

Prospective Association of Perceptual-Motor Efficiency and Perceived Well-Being with Performance Among Collegiate Wrestlers

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Background

- Assessments of perceptual-motor capabilities¹ and self-reported well-being² can guide both performance enhancement and injury prevention efforts
 - Collegiate wrestling is associated with an exceptionally high injury rate³
- Perceptual-motor and behavioral factors that reduce injury susceptibility may also contribute to competitive success⁴
 - Efficient brain processing may interact with emotions and metabolism⁵
- Given that many wrestlers compete with injury, physical and mental resilience may be essential to maintain effective competitive performance



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Purpose

To identify any prospective associations of perceptual-motor efficiency metrics, or indicators of perceived well-being, with the competitive performance of Division-I wrestlers



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Methods

- **Participants: 25 Male NCAA Division-I Wrestlers**
 - 18-23 years; 174.4 ±7.3 cm; 76.8 ±15.2 kg
- **Performance tests:**
 - Smartphone Flanker Test (FL) App
 - Whole-Body Reactive Agility (WBRA)
- **Surveys:**
 - Overall Wellness Index (OWI)
 - Sport Fitness Index (SFI)
 - Eating Attitudes Test (EAT-26)
 - Nutrition for Sport Knowledge Questionnaire (NSKQ)
 - Depression, Anxiety, and Stress Scale (DASS)
 - Pittsburgh Sleep Quality Index (PSQI)



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Smartphone Flanker Test App

- Rapid tilt of device in direction indicated by center arrow
 - Threshold for registration of response 2 rad/s (115 deg/s)
 - 20 trials (10 Incongruent and 10 Congruent) – random order
 - 5-arrow displays presented for 300 ms
 - Inter-stimulus intervals range from 500 ms to 1500 ms

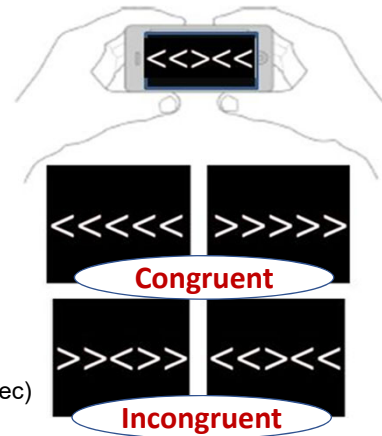
• Metrics:

Reaction Time (RT) = Time elapsed from stimulus to manual tilt (ms)

Flanker Conflict Effect (FCE) = Incongruent RT Avg – Congruent RT Avg

Rate Correct Score (RCS) = Number of Correct Responses / RT Sum (sec)

Rate Correct Ratio (RCR) = Incongruent RCS / Congruent RCS



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Whole-Body Reactive Agility

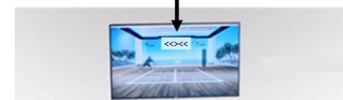
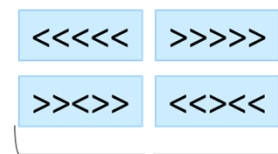
- Virtual reality displayed on monitor
 - (TRAZER Sport Simulator, TRAQ Global Ltd, Westlake, OH)
 - Targets appear on either right or left side of monitor (Single-Task)
 - Targets disappear when body moved to proper 3D coordinates
 - Tracked within 3 m X 3 m area
 - Testing conducted on wrestling mat

• Performance metrics:

- Reaction time
- Speed
- Acceleration
- Deceleration



Single-Task



Dual-Task

- Targets appear on both Right and Left sides of monitor
- Correct movement direction corresponds to direction indicated by center arrow of Flanker Test



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Injury Surveillance and Performance Tracking

- Injury definition:
 - Any musculoskeletal injury (dislocation, fracture, sprain, or strain) that was evaluated and treated, regardless of whether or not time was lost from participation in a subsequent practice session or match
- Surveillance period:
 - 19 weeks from baseline assessment (pre-season) to mid-season
- Match performance:
 - 13 wrestling matches over a period of 10 weeks
 - Total dual points scored



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Statistical Analysis

- Receiver Operating Characteristic Analysis
 - Area Under Curve (AUC) criterion for moderate association $\geq .600$
 - Youden's Index used to identify optimal cut point
 - Binary classification – High Risk versus Low Risk
- Chi-Square Analysis of each potential predictor
 - Fisher's Exact One-Sided P-Value
 - Univariable Odds Ratio (OR) with 95% Confidence Interval
- Logistic Regression Analysis
 - Backward Stepwise determination of strongest predictor sets



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Results

- A total of 53 injuries among the 25 wrestlers
 - Every wrestler sustained ≥ 1 injury during the surveillance period
 - 100% injury incidence precluded injury prediction analysis
- Dual points scored:
 - No wrestler had > 8 and < 12 dual points
 - 64% (16/25) ≤ 8 dual points
 - 36% (9/25) ≥ 12 dual points
- Prospective prediction of performance:
 - Binary categorization ≥ 12 versus ≤ 8 dual points

Dual Points	Number
0	12
3-8	4
12-19	4
21-39	5

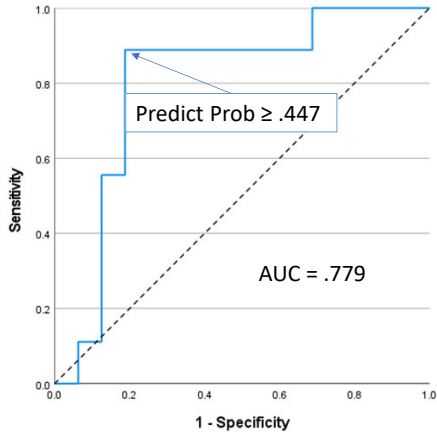


Prospective (Baseline Measure) Prediction: ≥ 12 Dual Points versus < 12 Dual Points Scored

