Taking one 'step' forward: exploring changes in balance and mobility after mild traumatic brain injury in adults from the general population

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Learning objectives

At the end of this session, participants will be able to:

1) Identify alterations in balance and mobility that occur within 7 days of mild traumatic brain injury in adults from the general population.

2) Characterize the discrepancies between subjective and objective findings in components related to balance and mobility.

3) Consider the potential utility of using cognitive dual-task paradigms to probe balance and mobility function in adults recovering from mild traumatic brain injury.

On the relationship between falls, balance, and brain injury
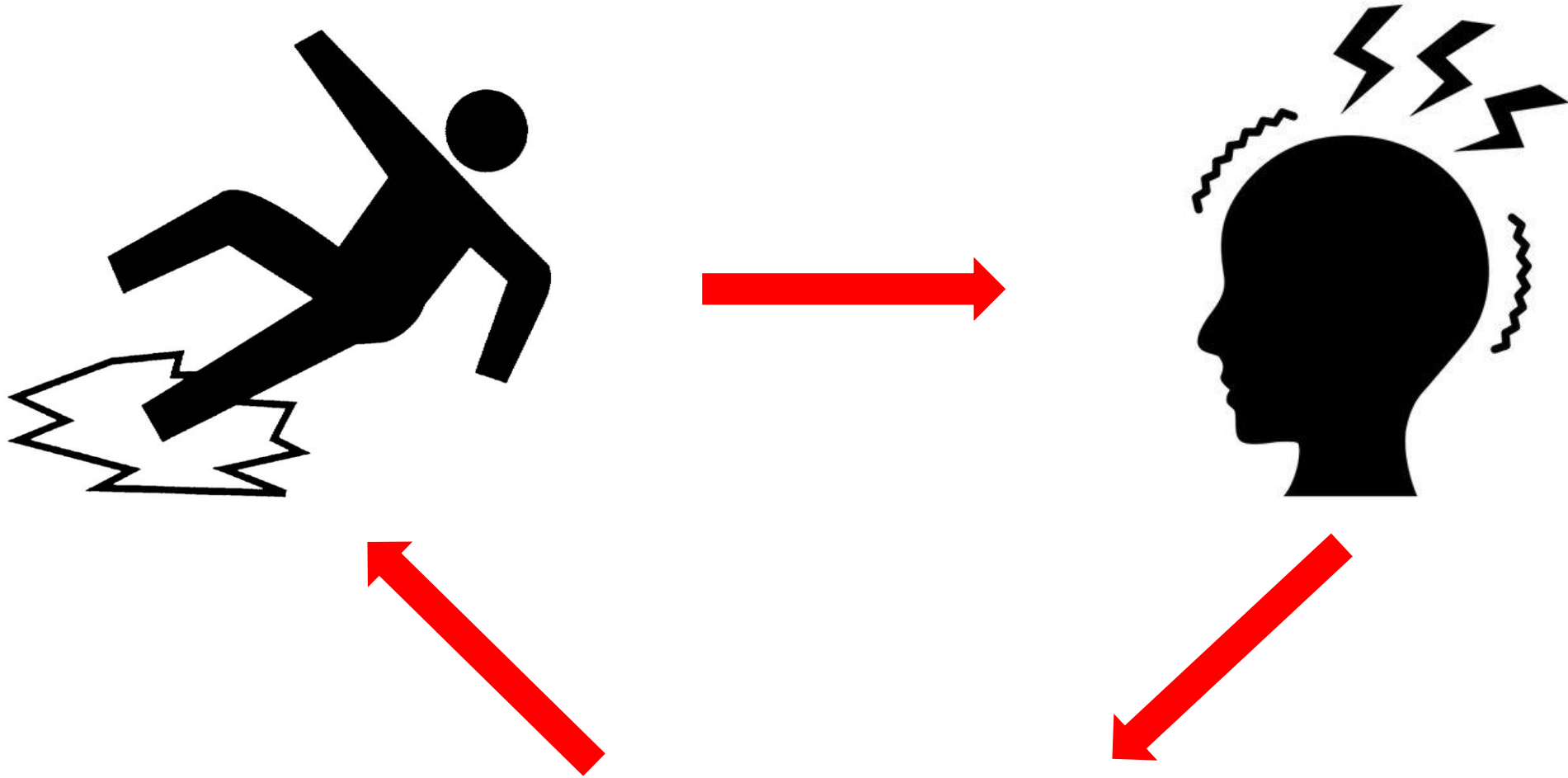
Alterations in balance and gait behaviours

