MOOD IN MOTION: EMOTIONAL BIAS, COGNITIVE LOAD, AND GAIT IN HEALTHY ADULTS

Dr Simon Briley, Dr Paul Briley, and Debbie Butler discuss research exploring how mood and motor control interact and can inform more integrated physical and psychological care.

Depression affects 13% of individuals during their lifetime (Kessler *et al.*, 2013). While often seen primarily as a psychological condition, depression is also linked with consistent, observable changes in movement particularly in how people walk, stand, and balance. These physical signs are gaining recognition as meaningful indicators of emotional distress and may suggest new ways to support mental health through movement (Murri *et al.*, 2020).

People with depression often show distinct motor patterns, such as shorter strides, reduced vertical head movement, and altered posture (e.g., forward head carriage, rounded shoulders) (Murri *et al.*, 2020). Postural stability is also frequently affected, especially when multitasking or under cognitive strain. Yet, these signs are rarely assessed in typical sport, exercise, or clinical settings, representing a missed opportunity for early identification and intervention.

For sport and exercise professionals, understanding how mood and motor control interact is valuable. It opens doors to early detection of emotional challenges, informs movement-based strategies to boost wellbeing, and supports more integrated physical and psychological care.

THE BIOMEQ-MD PROJECT

This study is part of the BioMeQ-MD initiative (Biomechanical Interventions for Mood and Quality of Life in Major Depression), a collaboration between the University of Derby and the University of Nottingham's Institute of Mental Health. This interdisciplinary team combines expertise in biomechanics, physiotherapy, and mental health, working closely with individuals who have lived experience of depression. This partnership ensures the research is person-centred, inclusive, and clinically relevant. A core aim is to investigate whether modifying

“While often seen primarily as a psychological condition, depression is also linked with consistent, observable changes in movement particularly in how people walk, stand, and balance.”

movement can positively influence mood and quality of life.

STUDY FOCUS

This article presents findings from the project's non-clinical arm, involving healthy adults. We examined how emotional bias, the tendency to interpret ambiguous emotional information positively or negatively, and cognitive load interact to influence walking and balance under typical conditions. Our aim was to identify key biomechanical variables associated with emotional processing and mood during both single-task and dual-task walking in a non-clinical sample of healthy adults.

KEY TERMS:

- Emotional bias refers to the tendency to interpret ambiguous emotional stimuli (e.g., facial expressions) in a more positive or negative way.
- Cognitive load is the mental effort required when performing an additional task while moving, such as walking while counting backwards.

WHAT WE DID

To date, 21 healthy volunteers aged 19–22 years (3 female) have completed baseline assessments. Participants were recruited from a university population and screened to ensure they had no known neurological or musculoskeletal impairments that might affect gait. Participants completed self-report measures of depressive symptoms (PHQ-8, scores spanned the low-moderate range) and anxiety (GAD-7, scores spanned the low-severe range).

Emotional bias was assessed using a computerised task where participants categorised ambiguous facial expressions as "happy" or "sad," generating individual scores indicating a tendency towards positive or negative interpretation (Figure 1).

Gait was assessed as participants walked along a 10-metre walkway. A force platform embedded in the walkway was used to measure the forces exerted against the ground during walking, and small wearable sensors (inertial measurement units, or IMUs) were used to track how different parts of the body moved while walking.

Participants performed six walking trials under two conditions:

- Single-task walking: walking at a comfortable pace without added cognitive demands
- Dual-task walking: walking while verbally counting backwards in threes, introducing cognitive load

We analysed how gait variables related to emotional bias and mood measures in each condition, testing the influence of cognitive load on the relationship between emotion and movement.

WHAT WE FOUND

During single-task walking, no significant associations were found between emotional bias and gait parameters, suggesting that under routine conditions emotional outlook does not markedly influence movement in healthy adults.

