

‘ENRICHED AESTHETIC INTERACTION’ THROUGH SENSE OF DYNAMIC EMOTIONAL BODILY EXPRESSION WITH GARMENT: SCIENTIFIC INVESTIGATION OF MOTION CAPTURE EXPERIMENTATION

Eunjeong Jeon
Curtin university of Technology
eunjeong.jeon@postgrad.curtin.edu.au

ABSTRACT

The aim of this study is to understand human walking behaviors in the correlation and comparison between three different walk types (‘natural,’ ‘happy,’ and ‘fearful’) and three different garment types (‘normal,’ ‘happy,’ and ‘fearful’). Based on the scientific investigation of the Motion Capture Experiment (MCE), this study revealed that three different garment types (‘normal,’ ‘happy,’ and ‘fearful’) were affected differently independently of what type of walking the subjects performed. In addition, three walking types (‘natural,’ ‘happy,’ and ‘fearful’) were significantly different. In other words, the more participants felt happy, the more they moved their head in an up-down way and their hands from side-to-side, up-down, and forward-backward. The more participants felt fearful, the more they moved their head in side-to-side way. When wearing the “Happy-Garment” and “Fear-Garment,” participants’ hands (including arms) were more actively or passively engaged in the garment while walking, which manifested in slower walking and bodily expression (e.g. speed, position).

Keywords: emotion, bodily expression, walking, garment.

INTRODUCTION

Just as emotions can be generated from body movements (Ekman et al., 1980), the characteristic styles of walking in everyday activities can provide vital information for recognizing affective states, because a walker’s movement reflects his/her identity,

personality, culture, health conditions or emotions (James, 1890; Laban, 1980; Wallbott, 1982; Montepare, 1985,1987). Considering the relationship between walking styles and emotions, if a person is feeling happy, they may walk along with a spring in her step. Conversely, if a person is feeling fearful, they may walk with short, quick or hurried steps. My motivation in this study is to investigate simple and practical movements, such as identifying walking characteristics, as an everyday activity in the relationship between emotion and the garment a person is interacting with.

RELATED WORK

Some interesting research has been done in the area of the identification of walking styles and patterns in related emotions. James (1890) found that observing a person’s walking could reveal what the walker was feeling. This concurs with German Expression psychologist, Wallbott (1982), who maintained that a person’s character could be ascertained from a person’s style of walking. In addition, variations in walking have been found to exert a strong influence on personality and emotion (Walk & Homan, 1984; Montepare, 1985, 1987; Dittrich, et al., 1996). In particular, Montepare and his colleagues (1987) examined styles of walking to reveal certain emotions. They found that walking information enabled them to identify participants’ specific emotions (e.g. sadness, anger, happiness, pride). They revealed that emotional cues could be determined from the way someone walks, such as the amount of arm swing, stride length, heavy footedness, and walking speed. More specifically, they found that happy walking was

revealed in a subjects paced faster pace than other waling. Angry walking was found to be relatively heavier footed than the other walking. Also, they explained how some emotions, such as pride, were difficult to identify on the basis of walking information. The reason for the difficulty of detecting emotion, in particular pride, in walking information is caused by the lack of the stimulus displayed which leads subjects to exhibiting movements (Montepare et al., 1987). In addition, there were differences in walkers' ability to communicate particular emotions which were consistent with encoder differences noted in other nonverbal research (Davitz & Davitz, 1959). Montepare and his colleagues (1987) revealed why some walkers' were better at encoding certain emotions than others. One of the factors was identified based on how efficiently subjects encode the task, which is the stimulus with which they were asked to imagine the specific situations. In order to use the stimulus effectively, they suggested "an alternative emotion manipulation technique such as allowing targets to think of a personal situation in which they have experienced a particular emotion" (Montepare et al., 2003, p.41). This technique has been used successfully by researchers interested in facial sources of emotion information (Malatesta & Izard, 1984). This indicates the validity of using scenarios for participant observation in terms of how much subjects could communicate and encode particular emotions. Because of the, the research involved subjectivity (a personal situation) in terms of allowing subjects to think of a personal situation in which they had experienced a particular emotion (e.g., happiness and fear). This study particularity is focused on the relationship of clothing with the way people walk in the context of emotional engagement. Different types of walking may be influenced by different garment types. However, although a person's walking has an important relationship with clothing and persons' specific emotions, there is lack of research investigating this within the clothing field. Because of this lack of research, this study has been challenging, but an interesting and important area to explore.