Multi-domain assessment of balance and mobility after concussion

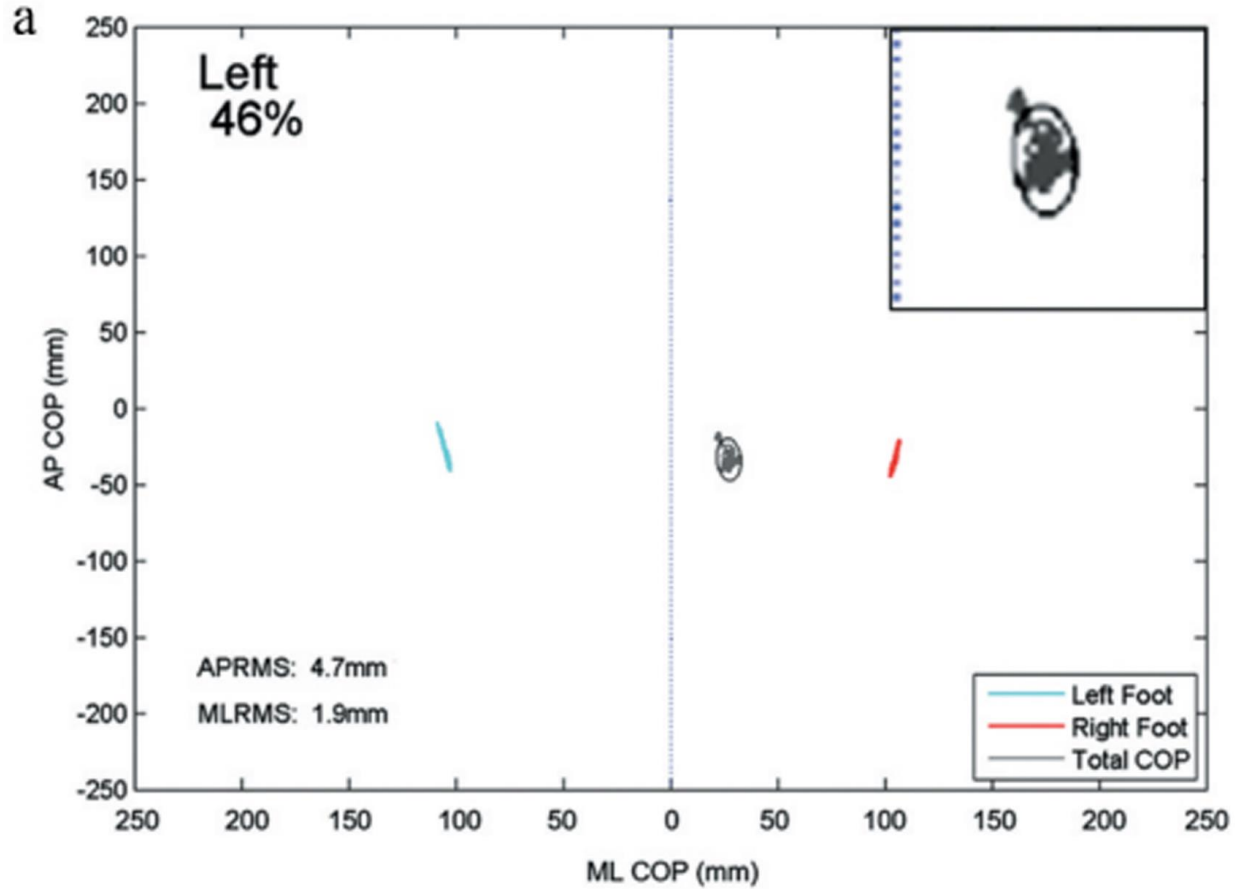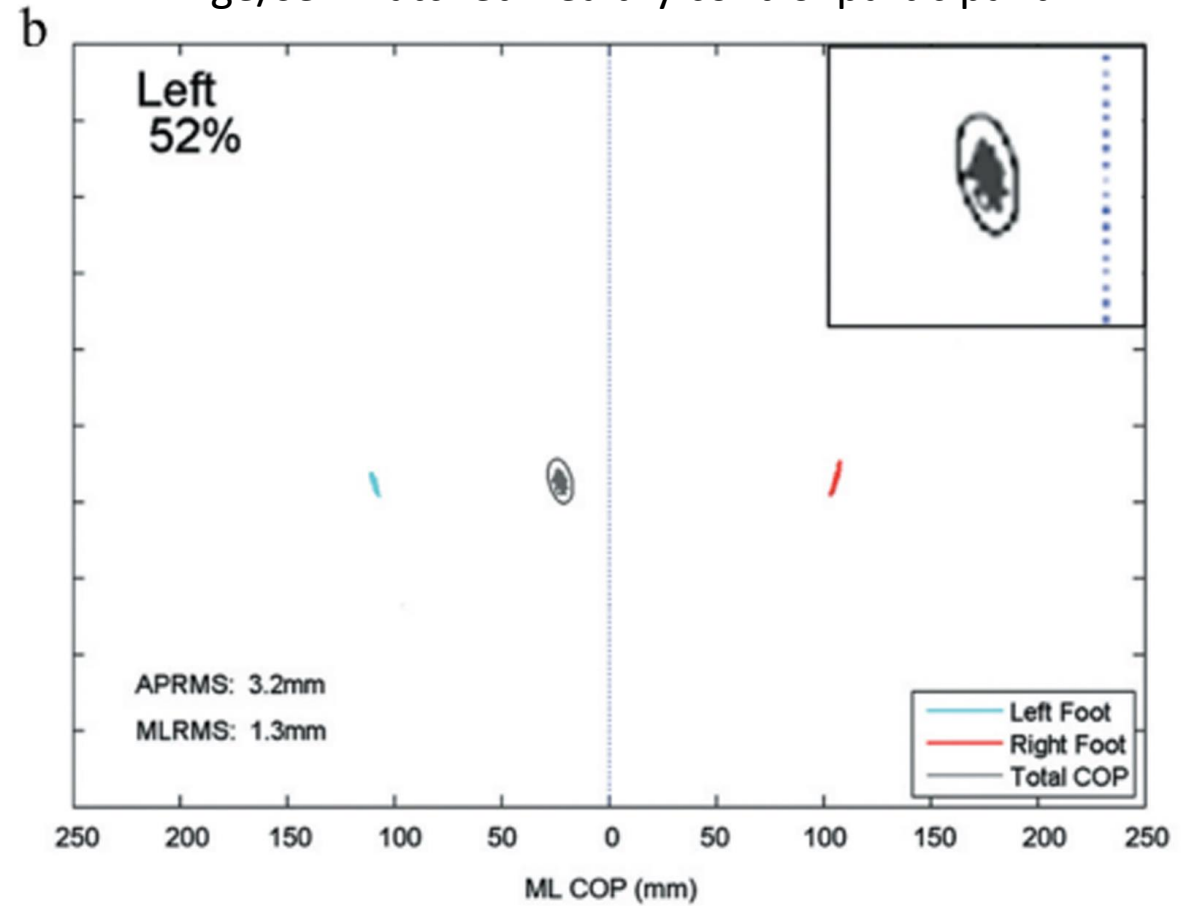| Force plate measures	Symptoms	Clinical Measures	Gait measures
Centre of pressure (spatial and spectral)	SCAT5 (balance, dizziness)	BESS test	Velocity
		ABC	Step length
		CB&M	Cadence
			Double support (% of gait cycle)

