Validity of Pre-season Athlete Baseline Tests for Computerized Concussion Testing

Darby D[1-4], Pereira-Gale J[3], Moriarity J[7], Kutcher J[8], Patricios J[9], Turner M[5], Hodgson L[6], McCrory P[10]

[1]Centre for Neuroscience, University of Melbourne, Australia. [2]Florey Neuroscience Institutes, Melbourne, Australia. [3]CogState Ltd, Melbourne, Australia. [4]Axon Sports LLC, Wausau, WI, USA. [5]British Horseracing Authority, London, UK. [6]Corobeus Sports Consultancy, West Yorkshire, UK. [7]Notre Dame University, Indiana, USA. [8]University of Michigan, Michigan, USA. [9]Sports Concussion South Africa, Rosebank, South Africa. [10]Department of Sports Medicine, University of Melbourne, Australia.

Background

- Concussion consensus guidelines recommend athletes undergo pre-season medical evaluation which may include computerized cognitive testing.[1]
- Such evaluations aim to detect pre-existing neurological impairment which may affect ability to participate, and establish a baseline for future comparisons.[1]
- Detection of subtle cognitive changes after concussion is dependent upon "best effort" baseline test performance which is affected by many factors.[2]
- Determining best effort is not straight forward but may utilize measures suggestive of suboptimal effort, including test completion, performance integrity criteria, and symptom validity checks.
- In clinical use, overly conservative or strict criteria can both lead to practical problems (e.g. false positives or negatives) indicating that criteria should be evaluated in clinical populations both on single and repeated testing.

Objective

- To evaluate the proportion of athletes failing "best effort" validity criteria of baseline computerized cognitive test performance in a large international group of athletes on single and repeated assessment.

Methods

- Participants were male and female contact sports athletes from Australia, USA, UK, and South Africa who had baseline testing using CogState Sport between Jan 2002 and May 2010.
- The test materials used CogState Sport software, with design features presented in Figure 1. Although changes to the task instructions occurred over the 8 years, the task scored components did not change.
- De-identified data was extracted from the CogState Sport database with the permission of the respective organizations.
- The test completion, accuracy and speed criteria for valid baselines are presented in Table 1.
- The proportion of baseline tests failing each criterion and any one criterion on first and subsequent testings were computed.
- The distributions of speed and accuracy were computed for the whole sample and with failed tests removed.
- These evaluations aimed to determine the effect of these criteria on real world likelihood of an athlete obtaining an invalid test (and hence having to repeat their test).

Figure 1: Principles of game-like tasks

Computer testing using playing card stimuli:
culture neutral, minimal language, game-like
Different rules - different tasks - assessment of cognition using same paradigm
Single card turns face-up from face-down:
Is it there? (Detection, DET)
Is it red? (Identification, IDN)
Was it there? (One card learning, OCL)
Is it the same? (One back, OBK)

Measure speed & accuracy of responses

Table 1: Integrity criteria

Criterion	Description
Completion	Total task trials ≥ 75% of expected correct trials
Accuracy	DET accuracy > 90%
	IDN accuracy > 80%
	OCL accuracy > 53%
	OBK accuracy > 53%
Speed	DET mean speed faster than IDN mean speed
	DET mean speed faster than OBK mean speed

Accuracy criteria for DET and IDN were based on the 5th percentile for a normative data sample [3]; OCL and OBK accuracy aim to exclude chance performances.

Table 2: Criteria failures by baseline test number

	n	ANY	TC	ACC	SPD
BL 1	17,368	14.1%	3.0%	12.8%	2.9%
BL 2	1,761	1.7%	0.4%	1.5%	0.3%
BL 3	521	0.6%	0.1%	0.5%	0.1%
BL 4	199	0.3%	0.1%	0.3%	0.04%

Legend: BL Baseline testing session, n = number of athletes tested, ANY = failure on any criterion, TC = test completion failure, ACC = accuracy criterion failure, SPD = relative speed criterion failure

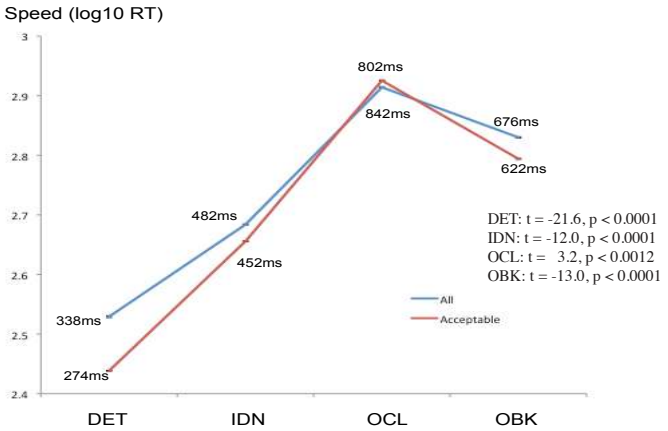
Table 3: Criterion failures & valid test speeds (μ, sd) by code (BL 1)

Code	n	ANY	% FAILS	DET	IDN
AFL	499	79	15.8%	2.42 (0.07)	2.61 (0.06)
ERL	2,005	143	7.1%	2.41 (0.06)	2.63 (0.06)
BHA	2,789	291	10.4%	2.45 (0.11)	2.68 (0.09)
RFL	4,494	592	13.2%	2.44 (0.07)	2.65 (0.06)
SA	3,076	724	23.5%	2.46 (0.09)	2.67 (0.08)
USA	4,505	628	13.9%	2.43 (0.07)	2.65 (0.07)
Total	**17,368**	**2,457**	**14.1%**	**2.44 (0.08)**	**2.66 (0.07)**

Legend: Code = Sporting code, BL Baseline testing session, n = number of athletes tested, ANY = number that failed on any criterion, % FAILS = percentage that failed any criterion, AFL = Aust Football League, ERL = English Rugby League, BHA = British Horseracing Authority, RFL = Rugby Football League, SA = South African Rugby (High schools), USA = College athletics.
NB: speed expressed in log10 units as mean (sd).

CogState

Figure 2. Speed differences with and without failures (BL 1)



Results

- There were 17,368 athletes with first baseline tests. Table 2 shows the proportion that failed any criterion, or any of the specific criteria.
- Overall, the proportion of athletes who failed any criterion on their first and subsequent baselines was 14.1%, 1.7%, 0.6%, and 0.3% respectively.
- Table 3 shows the breakdown by sporting code, with lowest initial baseline failure rate in ERL and BHA, and fastest reaction times (after exclusion of failed baselines) in ERL and AFL athletes.
- Figure 2 shows the mean speed performances of all athletes and those who obtained valid baseline tests. There is a significant difference between each of the tasks (DET, IDN and OBK improving after removal of failed baseline results).

Conclusions

- The validity criteria used in this study identified about 14% of an international sample of athletes from various codes as performing suboptimally on their initial baseline test.
- Repeated testing was associated with very few subsequent failures, with less than 1% failing 3 times. This suggests that the majority of failures were related to suboptimal effort.
- Performance speed measures were significantly different if all athlete performances (including failures) were included in or excluded from the analysis. This supports specifically evaluating baseline performances for such failures, and recommending repeat testing.
- Differences in the proportion of athletes failing BL 1 and their mean speeds by code were noted.

References

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