THE RESEARCH AIMS

The major tasks in scientific investigation of MCE are to understand human walking behaviors in the context

of emotional aspects and examine the correlation and comparison between three different walk types ('natural,' 'happy,' and 'fearful') and three different garment types ('normal,' 'happy,' and 'fearful').

THE RESEARCH QUESTIONS AND OBJECTIVES

The key questions and focus of the present paper are identified:

- How does a specific emotion (e.g. fear, happiness) influence walking behaviors when people are interacting with a garment?
- How do different garment styles affect walking behaviors in terms of 'natural,' 'happy' and 'fearful,' walks?

The objectives of the research using Motion Capture (MC) were to explore the following questions:

- What body positions do participants use- such as movement of head, hands, legs, and trunk?
- This included: (1) Path, which examines ways of using step; (2) Velocity, which contributes to measuring speed influenced by emotion while wearing three discrete styles of a garment; and (3) Various range of body movement- such as side to side, forward and backward, up and down- in the context of different garment styles and different emotions.

METHOD

In the study, in order to test above research questions and objectives, I employed Motion Capture (MC) data, which is a specialized scientific research technique designed to measure a wide range of human activities and human body motion of intangible properties (e.g., arm swing and leg movement, head movement). In order to analyze collected motion data quantitatively, the random effect regression model using the 'Mixed' procedure in the SAS statistical analysis software and in statistical analysis of variance (ANOVA) was used in comparing three or more means. In this study, the technique involved videotaping individuals with reflective dots (markers) attached to participants' skin (forehead, left and right back of the hand, instep of the feet). Markers were used to calibrate the cameras and obtain participants' positions, which were recorded by the computer graphic environment. The Motion Capture technique and videotaping took place in the

School of Physiotherapy, Motion Capture Analysis Laboratory, Curtin University of Technology, Western Australia.

PARTICIPANTS

Eight females participated in the study. They were between 20 and 40 years of age. The eight subjects represented different races (Australian, Indian, and Namibian) and educational background (Interior Architecture, Urban Regional Planning, Psychology, Art, and Communication and Cultural Studies).

STIMULI SCENARIOS

In order to conduct “the Fear and Happy-Walk” trial effectively, in two weeks before the experiment, participants were asked to retrieve autobiographical memories from the happiest and the most fearful events in their past experience which I conducted in phase of participant interview sessions. Based on the participants’ interview responses, two short scenarios were developed for participants, as follows:

- Scenario 1 (“the Happy-Walk” trial): Please recall memories of meeting close friends who you haven’t seen for a long time. Then “pretend” you are walking in this situation.
- Scenario 2 (“the Fear-Walk” trial): Please, recall your memories of walking along a dark street when someone is following behind you. Then “pretend” you are walking in this situation.

As highlighted already, I employed “an alternative emotion manipulation technique” suggested by Montepare and his colleagues (2003), such as allowing participants to think of a personal situation in which they have experienced a particular emotion described above in order to help the walkers recall emotions effectively so that they perform emotional walk trials efficiently (Malatesta & Izard, 1984). The research considered only two basic emotions, happiness and fear, because normally people remember their happiest and the most fearful events vividly so they can communicate and decode the emotions efficiently (Montepare et al., 2003). Prior to the onset of the study, the scenarios were reviewed again by Professor Leon Straker (School of Physiotherapy), Professor Suzette Worden (School of

Design) and an early career fellow and biomechanic, Amity Campbell (School of Physiotherapy), for their appropriateness as descriptions of situations associated with the intended emotions.

CONCEPTUAL PROTOTYPE GARMENT- FEEL ME, TOUCH ME, PLAY WITH ME

In this study, three distinctive styles of the garment were provided for the participants. One, called the “Normal-Garment”, was the garment that each subject was asked to wear. This was black leggings and a black tight and stretchable top. The other, called the “Happy-Garment” and “Fear-Garment”, was the conceptual prototype garment, *Feel me, Touch me, Play with me* (Figure 2).



Figure 1. The first image on the left side shows “Natural-Garment.” The middle image is called “Happy-Garment” and the last image on the right side is called “Fear-Garment.”

This garment was designed to transform into various shapes and styles depending on what moods or emotions a person had and how a person wrapped and used it in various ways (e.g. a sleeveless half coat, a short waist-line hood jacket, trousers, a skirt, a piece of cushion and so on). The “Happy-Garment” was a sleeveless-half-length-coat style. On the other hand, the “Fear-Garment” was a sleeveless-waist-jacket style with a hood (Figure 3).