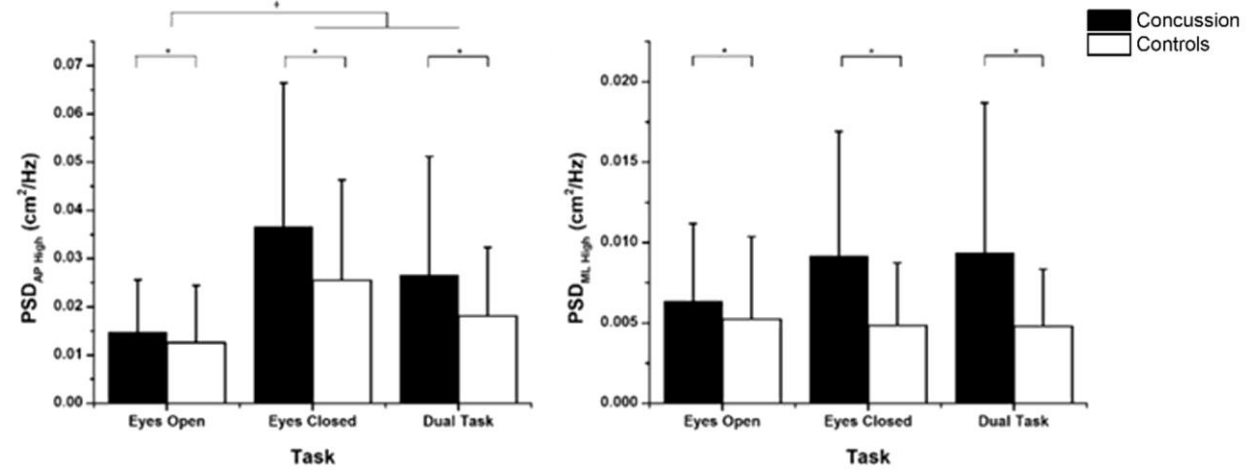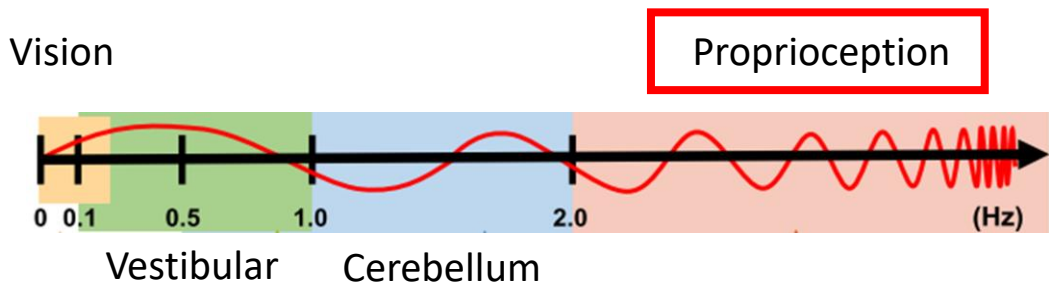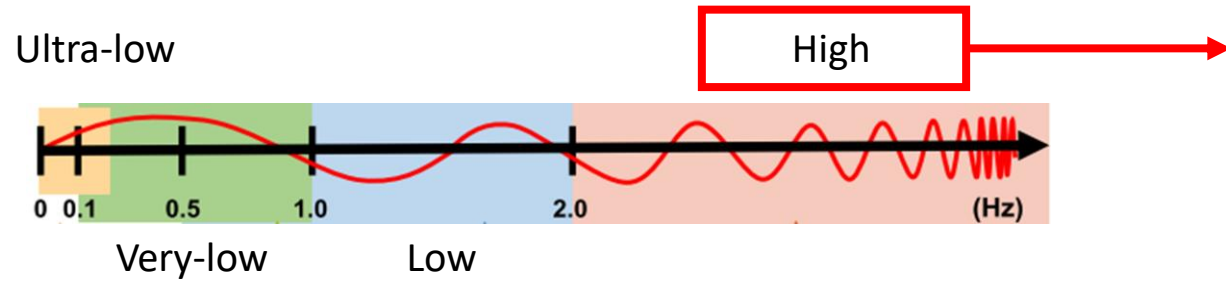# Postural sway after concussion – forceplate measurement

