Relationship of Perceptual-Motor Function with Lower Extremity Injuries Among Female College Basketball Players

Zach Brown, Sydne Stepaniuk, and Bailey Sexton
Graduate Athletic Training Program – Class of 2022

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Background

- Athletes often sustain repetitive musculoskeletal injuries, which can lead to progressive dysfunction and worsening disability across the lifespan[1,2]
- Relative to amount of exposure, female college basketball players have been documented to experience a very high injury rate of 31 per 1000 exposures[3]
- Perceptual-motor function is a key component of injury avoidance and successful sports performance[4]
- Athletes who exhibit symptoms of anxiety or depression have been found to have elevated injury risk[5]

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Study Purpose

- To assess the potential predictive value of various metrics derived from tests of perceptual-motor performance and responses to surveys pertaining to persisting effects of prior musculoskeletal injuries, mental well-being, and sleep quality for identification of individual female college basketball players who possess elevated risk for core or lower extremity injury.

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Methods

- **Participants**:
  - 11 NCAA D-1 Female Basketball players
- **Pre-Participation Assessment**
  - 6 weeks prior to first game of season
- **Performance Tests**:
  - Smartphone Flanker Test App
  - Whole-Body Reactive Agility
    - TRAZER Sport Simulator (Westlake, OH)
- **Surveys:**
  - Sport Fitness Index (SFI)
  - Pittsburgh Sleep Quality Index (PSQI)
  - Depression, Anxiety, and Stress Scale (DASS)
- **Injury Documentation:**
  - Electronic injury record
    - Core or Lower Extremity injury (CLEI)
    - CLEI surveillance period:122 days

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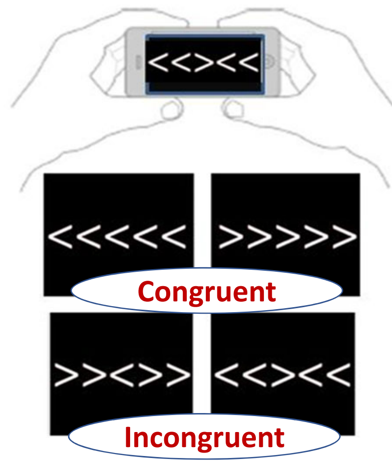
Smartphone Flanker Test App



- Rapid manual 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:

- Rate Correct Score (RCS) = Number of Correct Responses / RT Sum (sec)
- Flanker Conflict Effect (FCE) = Incongruent RT Avg – Congruent RT Avg

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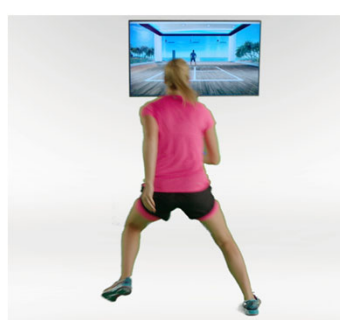
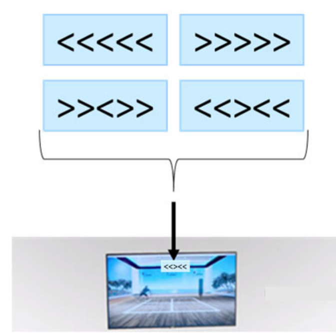
Whole-Body Reactive Agility

- Virtual reality right and left targets
- Infrared tracking of body position
- Targets disappear when body moved to proper 3-D coordinates
  - 3 m X 3 m area
  - 20 repetitions
- Performance metrics:
  - Reaction time
  - Speed
  - Acceleration
  - Deceleration

Single-Task
- Target appears either on Right or Left side of monitor





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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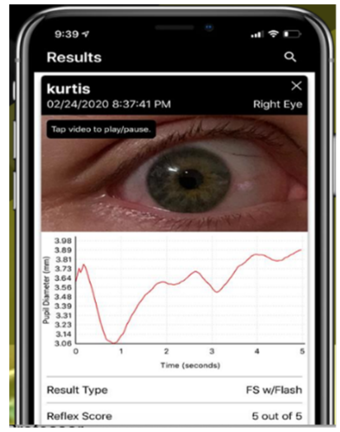
Pupil Light Reflex

- PLR recorded by 5-second video of eye response to smartphone camera flash (left and right eye tested separately)
  - Constriction Time (Constrict)
  - Constriction Latency (Latency)
  - Minimum Diameter (Min Dia)
  - Maximum Diameter (Max Dia)
  - Average Diameter (Avg Dia)



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Statistical Analysis

CLEI Occurrences

Ankle Sprain	2
Achilles Strain	0
Knee Sprain	0
Hamstring Strain	1
Hip/Groin Strain	0
Low Back Strain	0
Abdomen Strain	0

Procedures

- Receiver Operating Characteristic Analysis
  - Area Under Curve (AUC) criterion ≥ .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 predictors