Figure 2. Having different inside and outside forms of the conceptual prototype, *Feel me, Touch me, Play with me*: the first image on the left is called “Happy-Garment.” The image on the right is called “Fear-Garment,” and the middle image is when turned the garment from the first image over.

PROCEDURE

The subjects performed the experiment consisting of 27 trials – using 3 different walk types ('natural,' 'happy,' and 'fearful'), and 3 different garment types ('normal,' 'happy,' and 'fearful').

- Participants were asked to perform three trials in terms of the 'Natural-Walk' when worn with the "Normal-Garment," "Happy-Garment" and "Fear-Garment" (3 + 3 + 3).
- Participants were asked to perform three trials in terms of the 'Happy-Walk' when worn with the "Normal-Garment," "Happy-Garment" "Fear-Garment" (3 + 3 + 3).
- Participants were asked to perform three trials in terms of the "Fear-Walk" when worn with the "Normal-Garment," "Happy-Garment," and "Fear-Garment" (3 + 3 + 3).

The "Natural-Walk" was defined as the way participants walked with no intended emotion. On the other hand, the "Happy" and "Fear-Walk" were defined as the way they walked with the intended emotion (e.g., happiness and fear) as stated above. "Happy-Walk" participants were not allowed to float foot in the air (e.g. jumping). Participants' involvement in this research included the activity in the Motion Capture Laboratory. Dressed in a black top and leggings with 8 markers located on the hands, feet and head, each subject performed three trials (Figure 2).

The experimental protocol procedure was explained in detail to each walker. For example, for the "Fear-Walk" trial:

- Participants were asked to begin with a warm up for 3 minutes (e.g., any stretching, breathing exercises).
- Participants were asked to look at a written copy of a scenario, recalling their fearful experiences.
- When participants were ready to be filmed, the light in the lab was dimmed.
- Participants were asked to walk on the platform.

ANALYSING RESEULTS

A total of 27 trials for a subject were achieved. In total, 216 gait gestures were collected and analyzed by analysis of variance (ANOVA) and a random effect

regression model using the 'Mixed' procedure in the SAS statistical analysis software.

COMPARISON OF THE SSMHEAD(SIDE- TO-SIDE MOVEMENT OF THE HEAD)

In the quantitative analysis, the ANOVA showed that SSMHead differed between walk types ($p = 0.002$), but not between garment types ($p = 0.798$). The summary of the mean scores and their differences for different walk and garment types are as follows:

Walk type	LS Mean	p-values for pairwise comparisons	
		Happy	Natural
Fear (FW)	54.2	0.213	0.005
Happy(HW)	48.2		0.020
Natural(NW)	36.9		
Garment type	LS Mean	p-values for pairwise comparisons	
		Happy	Natural
Fear (FG)	45.0	0.510	0.818
Happy(HG)	48.1		0.668
Natural(NG)	46.1		

Table 1. Mean score and p -value of the comparison of the side to side movement of head between walk types and garment types in statistical Analysis of variance (ANOVA)

The results of the data (Table 1) showed that there were significant differences in how much the head moved (side-to-side) between walk types in conjunction with emotions. It appeared that the style of the "Fear-Walk" (FW), which was emotionally translated into fearful gaits, showed significant difference in a higher score ($m = 54.2$). The "Natural-Walk (NW)" style was different from the other walk types in a lower score ($m = 36.9$). In comparison, the "HW" and "NW" ($p = 0.020$) and the "FW" and "NW" ($p = 0.005$) were found to be significant for head side to side movement. In other words, comparing walk styles, participants moved their head more from side-to-side during the "FW" than in the "NW." Furthermore, participants moved their head more from side-to-side during the "HW" than in the "NW." Conversely, there were no significant differences in walk styles between garment types.

COMPARISON OF THE UDHEAD(UP-DOWN MOVEMENT OF THE HEAD)

The ANOVA showed that UDMHead differed between walk types ($p = 0.001$), but not between garment types ($p = 0.971$). A summary of the approximate mean scores and their differences for different walk and garment types is as follows:

Walk type	LS Mean	p-values for pairwise comparisons	
		Happy	Natural
Fear (FW)	40.9	0.019	0.144
Happy(HW)	52.0		0.0003
Natural(NW)	34.0		
Garment type	LS Mean	p-values for pairwise comparisons	
		Happy	Natural
Fear (FG)	42.2	0.887	0.921
Happy(HG)	42.9		0.809
Natural(NG)	41.8		

Table 2. Mean score and p- value of comparison of the up-down movement of head between walk types and garment types in statistical Analysis of variance (ANOVA)

The results of the data (Table 2) indicate that the style of the “Happy-Walk” (HW) was significantly different from the others (higher score, $m = 52.0$), but there were no differences between garment types. Comparisons of the “HW” and “FW” ($p = 0.019$) and the “HW” and “NW” ($p = 0.0003$) were found to be significant for head up-down movement. In other words, in the “HW” style which was the walk type emotionally associated with a state of happiness, participants moved their head more in an up-down way than in both “FW” and “NW” types.