Predictor	AUC	Cut Point	P	Sensitivity	Specificity	PPV	NPV	OR	95% CI
WBRA-DT Reaction Time (ms)	.712	≤ 755	.034	89	56	53	90	10.29	1.03, 102.75
WBRA-DT Speed Asym (%)	.681	≤ 6.3	.006	100	56	56	100	***	***
App Conflict Effect (ms)	.660	≤ 87	.024	100	44	44	100	***	***
App Rate Correct Ratio	.660	$\geq .84$.045	100	38	47	100	***	***
WBRA-DT Acc Asym (%)	.646	≤ 6.3	.062	89	50	50	89	8.00	0.80, 79.66
Overall Wellness Index (0-100)	.611	≥ 90	.174	89	38	44	86	4.80	0.48, 48.46
WBRA-ST Acc (m/s ²)	.597	≥ 3.76	.040	44	94	80	75	12.00	1.07, 134.11
App Reaction Time (ms)	.590	≤ 504	.098	67	69	55	79	4.40	0.77, 25.15



Prospective Prediction of ≥ 12 Dual Points Logistic Regression Model – Continuous Predictors



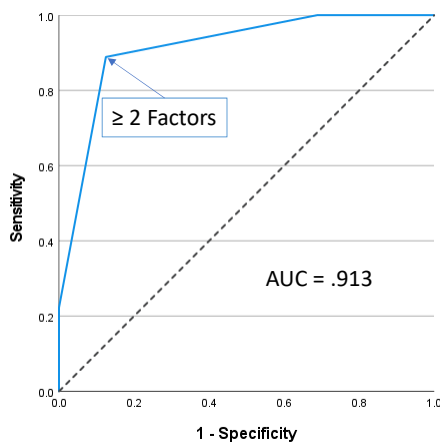
1. App Conflict Effect (Min-Max: -252 – 256)
2. App Rate Correct Ratio (Min-Max: 0.60 – 1.63)
3. Overall Wellness Index (Min-Max: 48 – 100)

		≥ 12 Dual Points		
		Yes	No	
Log Regression Predicted Prob $\geq .447$	Yes	8	3	PPV: 73%
	No	1	13	NPV: 93%
Total		9	16	

Sensitivity 89% Specificity 81%

$\chi^2(1)=11.50$ **OR=34.67**
 $P = .001$ 95% CI: 3.06, ∞

Prospective Prediction of ≥ 12 Dual Points Logistic Regression Model – Binary Predictors



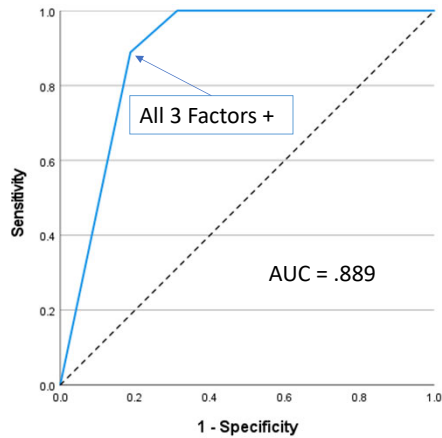
1. WBRA Dual-Task Speed Asymmetry $\leq 6.3\%$
2. WBRA Single-Task Acceleration ≥ 3.76 m/s²
3. Flanker Test App Reaction Time ≤ 504 ms

		≥ 12 Dual Points		
		Yes	No	
≥ 2 Factors	Yes	8	2	PPV: 80%
	No	1	14	NPV: 93%
Total		9	16	

Sensitivity 90% Specificity 88%

$\chi^2(1)= 14.01$ **OR= 56.00**
 $P < .001$ 95% CI: 4.36, ∞

Prospective Prediction of ≥ 12 Dual Points Univariable Analyses – 3 Strongest Binary Predictors



1. WBRA Dual-Task Reaction Time ≤ 755
2. WBRA Dual-Task Speed Asymmetry $\leq 6.3\%$
3. App Conflict Effect ≤ 87 ms

	≥ 12 Dual Points			
	Yes	No		
All 3 Factors vs. 0-2 Positive	Yes	8	3	PPV: 73%
	No	1	13	NPV: 93%
Total	9	16		

Sensitivity 89% Specificity 81%

$\chi^2(1)=11.50$ **OR=34.67**
 $P = .001$ 95% CI: 3.06, ∞



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Discussion

- Speed of brain processing of neural signals relating to perception of visual stimuli and muscle activations appears to be a critical factor influencing competitive performance capabilities
 - Whole-Body Reactive Agility and Phone App Flanker Test Reaction Time
- Symmetry of whole-body reactive movement capabilities in left and right directions may also contribute to the ability to outperform an opponent
 - Whole-Body Reactive Agility Speed and Acceleration
- The ability to maintain high-performance capabilities in an injured state may heavily depend on overall physical and mental well-being
 - Overall Wellness Index



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Clinical Relevance

- Training designed to improve speed and accuracy of responses to salient stimuli may be guided by the goal to exceed cut points associated with optimal performance
 - Frequency and duration of training to sustain high performance unknown
- Administration of Overall Wellness Index survey can permit identification of self-reported physical or mental problems that should be addressed by specific interventions
 - Implementation of individualized programs for performance enhancement
- Optimization of perceptual motor efficiency and overall well-being may simultaneously improve capability and reduce injury risk



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References

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