Bipedics: Towards a new category of kinesics. An empirical investigation of the expression of attitude, and emotion, through simple leg and foot gesture

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Abstract

Previous research in the field of nonverbal behaviour and communication has neglected a possible link between simple leg and foot posture and movement (or bipedic gesture) and the expression of attitudes and emotions. The present investigation explored this link in two studies; Study 1 employed analysis of a corpus that consisted of video recordings of first encounter dyadic interaction alongside interactants' self-reported measures of liking for their conversation partner. Study 2 employed a quasi-experimental design whereby participants were asked to interpret liking between interactants portrayed by mannequin dolls. The results from both studies support a link between certain bipedic gestures and the expression of attitudes and emotions. It is hoped that these findings stimulate further research on this neglected part of the human body and its communicative affordances.

Keywords: attitude display, bipedic gesture, kinesics, leg and foot positioning

1. Introduction

In 2004 the Heinz Nixdorf museum began the employment of an anthropomorphic artificial agent to interact with its visitors (Wachsmuth, 2008). Based at what is reputed to be the world's largest computer museum and known simply as 'Max' his design team at Bielefeld University noted communicative competencies such as 'small talk', demonstrable personality traits, and the expression of a variety of emotions (Pfeiffer et al., 2011).

Being a three-dimensional, full-bodied artificial agent Max communicates with visitors and colleagues using a variety of sense modalities. For instance; the hearing sense modality being activated via sound from Max's speech and the visual sense modality being activated via Max's facial expression, bodily gesture and posture. All of these conveying meaning and managing interaction (e.g. via turn management) through a synchronized interplay of speech and bodily communication.

However, in respect to the latter of these when observing Max in action he nearly always appears standing behind a desk, or projected from only the waist up. This, it would appear, is based on the assumption that the lower half of the body plays no part in nonverbal gestural or postural communication.

This assumption may arise from an absence in the scientific research literature investigating the role that the lower half of the human body – the legs and the feet – might play in nonverbal communication.

A corollary of this follows like so – does Max lose any aspect of communication through the loss of one half of his body (the lower half)? And, beyond human-machine interaction, what role might legs and feet play in human to human multimodal communication?

Research that investigates these questions not only contributes to a body of research seeking an understanding of nonverbal, multimodal communication, but also incorporates practical applications. These include; (i) informing the development of communicatively convincing full-bodied artificial agents of the future, with (ii) further commercial application to service encounter situations using *Artificial Embodied Agents* (Salomonson et al., 2013). As well as (iii) contributing to social skills training (Argyle, 1988), which in turn (iv) can be of utility to professionals that rely on interview interaction for the gathering of information (e.g. medicine, therapy and law enforcement).

2. Background

This investigation's empirical journey starts with Ekman & Friesen's (1969b) well known and influential taxonomy which provides for five categories of nonverbal behaviour; *Emblems*, *Illustrators*, *Affect Displays*, *Regulators* and *Adaptors* (Ekman & Friesen, 1969b). These categories, or modes of communication, rely exclusively upon the visual sense modality and for the most part require no sound to transmit meaning (the snapping of fingers and clapping of hands being obvious exceptions). Within this taxonomy nonverbal communication primarily transmits information pertaining to emotion, its intensity and nature, in four ways; (i) body acts, (ii) body positions, (iii) facial expression, and (iv) head orientation (Ekman and Friesen, 1967). However, within their taxonomy and 'four ways' of encoding emotion there is no room for the role that interactants' legs or feet might play. Indeed, within the specific context of deception cue leakage, the authors state that, "The feet and legs are almost in all respects the worst nonverbal senders" (Ekman & Friesen, 1969a, p.94).

This theoretical and empirical position has both represented and influenced the body of research such that, as already noted, previous research that examines the role that simple leg/foot gesture plays in multimodal communication is limited.

James (1932) was one of the first to explore the relationship between bodily posture, movement and the expression of emotion by analysing 1,200 observations of 347 different postures. However, in spite of the extensive analyses and use of a full-body mannequin / human actor the study failed to take any account of the lower half of the human body (James, 1932).

Smith-Hanen's (1977) study of nonverbal communication in therapeutic settings found that different leg positions were significantly related to perceptions of warmth and empathy, but also noted that, "…the effects of the various leg positions were more complex than the arm positions" (Smith-Hanen, 1977, p.87). Harrigan and colleagues (1985) reported in their study of physicians' use of nonverbal communication that certain symmetric and asymmetric leg positions were significantly related to participant ratings of rapport (Harrigan et al., 1985). In the intervening period between James' (1932) study and those of Smith-Hanen (1977) and Harrigan et al. (1985) other studies have referred in passing to this part of the human body. For instance; linked with quasi-courtship behaviours in therapeutic sessions (Dittmann et al., 1965; Scheflen, 1964, 1965) interviews (Ekman, 1969a) and social encounters (Dittmann & Llewellyn, 1969; Mehrabian, 1968, 1969, 1972/2007). As Harrigan sums up, when compared to research upon the head, face and hands there has been a neglect and a "lack of comprehensiveness" in respect to arms and legs in nonverbal communication (Harrigan, 2008, p.178).