COMPARISON OF THE FBHAND(FORWARD-BACKWARD VELOCITY OF THE HAND)

The ANOVA showed that FBVHand differed between walk types ($p = 0.001$), and also between garment types ($p < 0.0001$). Blow is a summary of the approximate mean scores and their differences for different walk and garment types:

Walk type	LS Mean	p-values for pairwise comparisons	
		Happy	Natural
Fear (FW)	715.2	0.0007	0.899
Happy(HW)	1149.8		0.001
Natural(NW)	730.6		
Garment type	LS Mean	p-values for pairwise comparisons	
		Happy	Natural
Fear (FG)	607.2	0.922	<0.0001
Happy(HG)	595.3		<0.0001
Natural(NG)	1393.0		

Table 3. Mean score and p- value of comparison of the forward-back velocity of hand between walk types and garment types in statistical Analysis of variance (ANOVA)

The results (Table 3) showed that, when considering the walk type in the context of emotions, there were significant differences in how much the hand moved (forward-backward velocity) between walking types. It appeared that the “Happy-Walk (HW)” type (higher score, $m = 1149.8$) was significantly different from the others. In a comparison, the “HW” and “FW” ($p = 0.0007$) and the “HW” and “NW” ($p = 0.001$), there were significant differences. In other words, participants’ hand (arm) moved much faster in a forward and backward way during the “HW” than in both of the “NW” and “FW.” Moreover, participants moved their hand speed (forward and backward) differently between the “FW” and “HW”, and between “NW” and “HW.”

Conversely, considering the garment types in association with emotional engagement, there was a significant difference in how much the hands moved (in terms of velocity of forward-backward) between the “Normal-Garment (NG)” and both of the “Fear-Garment (FG)” and the “Happy-Garment (HG).” The data showed that the “NG” (higher score, $m = 1393.0$) was different from both of the “HG” and “FG.” In other words, participants moved faster with their hand (arm) movements in a forward and backward way when wearing the “NG” than the “HG” and “FG.” However, there was no significant difference in how much the velocity of the hand moved between the “HG” and “FG.”

COMPARISON OF THE SSHAND(SIDE-TO-SIDE VELOCITY OF THE HAND)

The ANOVA showed that SSVHand differed between walk types ($p = 0.0003$), and also between garment types ($p = 0.013$). Blow is a summary of the approximate mean scores and their differences for different walk and garment types:

Walk type	LS Mean	p-values for pairwise comparisons	
		Happy	Natural
Fear (FW)	272.0	0.0009	0.637
Happy(HW)	472.3		0.0002
Natural(NW)	244.8		
Garment type	LS Mean	p-values for pairwise comparisons	
		Happy	Natural
Fear (FG)	251.8	0.293	0.004
Happy(HG)	312.0		0.053
Natural(NG)	425.3		

Table 4. Mean score and p -value of comparison of the side-to-side velocity of hand between walk types and garment types in statistical Analysis of variance (ANOVA)

The results (Table 4) show that the “Happy-Walk” (HW) type (higher score, $m = 472.3$) was different from the others. “Normal-Garment (NG)” was different (higher score, $m = 425.3$) to both the “HG” and “the Fear-Garment (FG).” In addition, comparing the “NG” with “FG” ($p = 0.004$) showed a significant difference in how much faster participants moved their hand in a side-to-side movement. In other words, considering the side to side velocity of hands, participants used their hand (arm) much faster into the “HW” type than the “FW” and “NW” types. Conversely, participants moved their hand (arm) faster using side-to-side movement while wearing the “NG” type.

