence of baseline data. Clin. Neuropsychol. 2012;26:1077–91.

237. Elbin RJ, Schatz P, Covassin T. One-year test-retest reliability of the online version of ImPACT in high school athletes. Am. J. Sports Med. 2011;39:2319–24.

238. Fakhran S, Yaeger K, Collins M, Alhilali L. Sex differences in white matter abnormalities after mild traumatic brain injury: localization and correlation with outcome. Radiology. 2014;272:815–23.

239. Falconer EK, Geffen GM, Olsen SL, McFarland K. The rapid screen of concussion: An evaluation of the non-word repetition test for use in mTBI research. Brain Inj. 2006;20:1251–63.

240. Ford JH, Giovanello KS, Guskiewicz KM. Episodic memory in former professional football players with a history of concussion: An event related-functional neuroimaging study. J. Neurotrauma. 2013;30:1683–701.

241. Galetto V, Andreetta S, Zettin M, Marini A. Patterns of impairment of narrative language in mild traumatic brain injury. J. Neurolinguistics. 2013;26:649–61.

242. Ghodadra A, Alhilali L, Fakhran S. Principal component analysis of diffusion tensor images to determine white matter injury patterns underlying postconcussive headache. AJNR Am. J. Neuroradiol. 2016;37:274–8.

243. Greiffenstein MF, Baker WJ. Validity testing in dually diagnosed post-traumatic stress disorder and mild closed head injury. Clin. Neuropsychol. 2008;22:565–82.

244. Greiffenstein MF, Baker WJ, Johnson-Greene D. Actual versus self-reported scholastic achievement of litigating postconcussion and severe closed head injury claimants. Psychol. Assess. 2002;14:202–8.

245. Grubenhoff JA, Kirkwood M, Gao D, Deakyne S, Wathen J. Evaluation of the standardized assessment of concussion in a pediatric emergency department. Pediatrics. 2010;126:688–95.

246. Hanten G, Dennis M, Zhang L, Barnes M, Roberson G, Archibald J, et al. Childhood head injury and metacognitive processes in language and memory. Dev. Neuropsychol. 2004;25:85–106.

247. Henry LC, Sandel N. Adolescent subtest norms for the ImPACT neurocognitive battery. Appl. Neuropsychol. Child. 2015;4:266–76.

248. Hobson E, Lannin NA, Taylor A, Farquhar M, Morarty J, Unsworth C. Determining client cognitive status following mild traumatic brain injury. Scand. J. Occup. Ther. 2016;23:138–46.

249. Johansson B, Berglund P, Rönnbäck L. Mental fatigue and impaired information processing after mild and moderate traumatic brain injury. Brain Inj. 2009;23:1027–40.

250. Keightley ML, Saluja RS, Chen J-K, Gagnon I, Leonard G, Petrides M, et al. A functional magnetic resonance imaging study of working memory in youth after sports-related concussion: Is it still working? J. Neurotrauma. 2014;31:437–51.

251. Killgore WDS, Singh P, Kipman M, Pisner D, Fridman A, Weber M. Gray matter volume and executive functioning correlate with time since injury following mild traumatic brain injury. Neurosci. Lett. 2016;612:238–44.

252. King KA, Hough MS, Walker MM, Rastatter M, Holbert D. Mild traumatic brain injury: Effects on naming in word retrieval and discourse. Brain Inj. 2006;20:725–32.

253. Kinsella GJ, Olver J, Ong B, Gruen R, Hammersley E. Mild traumatic brain injury in older adults: Early cognitive outcome. J. Int. Neuropsychol. Soc. 2014;20:663–71.

254. Konrad C, Geburek AJ, Rist F, Blumenroth H, Fischer B, Husstedt I, et al. Long-term cognitive and emotional consequences of mild traumatic brain injury. Psychol. Med. 2011;41:1197–1211.

255. Kuhn AW, Solomon GS. Supervision and computerized neurocognitive baseline test performance in high school athletes: An initial investigation. J. Athl. Train. 2014;49:800–5.

