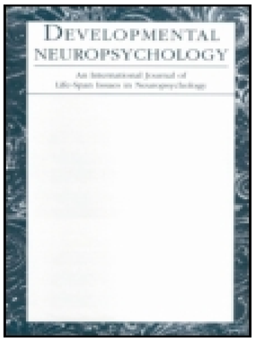

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The Return-to-Play Incentive and the Effect of Motivation on Neuropsychological Test-Performance: Implications for Baseline Concussion Testing

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Athletes may be less engaged in baseline cognitive testing in the absence of a powerful return-to-play incentive. The present study sought to evaluate whether athletes' level of motivation (1) influences baseline test performance and (2) changes across pre- and post-injury assessments. We found a significant relationship between examiners' ratings of athletes motivation toward testing and baseline cognitive test performance. Athletes, but not controls, demonstrated increased motivation between tests. These findings suggest that baseline test performance may underestimate true premorbid abilities for a subset of athletes.

Although some have questioned its utility (Randolph, 2011; Randolph, McCrea, & Barr, 2005), baseline testing is commonly considered in return-to-play decision making following sports-related concussion. However, those who work with athletes have noted that an athlete's approach to testing can be dramatically different during the baseline and post-concussion assessments. Sub-optimal motivation during baseline testing could lead to invalid conclusions regarding athletes' true level of pre-injury functioning. In fact, data presented by Bailey and colleagues demonstrates that some athletes exhibit markedly improved performance post-concussion relative to their baseline scores (Bailey, Echemendia, & Arnett, 2006). This strongly suggests that, for some athletes, baseline performance under-represents true ability level.

It is not surprising that athletes experience changes in motivation across assessments. Athletes are aware that their post-injury test results will be used to inform return-to-play decisions, which provides a powerful incentive on optimal performance. Although many concussion batteries now include validity indicators to detect invalid performance, recent work has shown that it is possible to under-perform without triggering validity indicators, at least on the ImPACT neurocognitive battery (Erdal, 2012).

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This study examines changes in motivation toward testing across baseline and post-injury assessments, and its impact of on athletes' cognitive test performance at baseline. We hypothesize that (1) baseline motivation rating will influence baseline ImPACT performance, such that highly motivated athletes will demonstrate the highest ImPACT scores and (2) concussed athletes, but not control participants, will exhibit increased motivation ratings at the second test session.

METHOD

All data were collected between October 29, 2003 and November 12, 2010 in compliance with the regulations of the Pennsylvania State University's Institutional Review Board.

Participants

Participants were 613 college athletes participating in a concussion management program at a large university, a multi-sport program that assesses participants prior to and following sports-related concussion. Forty-two control participants were students from the same university who play intramural sports, but do not participate in the concussion management program.

Measures

Participants were administered a neuropsychological test battery including the Wechsler Test of Adult Reading (Psychological Corporation, 2001), from which full scale IQ (FSIQ) can be estimated; and the Immediate Post-Concussion Assessment and Cognitive Testing computerized battery (Lovell, Collins, Podell, Powell, & Maroon, 2000), which assesses cognitive domains typically affected following such injury.

At the end of each session, examiners rated the athlete's motivation toward testing on a 1–7 scale, with 1 indicating that the athlete was "not trying at all," and 7 indicating optimal effort. Examiners were instructed to rate effort and not test performance. This rating is highly correlated with a 12-item observational measure of behaviors associated with poor effort, such as eyes wandering during testing, careless responses, and complaining of boredom to the examiner (Rabinowitz, Vargas, & Arnett, 2012). All raters were blind to the hypotheses under investigation.

Procedure

Athletes. Six-hundred and thirteen athletes completed baseline testing. Participants in the post-concussion group (N = 52) all underwent baseline assessment. Most post-injury assessments occurred within one week of injury, and within 48 hours whenever possible. Evaluations were conducted by a Ph.D.-level clinical neuropsychologist or a graduate or undergraduate assistant trained by a Ph.D.-level clinical neuropsychologist.

Controls. Control participants were administered the same test battery at two time points one month apart.

Participants were not informed that their effort towards testing was being evaluated.

RESULTS

The athlete sample (N = 613) was 79% male and 72% Caucasian. Mean age at baseline was 18.6 (.8). Among the control group (N = 42) participants were 49% male, 95% Caucasian, with a mean age of 18.5 (.8).

Athletes at baseline were divided into three groups based on examiners' ratings of motivation: less than or equal to four (*low motivation,* n = 67), five or six (*adequate motivation,* n = 381), and equal to seven (*high motivation,* n = 165).