COMPARISON OF THE UDHAND(UP-DOWN VELOCITY OF THE HAND)

The ANOVA showed that UDVHand differed between walk types ($p < 0.0001$), and also between garment types ($p = 0.0001$). Blow is a summary of the approximate mean scores and their differences for different walk and garment types:

Walk type	LS Mean	p-values for pairwise comparisons	
		Happy	Natural
Fear (FW)	417.6	<0.0001	0.184
Happy(HW)	690.1		<0.0001
Natural(NW)	332.6		
Garment type	LS Mean	p-values for pairwise comparisons	
		Happy	Natural
Fear (FG)	412.0	0.657	0.0005
Happy(HG)	383.7		0.0001
Natural(NG)	644.7		

Table 5. Mean score and p -value of comparison of the up-down velocity of hand movement between walk types and garment types in statistical Analysis of variance (ANOVA)

Results of the data (Table 5) showed that the “Happy-Walk (HW)” type (higher score, $m = 690.1$) was different to both the “Natural-Walk (NW)” and “Fear-Walk (FW).” In addition, comparing the “FW” and “HW” ($p < 0.0001$) and the “HW” and “NW” ($p < 0.0001$) showed significant differences in how much faster subjects moved their hand in an up-down movement, with more moving the “HW” than both the “FW” and “NW.”

Based on the garment types, the Normal-Garment (NG)” was different (higher score, $m = 644.7$) from both of the other garments. Results of the data also showed significant differences between the “NG” and “FG” ($p = 0.0005$) and between the “NG” and “HG” ($p = 0.0001$) in how much faster participants moved their hand in an up and down movement. In this sense, participants moved their hand faster when wearing the “NG” than the others. However, there was no significant difference between the “HG” and “FG” in the speed of hands’ up and down movement.

COMPARISON OF THE FBRHAND (FORWARD-BACKWARD RANGE OF THE HAND MOVEMENT)

The ANOVA showed that FBRH differed between walk types ($p < 0.0001$), and also between garment types ($p < 0.0001$). A summary of the approximate mean scores and their differences for different walk and garment types appear below:

Walk type	LS Mean	p-values for pairwise comparisons	
		Happy	Natural
Fear (FW)	175.8	<0.0001	0.020
Happy(HW)	335.2		0.002
Natural(NW)	243.5		
Garment type	LS Mean	p-values for pairwise comparisons	
		Happy	Natural
Fear (FG)	162.3	0.665	<0.0001
Happy(HG)	174.6		<0.0001
Natural(NG)	417.5		

Table 6. Mean score and *p*-value of comparison of the forward-back range of hand movement between walk types and garment types in statistical Analysis of variance (ANOVA)

The results (Table 6) show that all three walk types were significantly different from each other - between "HW" and "FW" ($p < 0.0001$), "HW" and "NW" ($p = 0.002$) and "NW" and "FW" ($p = 0.020$) - in how much participants moved their hand in a forward and backward way. "Happy-Walk (HW)" type (higher score, $m = 335.2$) was different to both the "Natural-Walk (NW)" and "Fear-Walk (FW)." In other words, in the "HW" style which was the walk type emotionally associated with a state of happiness, participants moved their hand more in a forward and backward way than in both the "NW" and "FW" types. Furthermore, comparing the "NW" with "FW" ($p = 0.020$) showed that in the "NW" style, which was defined as the way participants walked with no intended emotion, participants moved their hand more in a forward and backward way than "FW."

Considering garment types, the "Normal-Garment" was significantly different (higher score, $m = 417.5$). Comparing "NG" and "HG" ($p < 0.0001$) and "NG" and "FG" ($p < 0.0001$), showed significant differences in how much participants moved their hand in a forward and backward way. In other words, when participants wore the "NG" which was black leggings or jeans and a black tight and stretchable top, their hand moved more in a forward and backward way than for both of the "FG" and "HG."

COMPARISON OF THE UDRHAND (UP-DOWN RANGE OF THE HAND MOVEMENT)

The ANOVA showed that UDRHand differed between walk types ($p < 0.0001$), and also between garment

types ($p < 0.0001$). A summary of the approximate mean scores and their differences for different walk and garment types is shown in the Table 7:

Walk type	LS Mean	p-values for pairwise comparisons	
		Happy	Natural
Fear (FW)	73.7	<0.0001	0.616
Happy(HW)	138.7		<0.0001
Natural(NW)	78.6		
Garment type	LS Mean	p-values for pairwise comparisons	
		Happy	Natural
Fear (FG)	78.9	0.787	<0.0001
Happy(HG)	76.3		<0.0001
Natural(NG)	135.9		

Table 7. Mean score and *p*-value of comparison of the up-down range of hand movement between walk types and garment types in statistical Analysis of variance (ANOVA)

In conclusion, the "Happy-Walk (HW)" was significantly different (higher score, $m = 138.7$) to the other two walk types. In a comparison of the "HW" and "FW" ($p < 0.0001$) and the "HW" and "NW" ($p < 0.0001$), there were significant differences in how much participants moved their hand in an up and down way. In other words, in the "HW" style, which was defined as the way participants walked when intending a happy emotion, participants moved their hand more in an up and down way than "FW." Furthermore, in the "NW" style, which was defined as the way participants walked with no intended emotion, they moved their hand more in an up and down way than "FW."