256. Landre N, Poppe CJ, Davis N, Schmaus B, Hobbs SE. Cognitive functioning and postconcussive symptoms in trauma patients with and without mild TBI. Arch. Clin. Neuropsychol. 2006;21:255–73.

257. Langeluddecke PM, Lucas SK. Quantitative measures of memory malingering on the Wechsler Memory Scale--Third edition in mild head injury litigants. Arch. Clin. Neuropsychol. 2003;18:181–97.

258. Lax ID, Paniccia M, Agnihotri S, Reed N, Garmaise E, Azadbakhsh M, et al. Developmental and gender influences on executive function following concussion in youth hockey players. Brain Inj. 2015;29:1409–19.

259. Lee H, Wintermark M, Gean AD, Ghajar J, Manley GT, Mukherjee P. Focal lesions in acute mild traumatic brain injury and neurocognitive outcome: CT versus 3T MRI. J. Neurotrauma. 2008;25:1049–56.

260. Levin HS, Mattis S, Ruff RM, Eisenberg HM, Marshall LF, Tabaddor K, et al. Neurobehavioral outcome following minor head injury: a three-center study. J. Neurosurg. 1987;66:234–243.

261. Hulkower MB, Poliak DB, Rosenbaum SB, Zimmerman ME, Lipton ML. A decade of DTI in traumatic brain injury: 10 years and 100 articles later. Am. J. Neuroradiol. 2013;34:2064–2074.

262. List J, Ott S, Bukowski M, Lindenberg R, Flöel A. Cognitive function and brain structure after recurrent mild traumatic brain injuries in young-to-middle-aged adults. Front. Hum. Neurosci. 2015;9:228.

263. Littleton AC, Register-Mihalik JK, Guskiewicz KM. Test-Retest Reliability of a Computerized Concussion Test: CNS Vital Signs. Sports Health. 2015;7:443–7.

264. Losoi H, Silverberg ND, Wäljas M, Turunen S, Rosti-Otajärvi E, Helminen M, et al. Recovery from mild traumatic brain injury in previously healthy adults. J. Neurotrauma. 2016;33:766–776.

265. Luoto TM, Silverberg ND, Kataja A, Brander A, Tenovuo O, Öhman J, et al. Sport Concussion Assessment Tool 2 in a civilian trauma sample with mild traumatic brain injury. J. Neurotrauma. 2014;31:728–38.

266. Möller MC, de Boussard CN, Oldenburg C, Bartfai A. An investigation of attention, executive, and psychomotor aspects of cognitive fatigability. J. Clin. Exp. Neuropsychol. 2014;36:716–29.

267. Marsh NV, Smith MD. Post-concussion syndrome and the coping hypothesis. Brain Inj. 1995;9:553–62.

268. Marsh NV, Whitehead G. Skull Fracture During Infancy: A Five-Year Follow-Up. J. Clin. Exp. Neuropsychol. 2005;27:352–66.

269. Mathias JL, Beall JA, Bigler ED. Neuropsychological and information processing deficits following mild traumatic brain injury. J. Int. Neuropsychol. Soc. 2004;10:286–97.

270. Mathias JL, Dennington V, Bowden SC, Bigler ED. Community versus orthopaedic controls in traumatic brain injury research: How comparable are they? Brain Inj. 2013;27:887–95.

271. McCauley SR, Levin HS. Prospective memory in pediatric traumatic brain injury: a preliminary study. Dev. Neuropsychol. 2004;25:5–20.

272. McCullough CM, De Monte V, Sheedy J, Geffen GM. Generalisability of the Rapid Screen of Concussion: A Dual-Centre Approach. Brain Impair. 2006;7:16–25.

273. Meares S, Shores EA, Batchelor J, Baguley IJ, Chapman J, Gurka J, et al. The relationship of psychological and cognitive factors and opioids in the development of the postconcussion syndrome in general trauma patients with mild traumatic brain injury. J. Int. Neuropsychol. Soc. 2006;12:792–801.