In contrast, during dual-task walking, individuals with a more positive emotional bias (more likely to perceive ambiguous faces as "happy") showed significantly greater variability in key gait measures:

- Variability in anterior–posterior ground reaction forces (r = .658, p = .001)
- Variability in mediolateral ground reaction forces (r = .556, p = .009)
- Variability in walking speed (r = .553, p = .009)

Here, variability refers to the magnitude of fluctuations across trials, indicating flexible and adaptive motor behaviour a hallmark of a healthy motor system responsive to changing demands (Stergiou & Decker, 2011; Hausdorff, 2007). This supports the idea that emotional processing influences motor control, with a positive emotional outlook linked to more adaptable gait mechanics under cognitive challenge. Reduced gait variability and rigidity have previously been associated with depression and affective instability (Michalak *et al.*, 2009).

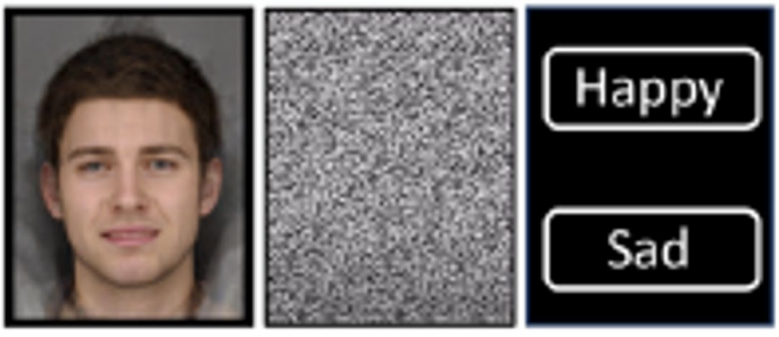
Notably, depressive symptom severity (PHQ-8 scores) showed no direct relationship with gait in this healthy sample, suggesting that emotional bias better explains the mood-movement connection than symptom severity alone.

IMPLICATIONS OF THE FINDINGS

These findings suggest that assessing gait during cognitive tasks may be more sensitive to detecting emotional and cognitive strain than standard walking assessments. When individuals divide their attention between walking and a cognitive task (such as counting backwards or responding to prompts), subtle changes in gait patterns can occur. These likely reflect increased cognitive and emotional demands and may serve as early signs of psychological vulnerability, reduced coping ability, or early executive function decline.

This approach shows potential across sport, exercise, and clinical settings. Monitoring mood alongside movement, especially during tasks engaging both cognitive and emotional processes, could provide valuable insights. In athlete monitoring, dual-task gait assessments might reveal subtle gait stability changes under cognitive load, indicating psychological strain like mental fatigue or anxiety. In rehabilitation, observing gait during cognitively demanding tasks may help clinicians understand how patients cope with stress or distraction during recovery, though further research is needed to confirm its utility. In clinical practice, changes in dual-task gait could signal early cognitive or emotional difficulties that standard assessments may miss; however, more investigation is required before routine clinical use.

Caution is warranted in interpreting these findings. The study was conducted in a small, non-clinical sample, and gait variability can be influenced by factors such as fatigue, motivation, and environmental conditions. Larger, more



▲ **Figure 1:** Participants completed an "emotional bias task" – judging whether ambiguous facial expressions are happy or sad (CANTAB, Cambridge Cognition).

diverse samples are needed to confirm and establish reliability. In the interim, dual-task gait assessment can serve as a useful auxiliary tool alongside existing measures, especially given evidence that emotional bias better explains the mood–movement connection than symptom severity alone. Incorporating such measures may help develop a nuanced understanding of how cognitive and emotional factors interact with motor performance. Therefore, movement data should always be considered in the context of an individual's history, current state, and other assessments, and not used in isolation to draw conclusions about mental health.

In conclusion, tailoring interventions to an individual's emotional processing style and recognising altered gait variability during cognitive challenge as a potential sign of emotional strain could inform more responsive and holistic programmes across sport, exercise, and healthcare settings.

FUTURE WORK

The BioMeQ-MD project is moving from foundational research to applied testing. Phase 1 focused on method development, baseline studies in healthy adults, and lived experience engagement to shape person-centred approaches. This foundation now guides Phase 2, where we trial movement-based interventions to improve mood and quality of life.

