# Supplemental Materials 1. MSVT

The Medical Symptom Validity Test (MSVT) was administered to a subset of participants at each visit (four weeks n=72; twelve weeks n=58). The MSVT was added to the neuropsychological test battery a year into data collection. In order to preserve the integrity of the Medical Symptom Validity Test, the details on the three subtests (Immediate Recognition [IR], Delayed Recognition [DR], and Consistency [CNS]) that were evaluated in this manuscript will not be presented herein. Please refer to the user manual for more information (Green, 2004). Participants’ demographic and injury characteristics were stratified by those who completed the MSVT (i.e., at least one subtest is available at four weeks or twelve weeks) and those who did not (see Supplemental Table 1).

Raw scores on the three MSVT subtests are presented in Supplemental Table 2 (four weeks) and Supplemental Table 3 (twelve weeks). For the performance to be valid, scores need to be greater than 85% on all three MSVT metrics (IR, DR, and CNS). Indeterminant performance was defined as not definitively qualifying for either valid or invalid categories due to missing data. Frequencies of valid, invalid, and indeterminant performance on the Medical Symptom Validity Test at four weeks and twelve weeks are presented in Supplemental Table 4. Wilcoxon tests were conducted to compare cognitive outcomes between participants with valid MSVT or indeterminant performance and participants with invalid MSVT at both timepoints. No differences in cognitive performance were found, *ps*≥.156 (see Supplemental Tables 5 and 6).

Sensitivity analyses were conducted to determine whether the main findings would change if participants with invalid MSVT were removed from the analyses. To qualify for the sensitivity analysis, participant must have had 1) valid performance at either four weeks or twelve weeks only, and indeterminant at the other timepoint OR 2) valid performance at both four weeks and twelve weeks (see Supplemental Table 4). Due to the limited number of participants with MSVT, we had to reduce the number of covariates in order to achieve sufficient statistical power within the constraints of our available degrees of freedom. As a result, we decided to conduct crude analyses for full sample (N=311) and sensitivity analyses (N=95). Specifically, the supplemental analyses were similar to the primary analyses, but with the only independent variable retained in the models being the continuous PCSI delta score, and week as the sole covariate. Results are presented in Supplemental Tables 7-16.

**Supplemental Materials 1 Table 1**. Participant’s demographic and injury characteristics stratified by those who completed the Medical Symptom Validity Test and those who did not