Based on the garment types, the "Normal-Garment (NG)" was significantly different (higher score, $m = 135.9$) to both the other garments. Comparing the "NG" with both the "HG" ($p < 0.0001$) and "FG" ($p < 0.0001$) showed significant differences. In other words, into the "NG" style, their hand moved more in an up and down way than for both the "FG" and "HG."

COMPARISON OF THE SSRHANDM (SIDE-TO-SIDE RANGE OF THE HAND MOVEMENT)

The ANOVA showed that SSRHand differed between walk types ($p = 0.0005$), and also between garment types ($p = 0.0008$). A summary of the approximate mean scores and their differences for different walk and garment types is given below (Table 8):

Walk type	LS Mean	p-values for pairwise comparisons	
		Happy	Natural
Fear (FW)	62.0	0.0004	0.687
Happy(HW)	118.7		0.0013
Natural(NW)	68.0		
Garment type	LS Mean	p-values for pairwise comparisons	
		Happy	Natural
Fear (FG)	58.9	0.340	0.0003
Happy(HG)	73.3		0.0054
Natural(NG)	116.6		

Table 8. Mean score and *p*-value of comparison of side-to-side range of hand movement between walk types and garment types in statistical Analysis of variance (ANOVA)

The results of the data showed that there were significant differences in how the hand (side-to-side) varied between walk types in conjunction with emotions. It appeared that the style of the “Happy-Walk” (FW), which was emotionally translated into happy gaits, showed significant difference in a higher score ($m = 118.7$). In addition, comparing the “FW” and “HW” ($p = 0.0004$) and the “HW” and “NW” ($p = 0.0013$) showed significant differences in how much participants moved their hand in a side to side movement. In other words, in comparing walk styles, participants moved their hand more from side-to-side during the “HW” type than in both the “FW” and the “NW” types.

Based on the garment types, the “Normal-Garment (NG)” was different (higher score, $m = 116.6$) to both the other garments. The results of the data also showed significant differences between the “NG” and “FG” ($p = 0.0003$). But in comparing the “NG” with “HG” ($p = 0.0054$) there was marginal difference in how much participants moved their hand in a side to side movement. In other words, participants moved their hand more in a side to side way in the “NG” type than both the “HG” and “FG” types.

COMPARISON OF THE WALKV (WALK VELOCITY)

The ANOVA showed that WALKV differed between walk types ($p = 0.007$), but not between garment types ($p = 0.766$). Below is a summary of the approximate mean scores and their differences for different walk and garment types (Table 9):

Walk type	LS Mean	p-values for pairwise comparisons	
		Happy	Natural
Fear (FW)	1.17	0.169	0.063
Happy(HW)	127		0.0017
Natural(NW)	1.03		
Garment type	LS Mean	p-values for pairwise comparisons	
		Happy	Natural
Fear (FG)	1.18	0.823	0.477
Happy(HG)	1.16		0.625
Natural(NG)	1.12		

Table 9. Mean score and *p*-value of comparison of walk velocity between walk types and garment types in statistical Analysis of variance (ANOVA)

The results showed that the “Happy-Walk (HW)” type was different (higher score, $m = 1.27$) to the other walk types. In addition, comparing the “NW” and “HW” ($p = 0.0017$) showed significant differences in how much faster the participant walked. In other words, comparing walk styles, participants walked faster during the “HW” than in both the “FW” and the “NW.”

Based on the garment types, there were no significant differences between garments.