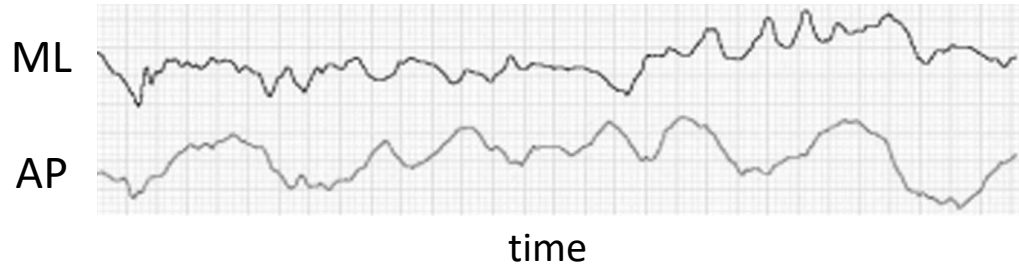Concussion participant   Age/sex matched healthy control participant

Sweeny et al. 2021

Greater high-frequency power in anteroposterior (AP) and mediolateral (ML) sway

ML

AP

time

Ultra-low

High

Very-low   Low

Vision

Proprioception

Vestibular   Cerebellum

Sweeny et al. 2021

Modified from Lin et al. 2019

# At 12 weeks post-injury, only a small proportion of individuals have 'recovered' their balance ability

	Eyes Open				Eyes Closed				Dual Task			
	W2	W4	W8	W12	W2	W4	W8	W12	W2	W4	W8	W12
AP RMS	29%	40%	32%	21%	25%	28%	32%	36%	32%	28%	46%	32%
ML RMS	29%	32%	25%	29%	21%	16%	25%	18%	29%	36%	29%	32%
AP Vel	21%	28%	36%	36%	21%	8%	18%	43%	21%	28%	18%	14%
ML Vel	43%	40%	36%	39%	29%	36%	25%	29%	25%	20%	29%	25%
BESS	11%	4%	26%	19%								

	Eyes Open				Eyes Closed				Dual Task			
	W2	W4	W8	W12	W2	W4	W8	W12	W2	W4	W8	W12
AP RMS	29%	36%	29%	21%	21%	24%	32%	36%	29%	24%	39%	21%
ML RMS	25%	28%	21%	29%	21%	12%	21%	14%	25%	36%	29%	32%
AP Vel	11%	24%	29%	29%	18%	4%	18%	39%	19%	24%	14%	14%
ML Vel	29%	32%	32%	25%	29%	32%	21%	21%	21%	12%	18%	18%
BESS	7%	0%	26%	15%								

Sweeny et al. 2020

Concussion symptoms resolve at between 4-8 weeks after injury

Table 3. Participant demographics for the within-individual analysis and self-reported symptom score for CONC participants across time.