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Variable** | **N** | **Completed MSVT**  **(n=103)** | **Did not complete MSVT**  **(n=208)** | ***p*-value** |
| **Sex, freq (%)** | 311 |  |  | .980 |
| Female |  | 36 (35.0) | 73 (35.1) |  |
| Male |  | 67 (65.0) | 135 (64.9) |  |
| **Age, median [IQR]** | 311 | 12.16 [9.40, 14.32] | 11.71 [9.04, 14.05] | .242 |
| **Time between head injury and triage (hours), median [IQR]** | 309 | 3.68 [1.86, 18.25] | 3.03 [1.60, 16.88] | .462 |
| **Previous number of concussion(s), freq (%)** | 310 |  |  | .366 |
| 0 |  | 67 (65.7) | 156 (75.0) |  |
| 1 |  | 24 (23.5) | 35 (16.8) |  |
| 2 |  | 6 (5.9) | 12 (5.8) |  |
| 3 |  | 3 (2.9) | 4 (1.9) |  |
| 4 |  | 2 (2.0) | 1 (0.5) |  |
| **Maximum symptom duration from previous concussion(s) (weeks), freq (%)** | 308 |  |  | .520 |
| Never had a concussion |  | 67 (65.7) | 156 (75.7) |  |
| <1 week |  | 14 (13.7) | 19 (9.2) |  |
| 1-2 weeks |  | 9 (8.8) | 14 (6.8) |  |
| 3-4 weeks |  | 4 (3.9) | 8 (3.9) |  |
| 5-8 weeks |  | 3 (2.9) | 4 (1.9) |  |
| >8 weeks |  | 5 (4.9) | 5 (2.4) |  |
| **History of migraine, freq (%)** | 309 | 10 (9.8) | 29 (14.0) | .295 |
| **History of learning disability, freq (%)** | 310 | 8 (7.8) | (10.1) | .498 |
| **History of attention deficit disorder, freq (%)** | 310 | 7 (6.8) | 17 (8.2) | .660 |
| **History of developmental disorder, freq (%)** | 308 | 5 (4.9) | 6 (2.9) | .390 |
| **History of anxiety, freq (%)** | 310 | 13 (12.7) | 12 (5.8) | .034 |
| **History of depression, freq (%)** | 311 | 5 (4.9) | 4 (1.9) | .147 |
| **History of sleep disorder, freq (%)** | 311 | 5 (4.9) | 5 (2.4) | .249 |
| **Mechanism of injury, freq (%)** | 311 |  |  | .262 |
| Sports/Recreation |  | 68 (66.0) | 130 (62.5) |  |
| Non-sport/Fall |  | 30 (29.1) | 72 (34.6) |  |
| Motor vehicle collision |  | 2 (1.9) | 5 (2.4) |  |
| Assault |  | 3 (2.9) | 1 (0.5) |  |
| **Loss of consciousness, freq (%)** | 311 |  |  | .252 |
| No |  | 84 (81.6) | 160 (76.9) |  |
| Yes |  | 12 (11.7) | 21 (10.1) |  |
| Unknown |  | 7 (6.8) | 27 (13.0) |  |
| **Duration of loss consciousness, median [IQR]** | 31 | 0.42 [0.25, 0.81] | 0.50 [0.10, 1.00] | .759 |
| **Seizure following injury, freq (%)** | 311 | 3 (2.9) | 5 (2.4) | .790 |
| **PCSI at initial ED visit, median [IQR]** | 302 | 1.60 [0.94, 2.49] | 1.76 [1.24, 2.47] | .211 |
| **Academic achievement prior to concussion, freq (%)** | 308 |  |  | .194 |
| Straight A student |  | 34 (33.0) | 49 (23.9) |  |
| A & B grades |  | 41 (39.8) | 81 (39.5) |  |
| Straight B student |  | 12 (11.7) | 43 (21.0) |  |
| B & C grades |  | 12 (11.7) | 27 (13.1) |  |
| Below C grades |  | 4 (3.9) | 5 (2.4) |  |
| **PCSI-C average item delta score at four weeks** | 284 | 0.18 [0.00, 0.88] | 0.20 [0.00, 0.88] | .620 |
| **PCSI-C average item delta score at twelve weeks** | 273 | 0.00 [0.00, 0.35] | 0.10 [0.00, 0.53] | .090 |

*Notes*. MSVT = Medical Symptom Validity Test; PCSI-C = Post-Concussion Symptom Inventory children version. Completion of the MSVT was defined as having completed at least one subtest available at four weeks or twelve weeks.

**Supplemental Materials 1 Table 2**. Frequency of low effort based on the Medical Symptom Validity Test at four weeks following pediatric concussion

|  |  |  |
| --- | --- | --- |
| **MSVT Variable** | **n** | **Freq (%)** |
| **Immediate Recognition - %** | 72 |  |
| 10 | 1 | 1.4 |
| 65 | 1 | 1.4 |
| 90 | 2 | 2.8 |
| 95 | 8 | 11.1 |
| 100 | 60 | 83.3 |
| **Delayed Recognition - %** | 71 |  |
| 10 | 1 | 1.4 |
| 65 | 1 | 1.4 |
| 80 | 1 | 1.4 |
| 90 | 4 | 5.6 |
| 95 | 6 | 8.5 |
| 100 | 58 | 81.7 |
| **Consistency - %** | 71 |  |
| 10 | 1 | 1.4 |
| 70 | 1 | 1.4 |
| 85 | 1 | 1.4 |
| 90 | 6 | 8.5 |
| 95 | 12 | 16.9 |
| 100 | 50 | 70.4 |