COMPARISON OF THE STEP LENGTH

The ANOVA showed that STEPL differed between walk types ($p = 0.0004$), but not between garment types ($p = 0.571$). Below is a summary of the approximate mean scores and their differences for different walk and garment types (Table 10):

Walk type	LS Mean	p-values for pairwise comparisons	
		Happy	Natural
Fear (FW)	632.9	0.0038	0.296
Happy(HW)	672.5		0.0001
Natural(NW)	619.1		
Garment type	LS Mean	p-values for pairwise comparisons	
		Happy	Natural
Fear (FG)	638.6	0.872	0.410
Happy(HG)	636.4		0.325
Natural(NG)	649.5		

Table 10. Mean score and *p*-value of comparison of step length between walk types and garment types in statistical Analysis of variance (ANOVA)

The results showed that there were significant differences in step length between walk types in conjunction with emotions. It appeared that the style of the “Happy-Walk” (FW), which was emotionally translated into happy gaits, showed significant difference in a higher score ($m = 672.5$). In addition, comparison of the “FW” and “HW” ($p = 0.0038$) and the “HW” and “NW” ($p = 0.0001$) showed significant differences in how much participants paced longer movements. In other words, in comparing walk styles, participants walked using longer steps during the “HW” than in both the “FW” and the “NW” types.

Based on the garment types, there were no significant differences between garments.

DISCUSSION

This study demonstrated that different walking types, including bodily expression, can be affected not only by specific emotions but also by specific garment types. More specifically, the study has compared with several walking characteristics and body movement patterns which differentiated naturalness, happiness, and fear as revealed by walking based on Motion Capture data.

There were unique patterns based on: hand range of movement (e.g. forward-backward, side to side, up and down); hand velocity (e.g. forward-backward, side to side, up and down); head movement; walk velocity; and step length in comparison with three different walk types (‘natural,’ ‘happy,’ ‘fearful’) and three different garment types (‘normal,’ ‘happy,’ ‘fearful’). Results obtained in this study for the “Happy-Walk”, which was the walk type emotionally associated with a state of happiness indicate subjects move their head more in up-and-down way; have more of an arm swing side-to-side, up-down, and forward-backward way; and appeared to relatively faster paced with longer stride lengths than the other walking styles. Conversely, the “Fear-Walk”, which was the walk type emotionally associated with a state of fear was found that subjects move their head more in a way side-to-side way than the other walking styles. In addition, the “Normal-Garment” when subjects wore was found that they swing their hands more and faster in a side-to-side, up-down, and forward-backward way than the other garment styles. In addition, results indicate that

there were significant differences in the extent of the participants’ range of hand movements (e.g., the hands’ velocity side to side, up-down, forward-backward) between garment types in conjunction with emotions. The different garments types (‘normal,’ ‘happy,’ and ‘fearful’) showed participants’ hands moved faster side-to-side, up and down, and forward-backward, when subjects wore the “Normal-Garment” than both the “Happy-Garment” and “Fear-Garment.” When participants wore the “Normal-Garment” their hands were positioned more side-to-side, with up and down movements, and forward-backward than for the others. The results suggest that the reason why both the “Happy-Garment” and “the Fear-Garment” were found to have less arm movement (e.g., less using arm swing, speed, position, and so on) than the “Normal-Garment” seems to be dependent on the hand position. For example, participants’ hands (whether left or right hand or both of hands) were positioned to cross and go around body and to interact with both the garments (“Happy-Garment” and “the Fear-Garment”) reviewed by video recording. This aspect indicates that subjects wearing a garment which made them feel happy may produce more bodily engagement and interaction with the garment, revealing a marked discrepancy between happy walking when subjects wore a natural garment and happy walking when they wore a happy garment. In this sense, they seemed to have a single focus, mainly towards the garment. In a similar manner, when subjects wore the “Fear-Garment,” they seemed to be aware of their body with slower and lesser step length. Their bodily tension involved controlled and restrained movement acting as if to watch out for somebody in order to be in a self-defense mode against social-psychological danger. Their hands, for instance, were folded or firmly grasping the garment, which influenced the arm’s movement (e.g., less use of arm swing, speed, position, and so on). These dynamic qualities of noncyclical movements were analyzed by 2D video data. In short, this study revealed participants’ walking characteristics in relationship with their emotions. The results obtained emotionally involved in walking characteristics (e.g. “Happy-Walk” and “Fear-Walk”) had similar results compared to previous research on emotion detection from gait characteristics (Montepare et al., 2003). However, unlike the aforementioned pattern of

