EFFECTS OF EMOTIONAL STATES ON DYNAMIC BALANCE DURING GAIT INITIATION AND SIT-TO-WALK TRANSITIONS

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Introduction

This study explores how emotional states—joy, sadness, anger, and fear—affect the biomechanics of gait initiation and sit-to-walk transitions in healthy young adults. Previous research indicates that emotions can impact motor performance, including gait and balance, but the specific biomechanical effects remain unclear. By examining changes in key parameters like the center of mass (COM)-ankle angle, this research aims to uncover how emotions influence movement coordination and planning. The findings could offer new insights into the relationship between emotions and motor control, potentially guiding therapeutic strategies to improve mobility and balance in individuals with emotional and mood disorders.

Methods

3 young, healthy adults were recruited from the university community (age = 22 ± 0.8165 years, sex = 2 Females, body-mass index = 20.53 ± 1.108 kg/m²). Participants were excluded if they had a history of neurological or neuromuscular conditions that may affect their gait. Participants were fitted with a motion capture suit and markers (n=74) and instructed to walk over a 10-meter walkway at a self-selected pace. Additionally, they performed sit-to-walk trials in which they transitioned from sitting in a chair to walking, both in triplicate. After collecting baseline trials, participants were instructed to recall a memory associated with the following emotions: Anger, sadness, Neutrality, joy, and fear. Participants then repeated baseline trials with specific emotions in mind. 16-motion capture cameras (VICON, United Kingdom) and 8 force plates (Kistler, Germany) were used to collect marker and force data during gait and sit-to-walk trials. Key metrics included the mean Center of Mass (COM)-Ankle Angle at heel strike (HS), toe off (TO), and seat-off (SO. sit-to-walk only). HS was defined as the foot's contact with the ground at the first step. TO was defined as when the first stepping foot leaves the ground for the subsequent step. SO was defined as the COM peak upward velocity.

Results and Discussion

The study suggests trends where emotions like anger and joy might lead to a more forceful gait and fear to a more cautious one, but the results are not statistically significant, possibly due to the small sample size of only three participants. A larger sample size could provide more definitive evidence of the impact of emotions on gait initiation and transitions, enhancing the reliability and generalizability of the findings.

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References

[1] Kang, G. E., Mickey, B. J., Krembs, B. S., McInnis, M. G., & Gross, M. M. (2019). The effect of mood phases on balance control in bipolar disorder. Journal of Biomechanics, 82, 266–270. https://doi.org/10.1016/j.jbiomech.2018.10.039

[2] Caron, R. R., Wagenaar, R. C., Lewis, C. L., Saltzman, E., & Holt, K. G. (2013). Center of mass trajectory and orientation to the ankle and knee in the sagittal plane is maintained with forward lean when the backpacking load changes during treadmill walking. Journal of Biomechanics, 46(1), 70–76

Table 1: Gait initiation moments for walking (middle 4 columns) and sit-to-walk (right 4 columns) for baseline and targeted emotions.

Trial Types	Walking				Sit-To-Walk			
	HS (°)	TO (°)	P-value	Cohen's D	SO (°)	TO (°)	P-value	Cohen's D
Baseline	17.32 ± 1.84	25.90 ± 0.29			17.81 ± 0.33	21.14 ± 1.39		
Anger	18.01 ± 0.76	28.71 ± 2.01	HS = 0.58 TO = 0.07	HS = 0.49 TO = 1.96	17.70 ± 1.29	21.68 ± 1.52	SO = 0.67 TO = 0.68	SO = -0.12 TO = 0.37
Sadness	17.80 ± 0.37	28.09 ± 2.93	HS = 0.68 TO = 0.27	HS = 0.36 TO = 1.05	18.17 ± 0.34	20.68 ± 2.35	SO = 0.42 TO = 0.52	SO = 1.07 TO = -0.24
Neutral	17.06 ± 0.37	27.87 ± 1.78	HS = 0.82 TO = 0.13	HS = -0.20 TO = 1.54	17.42 ± 1.42	21.26 ± 1.29	SO = 0.25 TO = 0.78	SO = -0.34 TO = 0.09
Joy	18.17 ± 0.15	26.91 ± 0.65	HS = 0.47 TO = 0.07	HS = 0.65 TO = 2.01	17.51 ± 0.94	21.41 ± 2.26	SO = 0.80 TO = 0.47	SO = -0.43 TO = 0.14
Fear	15.53 ± 0.15	27.97 ± 2.34	HS = 0.17 TO = 0.20	HS = -1.37 TO = 1.24	17.41 ± 1.10	20.72 ± 1.30	SO = 0.58 TO = 0.72	SO = -0.49 TO = -0.31

Cohen's D values: small (0.2), medium (0.5), and large (0.8)

P-values: $p<0.05$ (correlating observation)