BIOMECHANICAL ANIMATIONS COMMUNICATE EMOTION DURING WALKING

Lan Wei, Brendan Keen, Christine Herzog, Elizabeth Crane and Melissa Gross
School of Kinesiology, University of Michigan, Ann Arbor, MI 48109-2013
email: mgross@umich.edu, web: http://www.umich.edu/~mgross

INTRODUCTION

Emotion can be recognized in human movements from video displays showing only joint center motions [1,2]. These video displays are not derived from biomechanical models, and so limit the ability to integrate kinematic data with perceptual studies of emotion recognition. Although joint center displays generated from motion capture data have been used to study gender and person identification [3,4], biomechanical animations have not yet been validated in emotion recognition studies. Because view perspective has been shown to affect emotion, gender and person recognition [3-5], validation studies of emotion recognition using biomechanical displays should include different view perspectives.

The purpose of this study was to determine: (1) if emotions could be recognized from animated displays of gait data, (2) if emotion recognition rates were comparable to those obtained with video displays, and (3) if view perspective affected emotion recognition in animated displays.

METHODS

In a previous study [6], motion capture data were collected from 42 individuals during walking with five emotions: angry, joyful, content, sad and neutral. Sixty observers were shown side-view videos of the walking trials and then selected one of ten emotions they thought the walker was feeling. The 10 trials with the highest mean recognition rates for each emotion were included in this study. These 50 trials (5 emotions x 10 walkers) were generated by 32 walkers (44% male; 20.2 ± 2.8 yrs).

A single gait cycle from each walking trial was selected for analysis. Data from the right arm and right leg were not captured in the previous study, so left-side marker data were time-shifted and reflected to create marker data for the right-side limbs. The limbs were modeled with virtual markers placed at the joint centers of the shoulder, elbow, wrist, hip, knee, and ankle, and on the heads of the 3rd metatarsals and metacarpals and the heels. The trunk was modeled with virtual markers placed on the spine at the levels of C5, T6 and L3, and at the center of the head. Gait cycles were time normalized, and the endpoints were adjusted so that data at 0 and 100% of the cycle were the same.

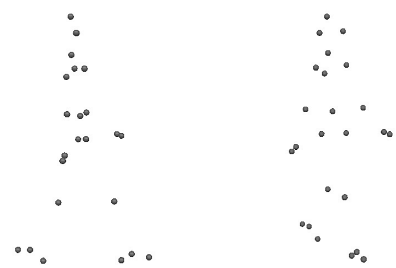

Figure 1: Side (left) and oblique (right) views of virtual markers in animated displays.

Animated displays of the virtual markers during the walking trials were exported from Visual3D as movie files displayed from side or oblique (45 deg between side and front) views (Figure 1). The walking speed, distance covered, and the number of gait cycles were the same in the video and animated displays of each walking trial. Each walking trial was looped so that it displayed three times in succession. The 100 videos (2 views x 50 walking trials) were ordered into three random sequences.
Observers (n=27; 59% female; 19.9 ± 1.6 yrs) viewed each of the 100 videos and selected one of ten emotions that they thought the walker was feeling. The mean recognition rate was calculated for each emotion and view. A Chi-square test was used to determine if the distribution of observer responses was different from chance. A mixed model with random walker and observer effects, and fixed effects of walker gender, observer gender, sequence, emotion and view was used to test for differences between means ($p < .05$).

RESULTS AND DISCUSSION

Observers were able to recognize the emotions felt by the walkers at levels that exceeded chance (10%) for all emotions and displays (Fig. 2). Side-view recognition rates were 33, 42, 53 and 25% less for animated than for video displays for angry, content, joyful and sad emotions, respectively. View interacted with emotion for the animated displays so that recognition was better with the side view for

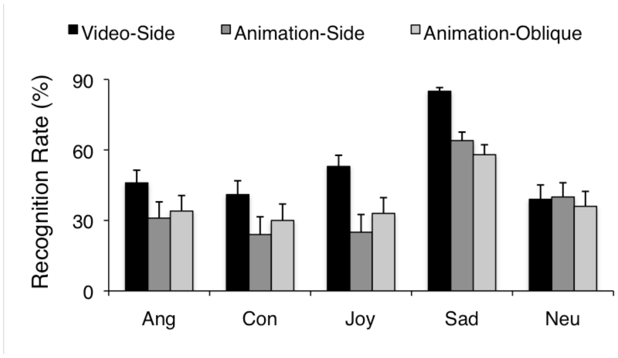

Figure 2: Recognition rates for video and animated displays of walking trials for each target emotion.

sad (9%) and with the oblique view for joy (32%). Recognition rates were not different among any displays for neutral trials. Recognition rates were not affected by video sequence, walker gender or observer gender.

The lower recognition rates with the animated displays were associated with greater confusion with neutral (Table 1). For content and joyful trials, decreased recognition with the animated displays was also associated with an increase in confusion between content and joy. Recognition rates for the non-target emotions were less than chance for all emotions and views except for disgust in angry.

Our results indicate that emotions felt by walkers were recognized with the animated displays but at rates less than video displays of the same walking trials. View affected recognition for two of the five target emotions. Our results demonstrate that animated displays generated from biomechanical models of the body can be used to test hypotheses related to emotion assessment during movement. Because the data used to create the animations can be used to calculate kinematics, our method can be used for future studies of the bodily expression of emotion in healthy individuals and individuals with affective disorders.

REFERENCES

1. Atkinson AP, et al. *Perception* 33, 717-746, 2004.
2. Roether CL, et al. *Current Biology* **18**, R329-330, 2008.
3. Troje NF, et al. *J Vision* **2**, 371-387, 2002.
4. Troje NF, et al. *Perception & Psychophysics* **67**, 667-675, 2005.
5. Gross MM, et al. *Proc. International Society for Research on Emotion,* Atlanta, GA, 2006.
6. Crane EA, et al., Emotion-related movement style during walking. *Submitted*.

ACKNOWLEDGEMENTS

Funded by NSF Grant (044430) to M. Gross.

Table 1: Mean recognition rates (%) for side-view video and animated displays.

Trial	Display	Angry	Content	Joyful	Sad	Neutral	Awe	Fear	Surprise	Disgust	None
Angry	Video	**46.2***	5.0	9.0	0.3	9.4	3.0	7.0	5.7	12.0	2.3
	Anim	**31.1**	4.8	9.3	5.9	13.0	0.4	10.4	4.8	16.3	4.1
Content	Video	4.7	**41.1***	9.4	8.0	22.1	4.0	2.0	1.0	5.4	2.3
	Anim	4.4	**24.4**	18.9	6.3	33.7	5.2	0.4	2.2	3.0	1.5
Joyful	Video	10.4	10.1	**52.7***	0.7	6.4	6.0	1.7	5.7	4.0	2.3
	Anim	15.9	13.7	**24.8**	5.9	14.4	5.6	5.6	2.6	7.4	4.1
Sad	Video	1.7	1.0	0.3	**84.6***	3.7	0.3	3.4	0.3	3.4	1.3
	Anim	0.7	9.7	1.1	**63.9**	8.2	2.2	7.4	2.6	3.0	1.1
Neutral	Video	6.0	21.7	4.0	12.7	**39.0**	3.7	4.0	1.3	4.7	3.0
	Anim	2.6	28.1	7.4	3.0	**39.6**	3.7	7.4	1.9	4.4	1.9

*p < .001