The effects of mild traumatic brain injury and vision occlusion on dynamic balance performance in Special Operations Forces Soldiers

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ABSTRACT

Over the past two decades, over 400,000 military service members were diagnosed with a traumatic brain injury, with 80% classified as a mild traumatic brain injury (mTBI). mTBIs are often underreported in military populations and can lead to balance and vision deficits. Balance assessments are used post-mTBI to detect these abnormalities, yet a more challenging functional balance test is necessary to be able to detect more hidden deficits. This was tested by adding vision occlusion to a Y-balance Test (YBT) through stroboscopic glasses. **PURPOSE:** To understand the effects of different levels of visual occlusion on performance scores during a functional balance assessment such as the YBT, as well as the differences between scores in a population with mTBI history and a population without a mTBI history. **METHODS:** Healthy asymptomatic SOF combat Soldiers (age=33.1±4.2yrs) cross-sectionally participated in this study at two career stages: baseline (n=179) and in-career (n=143). We collected self-reported mTBI history status as positive (n=214) and negative (n=108) mTBI history. We measured dynamic balance performance using the Y-Balance test. Each direction was randomized as well as the level of vision occlusion administered (eyes open, level 2, and level 6). We quantified the composite reach distance (CRD). We employed a 2x3 mixed model analysis of variance (ANOVA) to measure the effects of mTBI history (between-subject effect; levels: yes vs. no) and vision occlusion [within-subject effect; 3 levels: none vs. low (Level 2) vs. high (Level 6)] on each YBT outcome score. **RESULTS:** There was no significant interaction between mTBI history and vision occlusion level, nor a significant main effect of mTBI history on CRD in either limb. There was a main effect of vision occlusion on CRD (p-value= <0.001) for left and right limbs. Deteriorating visual information negatively impacts functional balance in Special Operations Forces combat Soldiers. **CONCLUSIONS:** mTBI history did not have a significant effect on functional balance in SOF combat Soldiers. There was no interaction observed between mTBI history and vision occlusion in functional balance either. Our findings indicate that increasing vision occlusion levels can negatively impact functional balance by disrupting the constant flow of visual information. Applying stroboscopic vision therapies can enhance visuo-motor control and force individuals to reduce their dependence on visual feedback.

METHODS

Participants
322 healthy and asymptomatic Special Operations Forces (SOF) combat Soldiers (age = 33.1±4.2 yrs) self reported their mTBI history and career status:
- *Positive (yes)* → 214 SOF combat Soldiers
- *Negative (no)* → 108 SOF combat Soldiers
- *Baseline* → 179 SOF combat Soldiers
- *"In- career"* → 143 SOF combat Soldiers

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METHODS
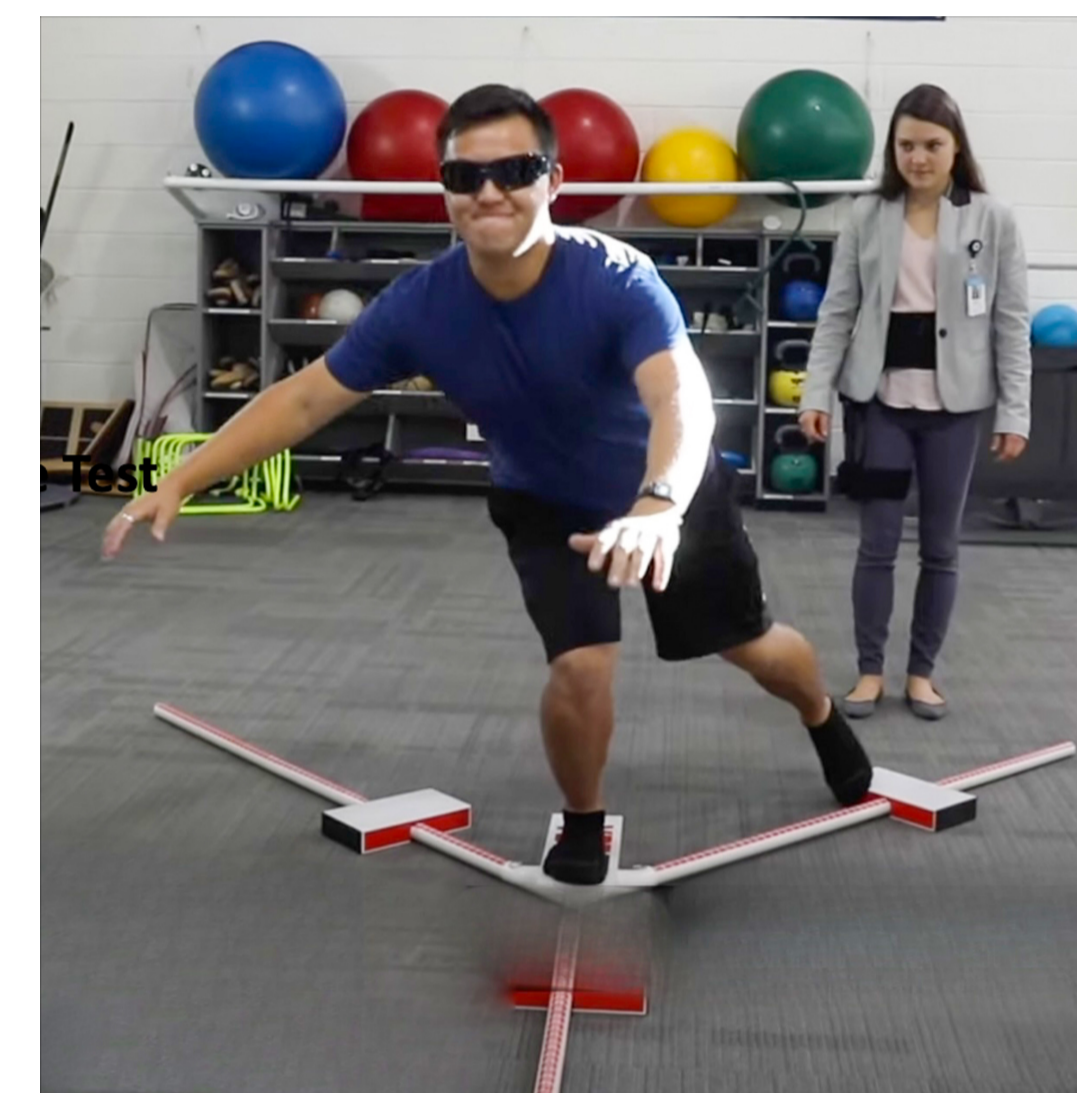
Figure 1. YBT assesses dynamic balance in 3 directions- anterior, posteromedial, and posterolateral

