Improving clinical interpretation of performance on a neuropsychological concussion battery by utilizing premorbid IQ

Erin Guty, M.S.
Department of Psychology
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Sports-Related Concussion (SRC)

• According to the most recent Consensus Statement (McCrory et al., 2017) SRC may be caused either by a direct blow to the head, face, neck or elsewhere on the body with an impulsive force transmitted to the head.

• Common post-concussion symptoms: Headache, dizziness, nausea, sensitivity to sound/light, mood symptoms, problems with sleep, cognitive problems (issues with memory, attention, etc.). (McCrory et al., 2017)
Return-to-Play (RTP) Decision Making

- How do we know when someone is back to “normal” following an SRC and should return to play?

- Neuropsychological assessments (psychological/cognitive testing) should be incorporated in making return to play decisions (McCrory et al., 2017; Bleiberg et al. 2004)
Norm-Based Comparison for Cognitive Testing

• A large group of healthy athletes is tested at baseline
  • Tests of memory, attention, processing speed, executive functioning
• They are considered the standard for what “normal” performance should be
• Concussed athletes who do not have a baseline can be compared to this standard when they are tested post-concussion
• If they have significantly more tests falling in the range of poor performance (“impaired”), then they are considered not cognitively recovered
Individual factors can affect performance

• An individual’s premorbid (pre-injury) IQ likely impacts what their “normal” baseline test performance would look like.

• Research indicates that premorbid IQ impacts rate of impairment across neuropsychological domains (Brooks & Iverson, 2013; Diaz-Asper et al., 2004; Crawford et al., 2007; Karr et al., 2017).

• Individuals with higher IQ’s have fewer impaired test scores at baseline.
• Evaluate whether IQ effects the number of impaired test scores for athletes on a standard neuropsychological concussion battery

• Based on this information, determine which cut-offs should be used for clear, quantitative guidelines for clinicians who want to determine whether an athlete has returned to their cognitive baseline following sports-related concussion.
Hypothesis

- Given that premorbid IQ predicts neuropsychological performance on cognitive testing, we predict that individuals with higher premorbid IQ will demonstrate fewer impaired scores across the battery of neuropsychological tests than those with lower premorbid IQ.
Participant Demographics and Methods

- **N = 771 (572 Males, 199 Females)**
- Individuals were excluded if they reported a history of ADHD/LD
- Needed to have a measure of premorbid IQ
- Sports included football, wrestling, men’s and women’s basketball, men’s and women’s lacrosse, men’s and women’s soccer, men’s and women’s ice hockey, rugby, baseball, softball, and volleyball
- Completed 17 cognitive tests

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<table>
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Data Analyses

- Defining IQ groups
  - Based on percentiles of the distribution of IQ scores
    - Bottom 25th percentile = less than 100 IQ
    - Middle 50th percentile = 100 through 107 IQ
    - Top 25th percentile = 108 IQ and above

<table>
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<th>IQ Groups</th>
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<tr>
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<tr>
<td>Mid</td>
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<tr>
<td>High</td>
<td>183</td>
<td>23.7</td>
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Data Analyses

• Defining Impairment
  • 2 different performance cut offs (Lezak, 2012):
    • **Borderline (and below):** scores that are less than 10th percentile
    • **Impaired:** less than or equal to the 2nd percentile
Data Analyses

• Using Univariate ANOVA
  • Compared the 3 IQ groups on the average number of scores in the borderline range or below (< 10\textsuperscript{th} percentile)
  • Compared the 3 IQ groups of the average number of scores in the impaired range or below (\leq 2\textsuperscript{nd} percentile)
  • If groups are significantly different, use frequency analyses to determine the base rates of impaired scores
  • This will help us determine what the clinical guidelines should be!
Results – Hypothesis Correct!

• Do individuals in the 3 IQ groups differ on their total number of ”Borderline (and below)” scores using a <10th percentile cut-off?
  • YES

• Overall, the groups differed significantly on number of borderline scores ($F(2,713) = 23.78$, $p< .001$, $\eta^2= .06$).

• Individuals in the **Low group** ($M= 2.06$, $SD= 2.03$) had more borderline (and below) scores than the **Mid group** ($M= 1.22$, $SD= 1.61$, $p<.001$, 95% CI [.46, 1.21]) and the **High group** ($M= .82$, $SD= 1.32$, $p< .001$, 95% CI [.80 1.68]). The **Mid group** also had significantly more borderline and below scores than the **High group** ($p< .001$, 95% CI [.04, .77]).

$\eta^2 = \text{partial eta squared; small = .01, medium = .06, large = .14 (Field, 2013)}$
Results – Hypothesis Correct! (Sort of)

• Do individuals in the 3 IQ groups differ on their total number of “Impaired” scores using a <=2\textsuperscript{nd} percentile cut-off?
  • YES

• Overall, the groups differed significantly on number of borderline scores ($F(2,712) = 8.00, p<.001, \eta^2 = .022$).

• BUT Individuals in the \textbf{Low group} ($M = .66, SD = 1.14$) had significantly more impaired scores than the Mid group ($M = .45 SD = .85, p = .045, 95\% CI [.003, .416]$) and the High group ($M = .26 SD = .80, p < .001, 95\% CI [.16, .65]$). However, the Mid group and High groups did not significantly differ on their number of impaired scores, but the effect was marginally significant ($p = .062$).

\eta^2 = \text{partial eta squared; small} = .01, \text{ medium} = .06, \text{ large} = .14$ (Field, 2013)
Yay for statistical significance!

**BUT** what about clinical meaningfulness??

Is an average difference clinically useful?

How many borderline or impaired scores is too many?
Algorithm updated from Arnett et al, 2016

1. Administer the test battery post-injury
2. What is the athlete’s premorbid IQ?

- **99 or Below**
  - **STEP 2**
    - Athlete has 3 or more impaired test scores (<= 2nd percentile)
      - OR
        - Athlete has 6 or more test scores that are at least borderline impaired (< 10th percentile)
          - Yes to Either
            - Cognitively recovered
          - No to Both
            - Cognitively Recovered

- **Between 100-107**
  - **STEP 2**
    - Athlete has 2 or more impaired test scores (<= 2nd percentile)
      - OR
        - Athlete has 4 or more test scores that are at least borderline impaired (< 10th percentile)
          - Yes to Either
            - Cognitively recovered
          - No to Both
            - Cognitively Recovered

- **108 or Above**
  - **STEP 2**
    - Athlete has 2 or more impaired test scores (<= 2nd percentile)
      - OR
        - Athlete has 3 or more test scores that are at least borderline impaired (< 10th percentile)
          - Yes to Either
            - Cognitively recovered
          - No to Both
            - NOT Cognitively Recovered
Conclusions

- Post-concussion clinical care often includes neuropsychological assessment of cognitive functioning
  - Pre-injury IQ affects performance on this testing
- This project provides updated research to help improve clinicians’ diagnosis of cognitive dysfunction in collegiate athletes following SRC which facilitates more accurate recommendations and treatment.
- This study also includes an easy-to-use guideline so that clinical decision-making can be easily updated to reflect the most recent scientific information.
References


Thank you!