Most recent mTBI: 5.6 ± 5.2 years; Median: 4.5 years; Range: 0.3 – 16.5 years

Adverse effects on brain function can result from either concussion occurrence and/or multiple subconcussive events

Analyses identified 10 performance metrics strongly associated with self-reported mTBI Hx; OR ≥ 4 (Table 2)

7 WBRA Asym metrics demonstrated good discriminatory power; 2 WBRA metrics demonstrated 100% specificity

Disruption of white matter tracts between brain hemispheres has been documented as a common consequence of mTBI

2 VMRT (DT-B) metrics discriminated: Conflict effect (Incongruent-Congruent) and Left-Right Difference (L-R Diff)

Performance asymmetries may be a manifestation of suboptimal exchange of information between brain hemispheres

Average of 8 WBRA Asym values (Lat and D/B: RT, Spd, Acc, Dec) demonstrated exceptionally strong discrimination

Our purposes were to assess the discriminatory power of VMRT and WBRA metrics to identify elite athletes who self-reported history of mTBI (mTBI Hx) and to assess the extent to which VMRT training might improve WBRA performance

Baseline VMRT and WBRA metrics revealed substantial differences between elite athletes with and without mTBI Hx

Asymmetries were strongly associated with mTBI Hx, which may relate to disrupted inter-hemispheric neural processing

Our findings support emerging evidence that VMRT deficiencies and WBRA asymmetries may be due to mTBI effects, and that a relatively small number of brief training sessions can produce substantial improvements in perception-action coupling

Participants completed a minimum of 6 and a maximum of 8 training sessions, followed by post-training assessment

WBRA quantified by 20-target lateral side-shuffle and 12-target diagonal movements (TRAZER® Westlake, OH; Figure 2)

Metrics included Reaction Time (RT), Acceleration (Acc), Deceleration (Dec), Speed (Spd), and Asymmetry (Asym)

Receiver operating characteristic (ROC) analyses used to define optimal cut-point for each potential predictor variable

Cross-validation and logistic regression analyses used to quantify exposure-outcome associations

Odds ratio (and one-sided 95% credible lower limit) calculated to quantify unavoidable and multivariable associations

Training activity conducted over a 4-week period, which consisted of a single 60-s VMRT DT-A session on a given day

Paired t-tests, standardized response mean (SRM), and percent change used to assess training effect

Baseline VMRT Conflict effect reduced by 43 ± 85 ms (mTBI Hx 55 ± 101 ms; No mTBI 31 ± 68 ms)

Among athletes with mTBI Hx, 7 of 8 WBRA Asym values reduced after training (Table 3)

SFI score ≤ 76 discriminated between mTBI Hx and No mTBI; greater persisting effects of prior sport injuries for mTBI Hx

CLINICAL RELEVANCE

Baseline VMRT and WBRA metrics revealed substantial differences between elite athletes with and without mTBI Hx

Subtle deficiencies in perception-action coupling capabilities may remain unrecognized for months or years after mTBI

Asymmetries were strongly associated with mTBI Hx, which may relate to disrupted inter-hemispheric neural processing

Right hemisphere visuospatial processing dominance may explain DT results (Left slower than Right VMRT for mTBI Hx)

Impaired perception-action coupling may explain increased occurrence of musculoskeletal injuries following mTBI

SFI discrimination between mTBI Hx and No mTBI cases suggests an association, but cause-effect cannot be inferred

Our findings support emerging evidence that WMRT deficiencies and WBRA asymmetries may be due to mTBI effects,6 and that a relatively small number of brief training sessions can produce substantial improvements in perception-action coupling

Participants & Procedures

20 healthy athletes at a residential training center volunteered to provide survey responses and to participate in training

12 males: 176.7 ± 9.5 cm, 74.4 ± 11 kg; 8 females: 161.1 ± 6.1 cm, 63.2 ± 9.4 kg

WMRT and WBRA baseline tests performed; Sport Fitness Index (SFI) survey quantified persisting effects of sport injuries

Single-task (ST) and dual-task (DT) VMRT quantified by 60-s tests (Dynavision D2 TM, West Chester, OH; Figure 1)

Buttons illuminated until hit: DT-B practice trial and 60-s DT trial/trial, followed by two different 60-s DT trials (A & B)

A: Flanker test – center arrow direction verbal responses (<<<<<, >>>>>, >><>>, <<><<); 20 LCD displays (DT-A)

B: Flanker test – center arrow direction motor responses (<<<<<, >>>>>, >><>>, <<><<); 48 LCD displays (DT-B)

WBRA quantified by 20-target lateral side-shuffle and 12-target diagonal movements (TRAZER® Westlake, OH; Figure 2)

Movements guided by randomized target appearances on monitor, which disappeared when contacted by avatar

Participants comprised a minimum of 6 and a maximum of 8 training sessions, followed by post-training assessment

VMRT, DT, DB, WBRA,Lat, and WBRA-Diagonal tests administered following training

Paired t-tests, standardized response mean (SRM), and percent change used to assess training effect

Whole-Body Reactive Agility Asymmetries Among Athletes with Concussion History

Ryan T. Crane, MS, ATC; Garrett M. Lesher, MS, ATC; Ethan J. Perry, MS, ATC; Gary B. Wilkerson, EdD, ATC; Dustin C. Nabhan, DC, DACBSP, FACSM

RESULTS

- mTBI Hx was self-reported by 58% of athletes (10/20) representing 6 different sport categories (Table 1)
  - Most recent mTBI: 5.6 ± 5.2 years; Median: 4.5 years; Range: 0.3 – 16.5 years
  - Analyses identified 10 performance metrics strongly associated with self-reported mTBI Hx; OR ≥ 4 (Table 2)
  - 7 WBRA Asym metrics demonstrated good discriminatory power; 2 WBRA metrics demonstrated 100% specificity
  - 4 Lateral (Lat) and 3 Diagonal (D/B) WBRA Asym-metrics (no Diagonal/Forward discriminating metrics)
  - 2 VMRT (DT-B) metrics discriminated: Conflict effect (Incongruent-Congruent) and Left-Right Difference (L-R Diff)
  - Incongruent (<<<<<, >>>>>, >><>>, <<><<) versus Congruent (<<<, >>, >><, <<><>); L-R Diff = Left side minus Right side VMRT
  - Average of 8 WBRA Asym values (Lat and D/B: RT, Spd, Acc, Dec) demonstrated exceptionally strong discrimination
  - WBRA Asym Avg ≥ 2.18 (Figure 3; 70% sensitivity, 95% specificity; OR = 21.90 [CI Lower Limit 2.64]
  - VMRT (DT-A) Pre-Post improvement (Figure 4; 202 ± 83 ms in mTBI Hx; 182 ± 104 ms in No mTBI; 212 ± 61 ms)
  - Among athletes with mTBI Hx, 7 of 8 WBRA Asym values reduced after training (Table 3)
  - SFI score ≤ 76 discriminated between mTBI Hx and No mTBI; greater persisting effects of prior sport injuries for mTBI Hx

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REFERENCES