*Notes*. MSVT = Medical Symptom Validity Test

**Supplemental Materials 1 Table 3**. Frequency of low effort based on the Medical Symptom Validity Test at twelve weeks following pediatric concussion

|  |  |  |
| --- | --- | --- |
| **MSVT Variable** | **n** | **Freq (%)** |
| **Immediate Recognition - %** | 58 |  |
| 60 | 1 | 1.7 |
| 77 | 1 | 1.7 |
| 80 | 1 | 1.7 |
| 85 | 2 | 3.4 |
| 90 | 3 | 5.2 |
| 95 | 1 | 1.7 |
| 100 | 49 | 84.5 |
| **Delayed Recognition - %** | 57 |  |
| 60 | 1 | 1.8 |
| 75 | 1 | 1.8 |
| 85 | 1 | 1.8 |
| 90 | 1 | 1.8 |
| 95 | 4 | 7.0 |
| 100 | 49 | 86.0 |
| **Consistency - %** | 57 |  |
| 50 | 1 | 1.8 |
| 75 | 1 | 1.8 |
| 80 | 1 | 1.8 |
| 85 | 1 | 1.8 |
| 90 | 3 | 5.3 |
| 95 | 5 | 8.8 |
| 100 | 45 | 78.9 |

*Notes*. MSVT = Medical Symptom Validity Test

**Supplemental Materials 1 Table 4**. Frequency of valid, invalid, and indeterminant performance on the Medical Symptom Validity Test at four weeks and twelve weeks following pediatric concussion

|  |  |  |
| --- | --- | --- |
| **Variable** | **n** | **Freq (%)** |
| **MSVT at Four Weeks** | 311 |  |
| Valid |  | 68 (21.9%) |
| Invalid |  | 3 (1.0%) |
| Indeterminant |  | 240 (77.2%) |
| **MSVT at Twelve Weeks** | 311 |  |
| Valid |  | 53 (17.0%) |
| Invalid |  | 5 (1.6%) |
| Indeterminant |  | 253 (81.4%) |
| **MSVT Grand Summary** | 311 |  |
| Not valid at any timepoints (only invalid/indeterminant) |  | 215 (69.1%) |
| Valid at either four weeks OR twelve weeks, but invalid at the other timepoint |  | 1 (0.3%) |
| Valid at either four weeks OR twelve weeks only, indeterminant at the other |  | 70 (22.5%) |
| Valid at both four weeks AND twelve weeks |  | 25 (8.0%) |

*Notes*. MSVT = Medical Symptom Validity Test. Valid performance is scoring >85% on all three Immediate Recall, Delayed Recall, and Consistency metrics of the MSVT. Invalid performance is scoring ≤85% on any of the three metrics. Indeterminant is defined as not definitively qualifying for either valid or invalid categories due to missing data.

**Supplemental Materials 1 Table 5**. Processing speed and executive functioning outcomes stratified by Medical Symptom Validity results at four weeks following pediatric concussion