Figure 2. Senaptec Stroboscopic glasses used level 2 and level 6 to create low and high levels of vision occlusion during YBT assessment.

Y-Balance Test (Figure 1)
- Participant stands with hands on hips in center box on one foot
- Instructed to slide designated box as far as possible with test foot and return to upright position
- Repeat for 3 successful reaches on both feet with a maximum of 6 attempts

Stroboscopic Glasses (Figure 2)
- 3 levels of vision occlusion were assessed: control (eyes open), low (level 2 of 8 strobe), and high (level 6 of 8 strobe)
- vision occlusion level was randomized to prevent learning effect and fatigue

Data Analyses
- 2x3 mixed model analysis of variance (ANOVA) to measure the effects of mTBI history (between-subject effect; levels: yes vs. no) and vision occlusion [within-subject effect; 3 levels: none vs. low (Level 2) vs. high (Level 6)] on each YBT outcome score

BOTTOM LINE UP FRONT

mTBI history did not influence the effect of vision occlusion on Y-Balance Test (YBT) composite reach distance scores in Special Operations Forces (SOF) combat Soldiers

RESULTS

Statistical data for all interaction and main effects for right and left composite reach distances

	Interaction effect (Aim 1)		mTBI main effect (Aim 2)		Vision main effect (Aim 3)	
	$F_{2,636}$	P	$F_{1,318}$	P	$F_{2,636}$	P
Right Limb	0.795	0.452	<0.001	0.998	18.343	<0.001
	$F_{2,628}$	P	$F_{1,314}$	P	$F_{2,628}$	P
Left Limb	0.833	0.435	0.396	0.529	20.146	<0.001

Table 1 (above). Any significant interaction (mTBI history x vision occlusion) or main (mTBI history; vision occlusion) effects were further explored with Tukey post hoc analyses. Statistical analyses were conducted using Jamovi (Version 2.3.28.0) software, and all tests employed an a priori 0.05 alpha level.

Descriptive data for all interaction and main effects for right and left composite reach distances

Limb	Vision Occlusion Level	mTBI History				Vision Overall	
		Yes (N= 214)		No (N= 108)			
		Mean	SD	Mean	SD	Mean	SD
Right	Eyes Open	108	13.9	108	14.1	108	13.9
	Level 2	107	14.1	107	14.4	107	14.1
	Level 6	106	13.8	106	14.6	106	14.0
	mTBI Overall	106.8	13.6	106.7	13.9		
		Mean	SD	Mean	SD	Mean	SD
Left	Eyes Open	107	14.0	108	14.6	108	14.2
	Level 2	106	14.0	107	15.0	106	14.3
	Level 6	105	14.3	106	15.6	106	14.7
	mTBI Overall	106.3	13.7	107.2	14.8		

Table 2 (left). CRD was reported in percentages reflecting reach distance normalized to limb length. Post Hoc testing identified differences across all three vision occlusion levels such that eyes open (normal) performance exceeded Levels 2 and 6, and Level 2 performance exceeded Level 6.

CONCLUSIONS

- mTBI history did not have a main effect on YBT scores or an interaction effect with vision occlusion on YBT scores
- Our CRD findings may indicate that the characteristics of the mTBI has a greater impact on balance deficits which can include severity, mechanism of injury (blast related, blunt force), frequency, and recency
- Limited visual feedback negatively impacted functional balance scores and requires enhanced visuo-motor control
- Continuing to challenge a patient's ability to complete dynamic balance tasks is one opportunity to expose any hidden deficits that remain

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