274. Mihalik JP, Register-Mihalik J, Kerr ZY, Marshall SW, McCrea MC, Guskiewicz KM. Recovery of posttraumatic migraine characteristics in patients after mild traumatic brain injury. Am. J. Sports Med. 2013;41:1490–6.

275. Nance ML, Polk-Williams A, Collins MW, Wiebe DJ. Neurocognitive evaluation of mild traumatic brain injury in the hospitalized pediatric population. Ann. Surg. 2009;249:859–63.

276. Newsome MR, Durgerian S, Mourany L, Scheibel RS, Lowe MJ, Beall EB, et al. Disruption of caudate working memory activation in chronic blast-related traumatic brain injury. Neuroimage Clin. 2015;8:543–53.

277. Nolin P, Heroux L. Relations among sociodemographic, neurologic, clinical, and neuropsychologic variables, and vocational status following mild traumatic brain injury: a follow-up study. J. Head Trauma Rehabil. 2006;21:514–26.

278. Nolin P, Stipanicic A, Henry M, Joyal CC, Allain P. Virtual reality as a screening tool for sports concussion in adolescents. Brain Inj. 2012;26:1564–73.

279. Olsson K, Kenardy JA, Brown EA, Charlton E, Brown FL, Lloyd O, et al. Evaluation of parent and child psychoeducation resources for the prevention of paediatric post-concussion symptoms. Brain Impair. 2014;15:177–89.

280. Ozen LJ, Fernandes MA. Effects of “diagnosis threat” on cognitive and affective functioning long after mild head injury. J. Int. Neuropsychol. Soc. 2011;17:219–229.

281. Ozen LJ, Fernandes MA. Slowing down after a mild traumatic brain injury: A strategy to improve cognitive task performance? Arch. Clin. Neuropsychol. 2012;27:85–100.

282. Phillipou A, Douglas J, Krieser D, Ayton L, Abel L. Changes in saccadic eye movement and memory function after mild closed head injury in children. Dev. Med. Child Neurol. 2014;56:337–45.

283. Ponsford JL, Willmott C, Rothwell A, Cameron P, Ayton G, Nelms R, et al. Cognitive and behavioral outcome following mild traumatic head injury in children. J. Head Trauma Rehabil. 1999;14:360–372.

284. Ponsford JL, Willmont C, Rothwell A, Cameron P, Kelly A-M, Nelms R, et al. Factors influencing outcome following mild traumatic brain injury in adults. J. Int. Neuropsychol. Soc. 2000;6:568–79.

285. Ponsford JL, Willmott C, Rothwell A, Cameron P, Ayton G, Nelms R, et al. Impact of early intervention on outcome after mild traumatic brain injury in children. Pediatrics. 2001;108:1297–1303.

286. Ponsford JL, Willmott C, Rothwell A, Cameron P, Kelly A-M, Nelms R, et al. Impact of early intervention on outcome following mild head injury in adults. J. Neurol. Neurosurg. Psychiatry. 2002;73:330–2.

287. Ponsford JL, Cameron P, Fitzgerald M, Grant M, Mikocka-Walus A, Schönberger M. Predictors of postconcussive symptoms 3 months after mild traumatic brain injury. Neuropsychology. 2012;26:304–13.

288. Resch JE, Brown CN, Macciocchi SN, Cullum CM, Blueitt D, Ferrara MS. A preliminary formula to predict timing of symptom resolution for collegiate athletes diagnosed with sport concussion. J. Athl. Train. 2015;50:1292–8.

289. Resch JE, Brown CN, Baumgartner TA, Macciocchi SN, Walpert KP, Ferrara MS. Influence of Mood State on the ImPACT. Athl. Train. Sports Health Care J. Pract. Clin. 2013;5:272–81.

290. Resch JE, Macciocchi S, Ferrara MS. Preliminary evidence of equivalence of alternate forms of the ImPACT. Clin. Neuropsychol. 2013;27:1265–80.

291. Resch JE, May B, Tomporowski PD, Ferrara MS. Balance performance with a cognitive task: A continuation of the dual-task testing paradigm. J. Athl. Train. 2011;46:170–5.