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Results

Predictor Variable	AUC	Cut Point	Sensitivity	Specificity	P
App Rate Correct per Second (s)	.889	≤ 1.68	0.67	1.00	0.045
		≤ 1.80	1.00	0.67	0.091
R Constrict Latency (s)	.792	≥ 0.28	0.67	1.00	0.055
Pittsburgh Sleep Quality Index	.792	≥ 7	1.00	0.75	0.061
Sport Fitness Index – Item 10 (0-5)	.750	≥ 1	1.00	0.63	0.121
WBRA Deceleration Asymmetry (%)	.750	≥ 6.5	1.00	0.63	0.121
App Flanker Test Conflict Effect (ms)	.704	≥ 87	0.67	0.89	0.127
R Max Constrict Speed (mm/s)	.667	≤ 8.8	1.00	0.50	0.212
WBRA Flanker Test RT (ms)	.625	≥ 776	0.67	0.75	0.279
DASS-21 Total (0-63)	.667	≥ 7	0.67	0.78	0.236

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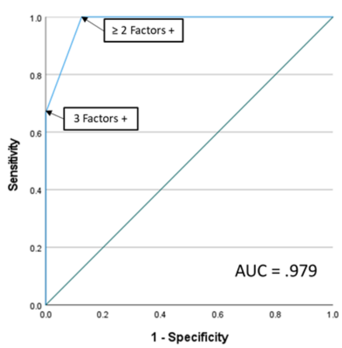
- **Logistic Regression Binary Model**
  1. App Rate Correct Score ≤ 1.68
  2. R Constrict Latency ≥ 0.28 sec
  3. Sport Fitness Index Item 10 ≥ 1



		LE Sprain/Strain in Practice or Game		
		Yes	No	Incidence
≥2 of 3 Factors	Yes	3	1	75%
	No	0	7	0%
	Total	3	8	

Sensitivity 100% Specificity 88%

$\chi^2(1)=7.22$ $P=.024$

		LE Sprain/Strain in Practice or Game		
		Yes	No	Incidence
3 of 3 Factors	Yes	2	0	100%
	No	1	8	11%
	Total	3	8	

Sensitivity 67% Specificity 100%

$\chi^2(1)=6.52$ $P=.055$

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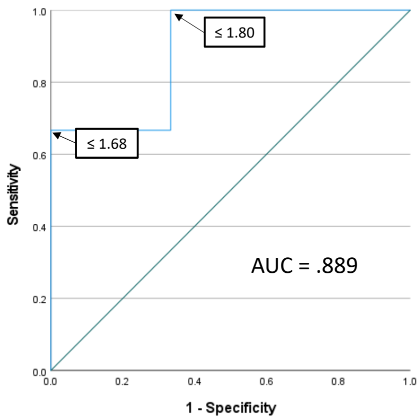
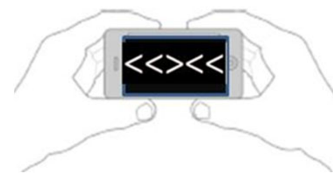
Rate Correct Score





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

RCS ≤ 1.80 100% Sensitivity 67% Specificity

RCS ≤ 1.68 67% Sensitivity 100% Specificity

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Results: Sport Fitness Index

10. Over the past 12 months, to what extent have personal life events created emotional responses (such as sadness, depression, and/or anxiety) that have interfered with your enjoyment of life, ability to concentrate, and/or fulfillment of routine daily responsibilities?

Never	Rare	Infrequent	Occasional	Frequent	Persistent
○	○	○	○	○	○

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Discussion

- Pre-participation injury risk screening results clearly discriminated players who subsequently sustained injury from those who avoided injury
  - Sensitivity 100% for 5 predictors and Specificity 100% for 1 predictor
- Neural efficiency (Flanker Test RCS) provided strongest predictive value
  - Sensitivity 100% (≤ 1.80) and Specificity 100% (≤ 1.68)
- Pupil Light Reflex constriction latency may result from a neural control mechanism that overlaps with processes quantified by Flanker Test RCS

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Discussion

- Speed of brain integration of perceptual, cognitive, and motor processes appears to be a critical factor for injury avoidance and optimal performance
- Despite a very small number of injured players, multiple performance metrics and survey responses were associated with injury occurrences
- Cognitive, motor, autonomic control, and psycho-behavioral processes appear to be interrelated and inefficient neural function may affect each
  - Life events, sleep quality, and mental well-being influence injury risk

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Clinical Relevance

- Pre-participation perceptual-motor test results and survey responses can be used to identify individual athletes with elevated injury risk
- Athletes who exhibit suboptimal perceptual-motor efficiency may derive benefit from training that progressively increases perceptual-motor demands
- Mental well-being may be an overlooked factor that adversely effects brain processing efficiency, which may also be an important injury risk factor[5]

References

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