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Outcome** | **Valid MSVT/ Indeterminant** | |  | **Invalid MSVT** | |  | ***p*-value** |
| **n** | **Value** |  | **n** | **Value** |  |
| **WISC-IV/WAIS-IV Coding** | 284 |  |  | 3 |  |  | .573 |
| Median [IQR] |  | 10.00 [8.00, 11.00] |  |  | 8.00 [8.00, 9.50] |  |  |
| Mean (SD) |  | 9.75 (2.73) |  |  | 9.00 (1.73) |  |  |
| **Conner’s CPT-II Omission** | 268 |  |  | 3 |  |  | .259 |
| Median [IQR] |  | 46.96 [43.76, 52.90] |  |  | 59.75 [51.88, 66.88] |  |  |
| Mean (SD) |  | 51.34 (14.06) |  |  | 59.25 (15.00) |  |  |
| **WISC-IV/WAIS-IV Backward Digit Span** | 284 |  |  | 3 |  |  | .188 |
| Median [IQR] |  | 10.00 [9.00, 12.00] |  |  | 8.00 [8.00, 9.00] |  |  |
| Mean (SD) |  | 10.39 (2.60) |  |  | 8.67 (1.15) |  |  |
| **D-KEFS Color-Word Interference Test** | 236 |  |  | 0 |  |  | .289 |
| Median [IQR] |  | 10.00 [9.00, 11.00] |  |  | N/A |  |  |
| Mean (SD) |  | 10.31 (2.19) |  |  | N/A |  |  |
| **D-KEFS Verbal Fluency** | 244 |  |  | 1 |  |  | .573 |
| Median [IQR] |  | 9.00 [7.75, 12.00] |  |  | 7.00 [7.00, 7.00] |  |  |
| Mean (SD) |  | 9.68 (2.98) |  |  | 7.00 [N/A |  |  |

*Notes*. CPT-II = Continuous Performance Test II; D-KEFS = Delis-Kaplan Executive Function System; MSVT = Medical Symptom Validity Test; N/A = Not Applicable; WAIS-IV = Wechsler Adult Intelligence Scale Fourth Edition; WICS-IV = Wechsler Intelligence Children Scale Fourth Edition. Valid performance is scoring >85% on all three Immediate Recall, Delayed Recall, and Consistency metrics of the MSVT. Invalid performance is scoring ≤85% on any of the three metrics. Indeterminant is defined as not definitively qualifying for either valid or invalid categories due to missing data.

**Supplemental Materials 1 Table 6**. Processing speed and executive functioning outcomes stratified by Medical Symptom Validity results at twelve weeks following pediatric concussion

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Outcome** | **Valid MSVT/Indeterminant** | |  | **Invalid MSVT** | |  | ***p*-value** |
| **n** | **Value** |  | **n** | **Value** |  |
| **WISC-IV/WAIS-IV Coding** | 191 |  |  | 5 |  |  | .156 |
| Median [IQR] |  | 10.00 [9.00, 13.00] |  |  | 8.00 [8.00, 9.00] |  |  |
| Mean (SD) |  | 10.61 (2.93) |  |  | 9.00 (2.35) |  |  |
| **Conner’s CPT-II Omission** | 178 |  |  | 5 |  |  | .538 |
| Median [IQR] |  | 46.87 [43.97, 52.75] |  |  | 49.32 [45.73, 68.87] |  |  |
| Mean (SD) |  | 51.30 (12.13) |  |  | 55.78 (14.39) |  |  |
| **WISC-IV/WAIS-IV Backward Digit Span** | 191 |  |  | 5 |  |  | .323 |
| Median [IQR] |  | 11.00 [8.50, 12.00] |  |  | 10.00 [9.00, 10.00] |  |  |
| Mean (SD) |  | 10.53 (2.85) |  |  | 9.40 (2.19) |  |  |
| **D-KEFS Color-Word Interference Test** | 160 |  |  | 3 |  |  | .262 |
| Median [IQR] |  | 10.00 [9.00, 12.00] |  |  | 9.00 [8.50, 10.00] |  |  |
| Mean (SD) |  | 10.46 (1.96) |  |  | 9.33 (1.53) |  |  |
| **D-KEFS Verbal Fluency** | 169 |  |  | 3 |  |  | .499 |
| Median [IQR] |  | 11.00 [8.00, 12.00] |  |  | 10.00 [9.00, 10.50] |  |  |
| Mean (SD) |  | 10.71 (3.26) |  |  | 9.67 (1.53) |  |  |

*Notes*. CPT-II = Continuous Performance Test II; D-KEFS = Delis-Kaplan Executive Function System; MSVT = Medical Symptom Validity Test; N/A = Not Applicable; WAIS-IV = Wechsler Adult Intelligence Scale Fourth Edition; WICS-IV = Wechsler Intelligence Children Scale Fourth Edition. Valid performance is scoring >85% on all three Immediate Recall, Delayed Recall, and Consistency metrics of the MSVT. Invalid performance is scoring ≤85% on any of the three metrics. Indeterminant is defined as not definitively qualifying for either valid or invalid categories due to missing data.