A GLM controlling for WTAR FSIQ estimate was conducted using the ImPACT composite scores as dependent variables. Results revealed a significant effect of *motivation group* on ImPACT performance on the whole (Pillai's Trace $F(8, 1{,}160) = 6.4$, $p < .001$). Univariate tests demonstrated that for each ImPACT composite score, there was a significant difference among the three motivation groups ($F(2, 582)$ = 13.0, 8.2, 11.2, and 7.0, on the Verbal Memory, Visual Memory, Visual Motor Speed, and Reaction Time composites, respectively; $p < .005$ for all ANOVA tests). The *high motivation group* exhibited the highest composite scores and the *low motivation group* exhibited the lowest composite scores (see Figure 1).

In order to evaluate the influence of return-to-play incentive on motivation, a repeated measures ANOVA predicting examiner motivation ratings was constructed using group (athletes versus controls) as a between subjects factor and time (baseline versus post-concussion for athletes; and test versus retest for controls) as a within subjects factor. There were no significant main effects for group ($F(1) = 0.0$, $p = .94$) or time ($F(1, 91) = 1.2$, $p = .29$). However, there was a significant group by time interaction ($F(1, 91) = 4.9$, $p < .05$). Athletes exhibited increased motivation rating post concussion ($t(50) = 2.2$, $p < .05$), whereas controls exhibited no significant change in motivation ratings across time points ($t(41) = -1.1$, $p = .27$).

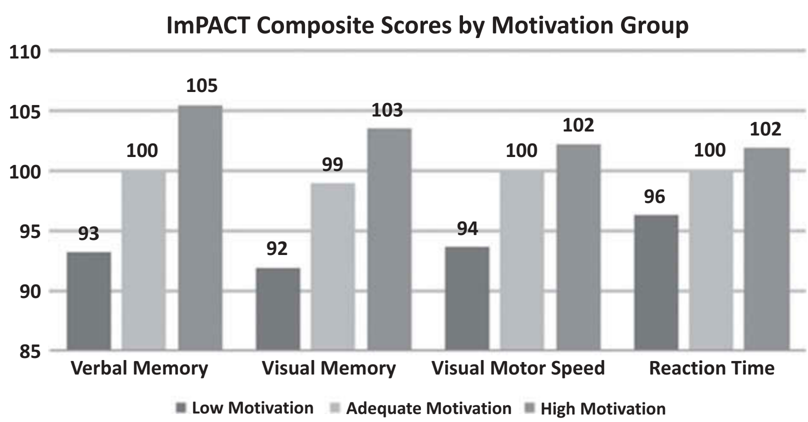

FIGURE 1 ImPACT Composite Scores in standard score units. There was a significant multivariate effect of *motivation group* on ImPACT performance (Pillai's Trace $F(8, 1{,}160) = 6.4$, $p < .001$).

DISCUSSION

The aim of the present study was to examine changes in motivation toward testing across baseline and post-concussion testing, as well as the influence of motivation on baseline neuropsychological test-performance within the context of a collegiate sports-concussion management program. Our findings suggest that athletes experience an increase in motivation post-concussion, and that high motivation at baseline improves their performance on neurocognitive tests. The cross-sectional analysis revealed that examiners' ratings of motivation were related to concurrent neurocognitive test performance suggesting that baseline test-performance may underestimate true premorbid abilities for some athletes.

There are limitations of the present study. First, athlete and control groups did not only differ in return-to-play incentive, but also in their level of athletic participation (varsity versus intramural). Examiners were not blind to athlete or control group status in the current study, and this information may have influenced the examiners' motivation rating. Furthermore, examiners' motivation ratings were assessed after the participant had completed the test battery, but before tests were scored. Examiners were blind to the hypotheses under study, and were instructed to rate how hard the participant was trying, and not how well they thought the participant performed. The validity of these ratings is supported by a high correlation (0.6) with a 12-item observational measure of behaviors associated with poor effort (Rabinowitz et al., 2012). Additionally, the interrater reliability of the motivation rating scale is not currently established, and this should be addressed in future work. It should also be noted that the observed differences in motivation post-concussion could reflect a concussion-related cognitive deficit. That is, athletes may find that they need to exert greater effort in order to perform tests that demanded relatively less effort pre-injury. This is an important topic that should be pursued in future research.

Baseline testing is a potentially powerful tool for neuropsychological assessment. However the influence of contextual differences between baseline and post-injury assessments raises concerns about the validity of pre–post injury comparisons. The present study endeavored to explore one such contextual factor—motivation. Future studies should evaluate the extent to which suboptimal motivation may undermine detection of post-concussion cognitive decline.

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