EFFECT OF EMOTION ON THE KINEMATICS OF GAIT

Melanie B. Cluss¹, Elizabeth A. Crane¹, M. Melissa Gross¹ and Barbara L. Fredrickson²

¹ University of Michigan, Ann Arbor, MI, USA
² University of North Carolina, Chapel Hill, NC, USA
E-mail: mgross@umich.edu Web: www.umich.edu/~mgross

INTRODUCTION

Emotion is expressed through multiple physiological channels including voice, facial expression, body movements, autonomic responses and subjective experience. Facial and bodily expressions of emotion can be recognized cross-culturally, suggesting a biological component (Ekman, 1971; Hejmadi, 2000). Although emotions have been recognized in individuals during walking, emotion-related gait characteristics have been described only qualitatively, e.g., “heavy-footed” for angry gait (Montepare, 1987). Such qualitative descriptions limit understanding of the biological phenomena underlying bodily expression of emotion. The effects of emotions on gait have not yet been described quantitatively.

The purpose of this study was to describe the effect of specific emotions on gait kinematics in trials in which the presence of the emotion was validated using both self-report and social consensus methods.

METHODS

Twenty-six undergraduate students (15 females, 11 males; 20±2.3 yrs) participated after giving informed consent. Before walking, each subject recalled an experience from their own lives in which they felt angry, sad, content, joy, or no emotion at all (neutral). After recalling a target emotion, participants walked across the lab. Whole body motion data were acquired using a video-based, 6-camera system. Front and side view videos were recorded at the same time as the motion data.

Participants performed three trials for each emotion in a block. After each trial, participants rated the intensity of eight emotions (4 target and 4 non-target) using a questionnaire. A 5-item Likert scale (0 = not at all; 1 = a little bit; 2 = moderately; 3 = a great deal; 4 = extremely) was used to score emotion intensity. Intensity scores of two (“moderately”) or greater were considered a “hit” (the subject felt the emotion). After blurring the faces so that facial expressions were not observable, the video clips were randomized and assembled into three different composite videos. The composite videos were shown to undergraduate student observers. After viewing each video clip, observers selected one of ten responses (Figure 1) corresponding to the emotion that they thought the walker felt during the trial.

Marker coordinate data were filtered at 6 Hz and gait parameters were calculated using Visual3D software. Stride length and velocity were normalized by body height. A general linear model was fitted using PROC GLM in SAS to determine the effects of emotion and gender on the dependent variables. Multiple pair-wise comparisons of the means were performed using Tukey's Honest Significant Difference test (p<0.05).

RESULTS AND DISCUSSION

Emotion validation. Self-report data indicated that the walkers felt the target
emotions at levels corresponding to “moderately” or above in all trials. For the neutral emotion, however, 42% of the trials failed to meet the criterion for neutrality, i.e., at least one emotion (typically content) was felt above the threshold value.

Validation data were collected from five female observers (20.6±4.7 yrs) on gait trials from a subset of subjects (n=16) (Figure 1). Recognition rates (side view) for sad, anger, neutral and content were 45%, 25%, 20% and 16%, respectively. Joy was recognized at chance levels (10%) with side view but was improved with front view (15%).

**Figure 1:** Observer responses for sad trials, viewed from the side.

Emotion kinematics. Normalized velocity, normalized stride length, cycle duration and velocity were significantly affected by emotion (Table 1). As expected for the two emotions associated with high levels of arousal (i.e., joy and anger), normalized velocities and normalized stride lengths were greater than in the neutral emotion trials. Sad trials had significantly longer cycle durations, shorter normalized stride lengths and slower normalized velocities than other emotion trials. Angular kinematic analyses are underway.

**SUMMARY/CONCLUSIONS**

This study is unique in describing the effects of specific emotions on gait in individuals for whom the presence of the emotions has been validated. The preliminary results indicate that gait kinematics change with emotion. Consistent with the reports for individuals with depression (Lemke, 2000), gait speed slows markedly with sadness. Although temporal-spatial kinematics were related to arousal levels, angular kinematics are needed to distinguish emotions with similar levels of arousal.

**REFERENCES**


**ACKNOWLEDGEMENTS**

We thank Zara Schulman, Zach Webster and Kelly Woznicki for their help with data collection and analysis.

**Table 1:** Gait characteristics for each emotion (mean ± SD).

<table>
<thead>
<tr>
<th></th>
<th>Anger</th>
<th>Sad</th>
<th>Neutral</th>
<th>Joy</th>
<th>Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cycle Duration (s)</td>
<td>1.01±0.09&lt;sup&gt;2&lt;/sup&gt;</td>
<td>1.13±0.13</td>
<td>1.09±0.07</td>
<td>1.01±0.10&lt;sup&gt;2&lt;/sup&gt;</td>
<td>1.07±0.08</td>
</tr>
<tr>
<td>Velocity (m/s)</td>
<td>1.41±0.22&lt;sup&gt;1,2&lt;/sup&gt;</td>
<td>1.10±0.21</td>
<td>1.19±0.13</td>
<td>1.42±0.23&lt;sup&gt;1,2&lt;/sup&gt;</td>
<td>1.29±0.19&lt;sup&gt;1,2&lt;/sup&gt;</td>
</tr>
<tr>
<td>Normalized Velocity (1/s)</td>
<td>0.83±0.12&lt;sup&gt;1,2&lt;/sup&gt;</td>
<td>0.66±0.13</td>
<td>0.71±0.08</td>
<td>0.84±0.13&lt;sup&gt;1,2&lt;/sup&gt;</td>
<td>0.76±0.11&lt;sup&gt;1,2&lt;/sup&gt;</td>
</tr>
<tr>
<td>Normalized Stride Length</td>
<td>0.83±0.07&lt;sup&gt;2&lt;/sup&gt;</td>
<td>0.73±0.08</td>
<td>0.76±0.05</td>
<td>0.84±0.08&lt;sup&gt;1,2&lt;/sup&gt;</td>
<td>0.80±0.08&lt;sup&gt;2&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

<sup>1</sup> Significantly different from neutral trials
<sup>2</sup> Significantly different from sad trials