**Supplemental Materials 1 Table 7**. Wald chi-square table for WISC-IV/WAIS-IV Coding scaled score for the crude analysis (N=311)

|  |  |  |  |
| --- | --- | --- | --- |
| **Factor** | **Chi-Square** | **df** | ***p*-value** |
| PCSI (Factor+Higher Order Factors) | 3.564 | 2 | .168 |
| Nonlinear | 3.068 | 1 | .080 |
| Week | 21.092 | 1 | **<.001 \*\*\*** |
| TOTAL | 24.861 | 3 | **<.001 \*\*\*** |
| Phi=.732, Obs=437, Cluster=295 | | | |

*Notes*. PCSI = Post-Concussion Symptom Inventory delta score. Bold fond denotes significance.

**Supplemental Materials 1 Table 8**. Wald chi-square table for WISC-IV/WAIS-IV Coding scaled score for the sensitivity analysis (N=95)

|  |  |  |  |
| --- | --- | --- | --- |
| **Factor** | **Chi-Square** | **df** | ***p*-value** |
| PCSI (Factor+Higher Order Factors) | .892 | 2 | .640 |
| Nonlinear | .865 | 1 | .352 |
| Week | 8.836 | 1 | **.003 \*\*** |
| TOTAL | 10.055 | 3 | **.018 \*** |
| Phi=.845, Obs=108, Cluster=90 | | | |

*Notes*. PCSI = Post-Concussion Symptom Inventory delta score. Bold fond denotes significance.

**Supplemental Materials 1 Table 9**. Wald chi-square table for Conner’s CPT-II Omission t-score for the crude analysis (N=311)

|  |  |  |  |
| --- | --- | --- | --- |
| **Factor** | **Chi-Square** | **df** | ***p*-value** |
| PCSI (Factor+Higher Order Factors) | 1.959 | 2 | 0.376 |
| Nonlinear | 1.838 | 1 | 0.175 |
| Week | 0.150 | 1 | 0.699 |
| TOTAL | 2.030 | 3 | 0.566 |
| Phi=.400, Obs=412, Cluster=287 | | | |

*Notes*. PCSI = Post-Concussion Symptom Inventory delta score. Bold fond denotes significance.

**Supplemental Materials 1 Table 10**. Wald chi-square table for Conner’s CPT-II Omission t-score for the sensitivity analysis (N=95)

|  |  |  |  |
| --- | --- | --- | --- |
| **Factor** | **Chi-Square** | **df** | ***p*-value** |
| PCSI (Factor+Higher Order Factors) | 1.084 | 2 | .581 |
| Nonlinear | 0.186 | 1 | .666 |
| Week | 0.015 | 1 | .902 |
| TOTAL | 1.101 | 3 | **.777** |
| Phi=.841, Obs=106, Cluster=89 | | | |

*Notes*. PCSI = Post-Concussion Symptom Inventory delta score. Bold fond denotes significance.

**Supplemental Materials 1 Table.11**. Wald chi-square table for WISC-IV/WAIS-IV Backward Digit Span scaled score for the crude analysis (N=311)

|  |  |  |  |
| --- | --- | --- | --- |
| **Factor** | **Chi-Square** | **df** | ***p*-value** |
| PCSI (Factor+Higher Order Factors) | 7.906 | 2 | **.019 \*** |
| Nonlinear | 1.166 | 1 | .280 |
| Week | 0.406 | 1 | .524 |
| TOTAL | 9.041 | 3 | **.029 \*** |
| Phi=.574, Obs=437, Cluster=295 | | | |

*Notes*. PCSI = Post-Concussion Symptom Inventory delta score. Bold fond denotes significance.