Variable		CONC					HC
		n = 28					n = 19
Sex [Number (%)]	Men	10 (35%)					8 (40%)
	Women	18 (64%)					12 (60%)
Age [Mean (SD)]		34.8 (11.1)					31.9 (10.1)
		W1	**W2**	**W4**	**W8**	**W12**	
SCAT3 [Median (Range)]	Total	38 (0–94)	25 (0–104)	23 (1–99)	8 (0–104)	7 (0–96)	
	Balance	0 (0–2)	0 (0–4)	0 (0–5)	0 (0–3)	0 (0–1)	
	Dizziness	1 (0–4)	1 (0–5)	0 (0–4)	0 (0–4)	0 (0–6)	

Sweeny et al. 2020

Regardless of balance-related symptom load, more balance errors are committed

Register-Mihalik et al. 2019

Sweeny et al. 2021
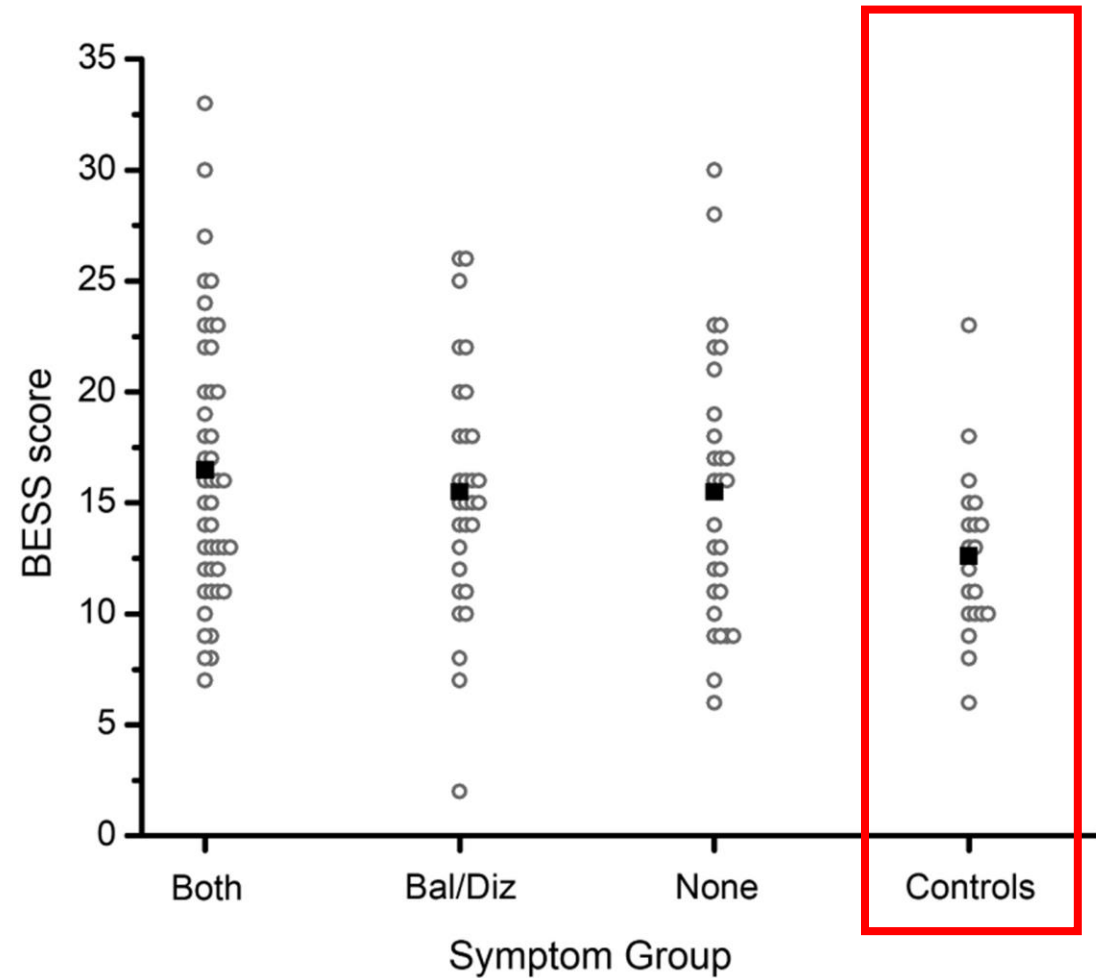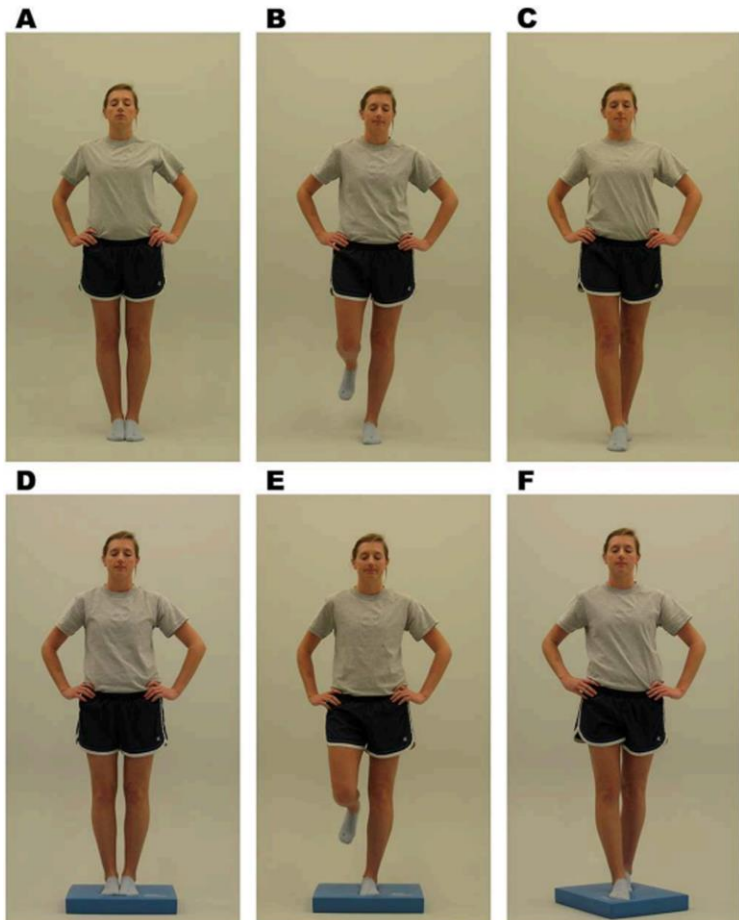
The level of agreement between subjective (symptoms) and objective (force plate) or clinical (BESS) measures of balance is low