292. Riegler LJ, Neils-Strunjas J, Boyce S, Wade SL, Scheifele PM. Cognitive intervention results in web-based videophone treatment adherence and improved cognitive scores. Med. Sci. Monit. Int. Med. J. Exp. Clin. Res. 2013;19:269–75.

293. Ruffolo CF, Friedland JF, Dawson DR, Colantonio A, Lindsay PH. Mild traumatic brain injury from motor vehicle accidents: factors associated with return to work. Arch. Phys. Med. Rehabil. 1999;80:392–8.

294. Ruttan LA, Heinrichs RW. Depression and neurocognitive functioning in mild traumatic brain injury patients referred for assessment. J. Clin. Exp. Neuropsychol. 2003;25:407–19.

295. Schatz P, Moser RS, Solomon GS, Ott SD, Karpf R. Prevalence of invalid computerized baseline neurocognitive test results in high school and collegiate athletes. J. Athl. Train. 2012;47:289–96.

296. Scherwath A, Sommerfeldt DW, Bindt C, Nolte A, Boiger A, Koch U, et al. Identifying children and adolescents with cognitive dysfunction following mild traumatic brain injury—Preliminary findings on abbreviated neuropsychological testing. Brain Inj. 2011;25:401–8.

297. Sheedy J, Geffen G, Donnelly J, Faux S. Emergency department assessment of mild traumatic brain injury and prediction of post-concussion symptoms at one month post injury. J. Clin. Exp. Neuropsychol. 2006;28:755–72.

298. Sheedy J, Harvey E, Faux S, Geffen G, Shores EA. Emergency department assessment of mild traumatic brain injury and the prediction of postconcussive symptoms: A 3-month prospective study. J. Head Trauma Rehabil. 2009;24:333–43.

299. Shuttleworth-Edwards AB, Radloff SE. Compromised visuomotor processing speed in players of Rugby Union from school through to the national adult level. Arch. Clin. Neuropsychol. 2008;23:511–20.

300. Silverberg ND, Berkner PD, Atkins JE, Zafonte R, Iverson GL. Relationship between short sleep duration and preseason concussion testing. Clin. J. Sport Med. 2016;26:226–31.

301. Stokum JA, Sours C, Zhuo J, Kane R, Shanmuganathan K, Gullapalli RP. A longitudinal evaluation of diffusion kurtosis imaging in patients with mild traumatic brain injury. Brain Inj. 2015;29:47–57.

302. Storzbach D, O’Neil ME, Roost S-M, Kowalski H, Iverson GL, Binder LM, et al. Comparing the neuropsychological test performance of Operation Enduring Freedom/Operation Iraqi Freedom (OEF/OIF) Veterans with and without blast exposure, mild traumatic brain injury, and posttraumatic stress symptoms. J. Int. Neuropsychol. Soc. 2015;21:353–63.

303. Studer M, Goeggel Simonetti B, Heinks T, Steinlin M, Leichtle A, Berger S, et al. Acute S100B in serum is associated with cognitive symptoms and memory performance 4 months after paediatric mild traumatic brain injury. Brain Inj. 2015;29:1667–73.

304. Swick D, Honzel N, Larsen J, Ashley V, Justus T. Impaired response inhibition in veterans with post-traumatic stress disorder and mild traumatic brain injury. J. Int. Neuropsychol. Soc. 2012;18:917–26.

305. Terry DP, Adams TE, Ferrara MS, Miller LS. fMRI hypoactivation during verbal learning and memory in former high school football players with multiple concussions. Arch. Clin. Neuropsychol. 2015;30:341–55.

306. Thornton AE, Cox DN, Whitfield K, Fouladi RT. Cumulative concussion exposure in rugby players: Neurocognitive and symptomatic outcomes. J. Clin. Exp. Neuropsychol. 2008;30:398–409.

307. Tombaugh TN, Stormer P, Rees L, Irving S, Francis M. The effects of mild and severe traumatic brain injury on the auditory and visual versions of the Adjusting-Paced Serial Addition Test (Adjusting-PSAT). Arch. Clin. Neuropsychol. 2006;21:753–61.