**Supplemental Materials 1 Table 12**. Wald chi-square table for WISC-IV/WAIS-IV Backward Digit Span scaled score for the sensitivity analysis (N=95)

|  |  |  |  |
| --- | --- | --- | --- |
| **Factor** | **Chi-Square** | **df** | ***p*-value** |
| PCSI (Factor+Higher Order Factors) | 0.534 | 2 | .766 |
| Nonlinear | 0.391 | 1 | .532 |
| Week | 8.628 | 1 | **.003 \*\*** |
| TOTAL | 9.713 | 3 | **.021 \*** |
| Phi=.573, Obs=108, Cluster=90 | | | |

*Notes*. PCSI = Post-Concussion Symptom Inventory delta score. Bold fond denotes significance.

**Supplemental Materials 1 Table 13**. Wald chi-square table for D-KEFS Color-Word Interference Test Inhibition vs. Color Naming contrast scaled score for the crude analysis (N=311)

|  |  |  |  |
| --- | --- | --- | --- |
| **Factor** | **Chi-Square** | **df** | ***p*-value** |
| PCSI (Factor+Higher Order Factors) | 1.409 | 2 | .494 |
| Nonlinear | 0.091 | 1 | .763 |
| Week | 0.131 | 1 | .717 |
| TOTAL | 1.455 | 3 | .693 |
| Phi=.300, Obs=362, Cluster=245 | | | |

*Notes*. PCSI = Post-Concussion Symptom Inventory delta score. Bold fond denotes significance.

**Supplemental Materials 1 Table 14**. Wald chi-square table for D-KEFS Color-Word Interference Test Inhibition vs. Color Naming contrast scaled score for the sensitivity analysis (N=95)

|  |  |  |  |
| --- | --- | --- | --- |
| **Factor** | **Chi-Square** | **df** | ***p*-value** |
| PCSI (Factor+Higher Order Factors) | 6.572 | 2 | **.037 \*** |
| Nonlinear | 6.231 | 1 | **.013 \*** |
| Week | 1.234 | 1 | .267 |
| TOTAL | 7.450 | 3 | .059 |
| Phi=.449, Obs=100, Cluster=83 | | | |

*Notes*. PCSI = Post-Concussion Symptom Inventory delta score. Bold fond denotes significance.

**Supplemental Materials 1 Table 15**. Wald chi-square table for D-KEFS Verbal Fluency scaled score for the crude analysis (N=311)

|  |  |  |  |
| --- | --- | --- | --- |
| **Factor** | **Chi-Square** | **df** | ***p*-value** |
| PCSI (Factor+Higher Order Factors) | 7.144 | 2 | **.028 \*** |
| Nonlinear | 0.065 | 1 | .798 |
| Week | 19.657 | 1 | **<.001 \*\*\*** |
| TOTAL | 31.836 | 3 | **<.001 \*\*\*** |
| Phi=.771, Obs=380, Cluster=259 | | | |

*Notes*. PCSI = Post-Concussion Symptom Inventory delta score. Bold fond denotes significance.

**Supplemental Materials 1 Table 16**. Wald chi-square table for D-KEFS Verbal Fluency scaled score for the sensitivity analysis (N=95)

|  |  |  |  |
| --- | --- | --- | --- |
| **Factor** | **Chi-Square** | **df** | ***p*-value** |
| PCSI (Factor+Higher Order Factors) | .343 | 2 | .842 |
| Nonlinear | .281 | 1 | .596 |
| Week | 18.172 | 1 | **<.001 \*\*\*** |
| TOTAL | 18.682 | 3 | **<.001 \*\*\*** |
| Phi=.809, Obs=104, Cluster=87 | | | |

*Notes*. PCSI = Post-Concussion Symptom Inventory delta score. Bold fond denotes significance.