TABLE 4 *Level of agreement between subjective (symptom reporting) and objective (performance-based) methods of assessing balance disturbance[a]*

	Sx-Balance		Sx-Dizziness	
	% Agreement	κ (95% CIs)	% Agreement	κ (95% CIs)
BESS	58	0.13 (−0.05 to 0.31)	58	0.13 (−0.05 to 0.31)
mBESS	58	0.16 (−0.03 to 0.35)	55	0.06 (−0.13 to 0.25)
APRMS—EO	55	0.11 (−0.07 to 0.28)	55	0.15 (−0.02 to 0.31)
MLRMS—EO	52	0.05 (−0.13 to 0.23)	44	−0.07 (−0.24 to 0.11)
APVel—EO	49	−0.00 (−0.18 to 0.18)	42	−0.07 (−0.24 to 0.20)
MLVel—EO	47	0.04 (−0.23 to 0.14)	38	−0.20 (−0.37 to 0.02)
APRMS—EC	62	0.26 (0.08 to 0.43)	55	0.15 (−0.01 to 0.31)
MLRMS—EC	54	0.10 (−0.07 to 0.27)	54	0.16 (0.01 to 0.31)
APVel—EC	54	0.09 (−0.08 to 0.27)	52	0.10 (−0.06 to 0.26)
MLVel—EC	57	0.13 (−0.05 to 0.32)	51	0.03 (−0.15 to 0.21)