A randomised controlled trial is underway, comparing follow-up only, standardised group exercises, and personalised movement plans based on individual assessments. Concurrently, we are developing resources for supporting scalable, accessible intervention models.

Next, we will analyse IMU data recorded during walking tasks to examine detailed movement (such as joint angles and coordination) alongside emotional and cognitive factors. This will deepen our understanding of how emotional processing is embodied in movement beyond ground reaction forces alone.

Complementary qualitative interviews and scoping reviews continue to provide essential insights into the lived experience of depression and its physical expressions. Together, these efforts aim to create effective, inclusive, evidence-based interventions bridging physical and mental health.

We are keen to connect with others interested in the intersection of movement and mental health, and welcome opportunities for collaboration as the project evolves.

REFLECTIONS

Working closely with individuals who have lived experience of depression has been invaluable. Their perspectives reinforced that movement changes are not just physical symptoms but embodied expressions of mental health. This insight shaped our methodology and strengthened our belief in gait and posture as meaningful, yet underused, indicators of psychological wellbeing.

The project highlighted the importance of considering emotional and cognitive factors when assessing motor control, moving beyond purely mechanical views of gait. It also challenged us to design person-centred, adaptable interventions that respect the complexity of mood-movement interactions.

CONCLUSIONS AND BROADER IMPACT

Gait reflects more than just biomechanical function; it provides insight into how individuals think, feel, and cope with daily challenges. Under cognitive and emotional stress, changes in movement patterns reveal important aspects of mental functioning.

For sport and exercise professionals, dual-task gait assessments and measures of movement variability offer practical, evidence-based tools to support both physical and emotional health. However, to fully harness this potential, greater recognition is needed that physical signs of mental health are important and currently underused in mental health and exercise practice.

Translating this evidence into practice requires:

- Greater interdisciplinary collaboration: Mental health professionals, physiotherapists, and biomechanists must work together to acknowledge the body as a key site of psychological expression and intervention.
- Community engagement: Involving people with lived experience of depression ensures that interventions are relevant, meaningful, and acceptable.
- System-level integration: Incorporating physical indicators into mental health screening, treatment, and recovery pathways could help bridge the gap between physical and psychological care.

Developing this shared understanding is essential to move beyond symptom management toward truly holistic, person-centred wellbeing. ■

DR SIMON BRILEY

Simon is a Lecturer in Sport and Exercise Biomechanics at the University of Derby, with research interests spanning mental health, human movement, and wearable technology.

DR PAUL BRILEY

Paul is a Clinical Assistant Professor of General Adult Psychiatry at the Institute of Mental Health, University of Nottingham, with research interests in novel neurotechnology interventions for mood disorders.

DEBBIE BUTLER

Dbbie is an experienced lived experience researcher contributing to the BioMeQ-MD project, advocating for person-centred research and mental health innovation.

REFERENCES

Hausdorff, J. M. (2007). Gait dynamics, fractals and falls: Finding meaning in the stride-to-stride fluctuations of human walking. Human Movement Science, 26(4), 555–589.

Kessler, R. C. *et al.* (2013). The epidemiology of depression across cultures. Annual Review of Public Health, 34, 119–138.

Michalak, J. *et al.* (2009). Embodiment of sadness and depression: Gait patterns associated with dysphoric mood. Psychosomatic Medicine, 71(5), 580–587.

Murri, M.B. *et al.* (2020). Instrumental assessment of balance and gait in depression: A systematic review. Psychiatry Research, 284, 112687. https://doi.org/10.1016/j.psychres.2019.112687

Stergiou, N., & Decker, L. M. (2011). Human movement variability, nonlinear dynamics, and pathology: Is there a connection? Human Movement Science, 30(5), 869–888.

Yogev-Seligmann, G., Hausdorff, J. M., & Giladi, N. (2008). The role of executive function and attention in gait. Movement Disorders, 23(3), 329–342

ACKNOWLEDGEMENTS: We thank the University of Derby Vice Chancellor's Partnership Award Scheme for funding support our lived experience advisory panel and thanks to Dan Walton, Alex Brent, and all participants for their invaluable contributions.