308. Troyanskaya M, Pastorek NJ, Scheibel RS, Petersen NJ, McCulloch K, Wilde EA, et al. Combat exposure, PTSD symptoms, and cognition following blast-related traumatic brain injury in OEF/OIF/OND service members and veterans. Mil. Med. 2015;180:285–9.

309. Tsirka V, Simos P, Vakis A, Vourkas M, Arzoglou V, Syrmos N, et al. Material-specific difficulties in episodic memory tasks in mild traumatic brain injury. Int. J. Neurosci. 2010;120:184–91.

310. Tsirka V, Simos PG, Vakis A, Kanatsouli K, Vourkas M, Erimaki S, et al. Mild traumatic brain injury: Graph-model characterization of brain networks for episodic memory. Int. J. Psychophysiol. 2011;79:89–96.

311. Tsushima WT, Geling O, Arnold M. Effects of two concussions on the neuropsychological functioning and symptom reporting of high school athletes. Appl. Neuropsychol. Child. 2016;5:9–13.

312. Tsushima WT, Siu AM, Pearce AM, Guangxiang Zhang, Oshiro RS. Two-year test-retest reliability of impact in high school athletes. Arch. Clin. Neuropsychol. 2016;31:105–11.

313. Van Beek L, Ghesquière P, Lagae L, De Smedt B. Mathematical difficulties and white matter abnormalities in subacute pediatric mild traumatic brain injury. J. Neurotrauma. 2015;32:1567–78.

314. Vassilyadi M, Macartney G, Barrowman N, Anderson P, Dube K. Symptom experience and quality of life in children after sport-related head injuries: A cross-sectional study. Pediatr. Neurosurg. 2015;50:196–203.

315. Wall SE, Williams WH, Carlwright-Hatton S, Kelly TP, Murray J, Murray M, et al. Neuropsychological dysfunction following repeat concussions in jockeys. J. Neurol. Neurosurg. Psychiatry. 2006;77:518–20.

316. Wilson MJ, Harkrider AW, King KA. The effects of visual distracter complexity on auditory evoked P3b in contact sports athletes. Dev. Neuropsychol. 2014;39:113–30.

317. Wong MN, Murdoch B, Whelan B-M. Language disorders subsequent to mild traumatic brain injury (MTBI): Evidence from four cases. Aphasiology. 2010;24:1155–69.

318. Yallampalli R, Wilde EA, Bigler ED, McCauley SR, Hanten G, Troyanskaya M, et al. Acute white matter differences in the fornix following mild traumatic brain injury using diffusion tensor imaging. J. Neuroimaging. 2013;23:224–7.

319. Yengo-Kahn AM, Solomon G. Are psychotropic medications associated with differences in baseline neurocognitive assessment scores for young athletes? A pilot study. Phys. Sportsmed. 2015;43:227–35.

320. Zuckerman SL, Lee YM, Odom MJ, Solomon GS, Forbes JA, Sills AK. Recovery from sports-related concussion: Days to return to neurocognitive baseline in adolescents versus young adults. Surg. Neurol. Int. 2012;3:709–15.

321. Pineau H, Marchand A, Guay S. Objective neuropsychological deficits in post-traumatic stress disorder and mild traumatic brain injury: What remains beyond symptom similarity? Behav. Sci. 2014;4:471–86.

322. Meyer JE, Arnett PA. Changes in symptoms in concussed and non-concussed athletes following neuropsychological assessment. Dev. Neuropsychol. 2015;40:24–8.

323. The International Organization for Migration. 2015 Global Migration Trends Factsheet [Internet]. 2017. Available from: http://gmdac.iom.int/global-migration-trends-factsheet

324. Olson K, Jacobson K. Cross-cultural considerations in pediatric neuropsychology: A review and call to attention. Appl. Neuropsychol. Child. 2015;4:166–77.

**Figure 1.** Study selection PRISMA flowsheet

**Figure 2.** Number of articles by country. Colors are present in a log10 scale. For reference, research groups in the United States contributed 489 articles.