Inness et al. 2018

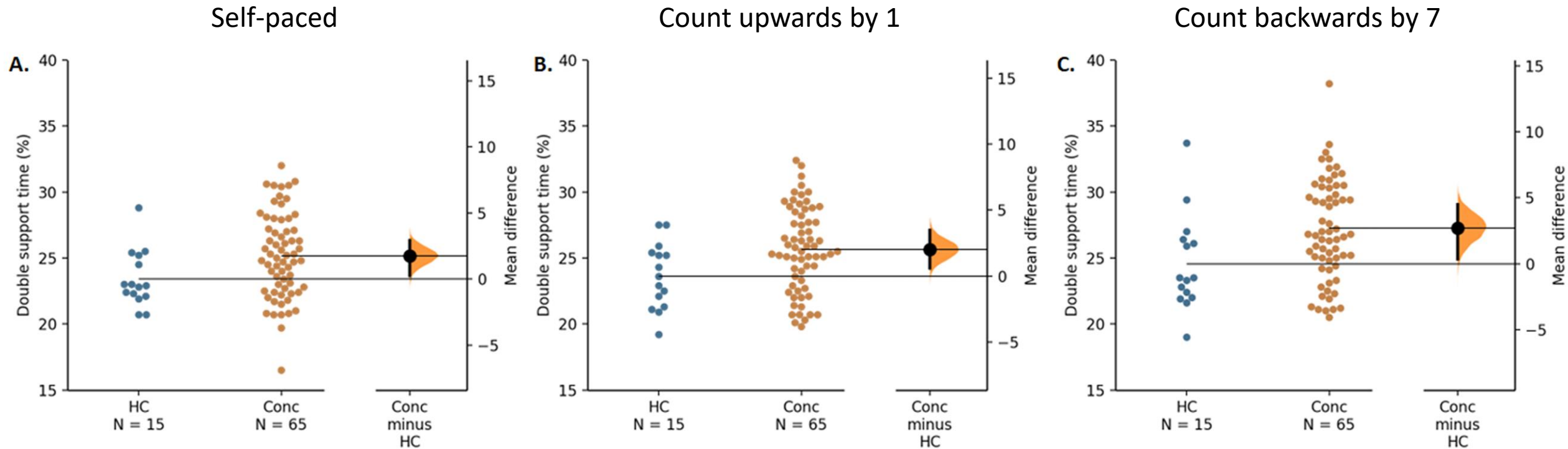# Stability during gait: double support phase (DSP)

Double support phase: approximately 20% of the gait cycle

Increased DSP can be deployed <u>as a strategy</u> to increase stability during gait

OR

represents <u>reduced ability</u> to allocate cognitive resources to task demands

https://www.physio-pedia.com/The_Gait_Cycle

Cautious gait behaviour (DSP): influence of distraction

Self-paced   Count upwards by 1   Count backwards by 7

Hameed et al., in preparation

Cautious gait behaviour (DSP): influence of symptom load

Hameed et al., in preparation
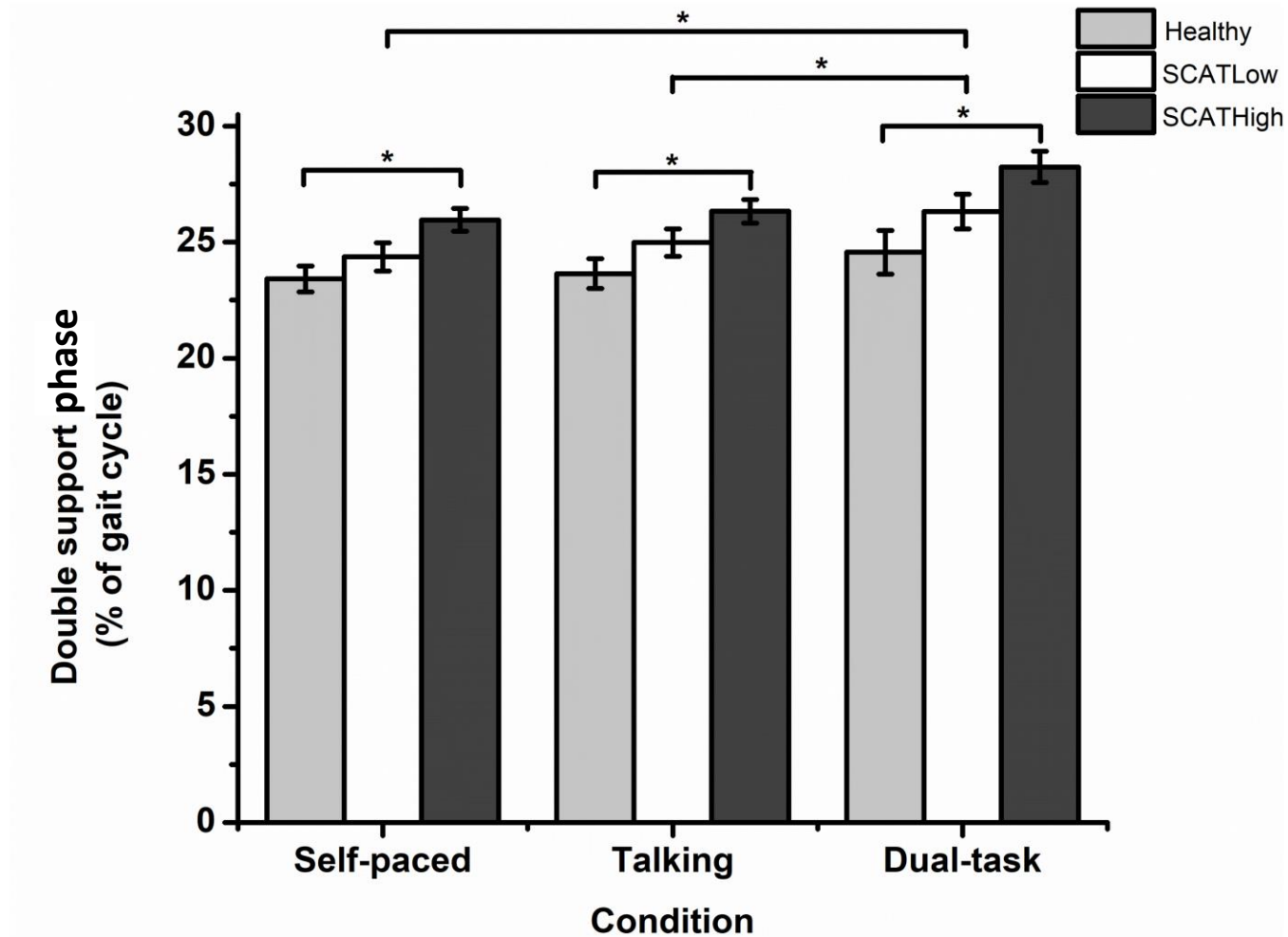
Balance confidence – relationship to concussion symptoms