emotionally intended walking, the pattern of walking characteristics associated with wearing different garment types differed across the emotional conditions for each walker. A likely explanation for this discrepancy is the extent of the hands' range of movement differences. For example, participants' hands moved faster in a forward-backward, side to side, and up and down way when subjects wore the "Normal-Garment" than both the "Happy-Garment" and "Fear-Garment." When participants wore the "Normal-Garment" their hands were positioned more for forward-backward, side-to-side, and up and down movements than for the others. Finally, the "alternative emotion manipulation technique" (Montepare et al., 2003) employed, was valid and effective as a way of incorporating personal subjective experience into walking trials in terms of retrieving autobiographical memories from specific happiest and the most fearful events in their past experience. However, there were some difficulties for participants in switching emotions quite quickly while interacting with three styles of a garment. From this perspective the method used to evoke emotion may require further research in a real-life situation in order to collect the data more effectively and precisely. For example, some video footage would be useful to record an actual fearful or 'happy' site (i.e. fearful in an alley way at night, happy in a park or shopping mall and so on).

CONCLUSION

The aesthetic continuum is our organization of the elements of the movement pattern we are performing, the more unity of "feeling" we receive from our own motions. The perception of human motion or movement, particularly walking, has specific characteristics in conjunction with the form of interaction occurring. From the study, a walker of well-executed movements sparked by specific purposes (e.g. type of emotions and a garment) yields a correspondingly greater emotion (e.g., happiness and fear). The study revealed that the garments affected the way people walk differently independently of what type of walking the subjects performed. In addition, the three walking types are significantly different in terms independent of which emotion ('natural,' 'happy,' 'fearful') people felt. In other words, the more participants felt happy, the more they moved their

head in an up-down way and their hands from side-to-side, up-down, and forward-backward. The more participants felt fearful, the more they moved their head in side-to-side way. When wearing the "HG" and "FG," participants' hands (including arms) were more actively or passively engaged in the garment while walking, which manifested in slower walking and bodily expression (e.g. speed, position). From the experiment, understanding a person's walk characteristic in the relationship between emotions and garments could be an important source to inform designers how movement (e.g., how body is shaped and patterned and how people wrap their bodies) is affected by a person's emotion and type of garment. In this sense, this study offers insights into how a garment can be designed precisely to adapt to body movements and bodily transformation through the way people constantly change moods and emotions. When fulfilling this design principle in the context of clothing, comfort can be maximized.

ACKNOWLEDGEMENT

I would like to acknowledge my supervisor, Professor Suzette Worden (School of Design), Professor Leon Straker (School of Physiotherapy), and an early career fellow and biomechanic, Amity Campbell (School of Physiotherapy), who provided valuable comments, support, and their assistance in this work.

REFERENCES

This research is linked to the ARC Linkage project "Innovative Solutions for Wool Garment Comfort through Design" (Project ID: LP0775433), in conjunction with the Wooldesk at DAFWA (Department of Agriculture and Food, Western Australia).

- Davitz, J. R., & Davitz, L. J. (1959). The communication of feelings by content-free speech. *Journal of Communication*, 9, 6-13.
- Dittrich, W. H., Troscianko, T., Lea, S. E. G., & Morgan, D. (1996). Perception of emotion from dynamic point-light displays represented in dance. *Perception*, 25, 727-738.
- Ekman, P., Freisen, W.V., O'Sullivan, M., & Scherer, K. R. (1980). Relative importance of face, body, and speech in judgments of personality and affect. *Journal of Personality and Social Psychology*, Vol. 38, 270-277
- James, W. (1890) *Principles of psychology*. New York: Henry Holt.
- Laban, R. (1980) *The mastery of movement*. 3rd eds revised by Lisa Ullmann. Play Inc, Boston.

Malatesta, C. Z., & Izard, C. E., (1984). The facial display of emotion: Young, middle-aged, and older adult expressions. In C. Z. Malatesta and C. E. Izard (Eds.). *Emotion in adult development*. Beverly Hills, C.A.: Sage Publications.

Montepare, J. M., & Goldstein, S. B., & Clausen, A (1987). The identification of emotions from gait information. *Journal of Nonverbal Behavior*, Vol. 11, Issue 2, Spring 1987, Human Sciences Press.

Montepare, J. M. (1985). *Dynamic sources of age and gender information: Influences of voice and gait*. Unpublished doctoral dissertation: Brandeis University.

McArthur, L. Z., & Baron, R. M. (1983). Toward an ecological theory of social perception. *Psychological Review*, 90, 215-238

Walbott, H. C. (1982). Gait, gestures, and body movement. *Journal of Nonverbal Behavior*, 7, 20-32.

Walk, R. D., & Homan, C. P. (1984). Emotion and dance in dynamic light displays. *Bulletin of the Psychonomic Society*, 22, 437-440