0% 10 20 30 40 50 60 70 80 90 100%
No Confidence   Completely Confident

How confident are you that you will <u>not</u> lose your balance or become unsteady when you...

1. ...walk around the house? _____%
2. ...walk up or down stairs? _____%
3. ...bend over and pick up a slipper from the front of a closet floor? _____%
4. ...reach for a small can off a shelf at eye level? _____%
5. ...stand on your tip toes and reach for something above your head? _____%
6. ...stand on a chair and reach for something? _____%
7. ...sweep the floor? _____%
8. ...walk outside the house to a car parked in the driveway? _____%
9. ...get into or out of a car? _____%
10. ...walk across a parking lot to the mall? _____%
11. ...walk up or down a ramp? _____%
12. ...walk in a crowded mall where people rapidly walk past you? _____%
13. ...are bumped into by people as you walk through the mall? _____%
14. ...step onto or off of an escalator while you are holding onto a railing? _____%
15. ...step onto or off an escalator while holding onto parcels such that you cannot hold onto the railing? _____%
16. ...walk outside on icy sidewalks? _____%

Table 4. Spearman's correlations between ABC/ABC-6 and concussion symptom, gait, and balance outcomes.

	N	ABC	ABC-6
SCAT Number of Symptoms	252	-0.573	-0.580
SCAT Total Score	252	-0.571	-0.567
SCATHeadache	252	-0.365	-0.350
SCATVestibulo-ocular	252	-0.604	-0.578
SCATSensory	252	-0.506	-0.509
SCATCognitive	252	-0.592	-0.600
SCATFatigue	252	-0.507	-0.505
SCATEmotional	252	-0.484	-0.474
mBESS	208	-0.111 (ns)	-0.090 (ns)
Double-support during self-paced walking (% gait cycle)	195	-0.165 (ns)	-0.195 (ns)
Double-support during dual task (% gait cycle)	194	-0.185 (ns)	-0.218
APvelocity-eyes closed	203	-0.085 (ns)	-0.076 (ns)
MLvelocity-eyes closed	203	-0.149 (ns)	-0.155 (ns)

Significance was set at p<0.0035 corrected for multiple comparisons; ns=not statistically significant.

Powell and Myers, 1995

Mochizuki et al., in revision

Take-home messages

Within 7 days after concussion, adults from the general population:

- sway at higher frequencies during quiet standing (i.e. have increased reliance on proprioception)

- commit more balance 'errors'

- engage in more cautious gait behaviour

- demonstrate a disconnect between balance symptoms and instrumented balance measures*

- display stronger relationships between endorsed symptoms and balance confidence

*this persists out to at least 12 weeks post-injury

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