More recently Dael and colleagues (2011, 2012) have developed their Body Action Posture (BAP) coding system in an attempt to code the expression of emotion by all parts of the human body. Using the GEMEP (Geneva Multimodal Emotion Portrayals) corpus their studies however have failed to account for simple leg/foot movement, and position, citing visibility and technical difficulties (Dael et al., 2012).

The present investigation did find one source of material relating to this part of the human body; popular literature (Navarro, 2008; Pease, 1991). Caution was taken in the handling of this material due to a commonly cited lack of scientific method (Harrigan, 2008) and reported "grossly exaggerated claims" (Lecci et al. 2008. p.70). However, careful analysis of these works provided for a basic taxonomous model of simple leg/foot movement and positioning, referred to as *bipedic gestures* in the present investigation, which were then aligned to different emotions and attitudes for the purpose of experimental testing (Fig. 1 below).

Positive Emotion & Attitude	Positive Foot Pointing (standing)	**Basic Emotions**: joy and/or surprise
	Positive Leg Crossing (standing)	**Circumplex (Dimensional) Model of Emotion**: positive valence, high or low arousal
	Positive Leg Crossing (seated)	**Attitudes**: friendliness, submissiveness, either stable or temporal
Negative Emotion & Attitude	Negative Foot Pointing (standing)	**Basic Emotions**: fear, disgust, anger or distress
	Negative Leg Crossing (standing)	**Circumplex (Dimensional) Model of Emotion**: negative valence, high or low arousal
	Negative Leg crossing (seated)	**Attitude**: hostility, dominance, either stable or temporal

Fig. 1: The bipedic gesture model; gestures aligned to different models' concepts of emotions and attitudes.

In respect to the concepts of attitude and emotion there is a significant absence of any one theoretical model which has gained consensus within the scientific literature. In their study Dael and colleagues (2012) list three types of emotion theory; Basic Emotion Models, Dimensional Models, and Componential Models. Reviewing research on attitude Bohner & Dickel (2011) define attitude as, "an evaluation of an object of thought" and highlight two important features; attitudes as being either stable cognitive constructs within memory or something more temporary (Bohner & Dickel, 2011, p.392). Argyle (1988) reports that factorial analysis studies of attitude research reveals two dimensions; Dominance-Submissiveness and Friendliness-Hostility. Furthermore, Argyle argues that emotions and attitudes can be viewed as broadly similar behavioural phenomena based on (i) frequently similar nonverbal display characteristics, and (ii) similar speeds of display onset/cessation (Argyle, 1988, p.86).

Taking the lead from Argyle's position emotion and attitude are subsequently reduced and conceptualized in the present investigation to positive or negative, and aligned to appropriate bipedic gestures from the source literature (Navarro, 2008; Pease, 1991) as summarized above (see Fig.1 and Fig. 2).

Fig. 2: The bipedic gestures portrayed by actors. The arrows indicate positive attitude / emotion towards an object of interest. In negative attitude / emotion orientation the leading foot orientates away and leg forms a barrier to the object of disinterest.

Drawing these threads together; the purpose of the present investigation is to empirically explore and seek validation of bipedic gestures. In doing so ascertaining whether simple leg and foot gestures are associated with the expression of emotion and attitude.

3. Method

Two studies were conducted to explore the link between bipedic gesture and the expression of emotions and attitudes.

Study 1: Corpus Analysis

Design & Materials: Drawing upon the methodological approaches adopted in recent related studies (Dael et al., 2011, 2012) an ex post facto experimental design (Coolican, 1994) was employed using video material from the SSKKII/SCCIIL interdisciplinary centre at the University of Gothenburg. This material forming part of the wider NOMCO corpora (Paggio et al., 2010). This video corpus possessed advantages over others used in previous research (such as GEMEP) as it recorded full-body interaction (see Fig.3), it recorded ‘real encounters’ with potential for enhanced ecological validity, and it was accompanied with self-report attitudinal data whereby interactants had rated liking for their conversational partner post-conversation.

Participants: The video corpus consisted of 40 recordings of 37 adults (15 male / 22 female) aged approximately between their early twenties and mid to late thirties. Conversations were conducted in Swedish and all but one of the interactants were native Swedish speakers. After extraction and synthesis of data 20 video clips of dyadic first encounter interactions were coded and analysed involving 10 females and 8 male interactants (some interactants were involved in more than one conversation, but never with the same interactant).

Fig. 3: Screen captures from corpus video material used in Study 1.

Procedure: Self-report attitude questionnaires from the video corpus were coded using scale items deemed relevant to liking. These questionnaires were then ranked and arranged into the ten highest and ten lowest scores. A high score denoting a high level of liking and positive attitude/emotional orientation towards the conversational partner and a low score denoting the opposite. Content analysis of the corresponding 20 video clips was conducted using coding units from the bipedic gesture model (see Fig. 1 and 2). Due to coding difficulties caused by observed leg/foot posture and movement not adhering precisely with those within the bipedic gesture model subsequent analysis was adapted by focusing on (i) Frequency of Change in bipedic gesture (number of changes during the encounter), (ii) Leg Crossed behaviour (total cumulative seconds spent in a leg crossed position) and (iii) Negative Leg Pointing (total cumulative seconds spent with leading leg/foot orientated away from partner). Analysis was conducted using an independent samples *t*-test to determine statistical significance in differences between groups arranged according to high/low levels of liking vis-à-vis high/low levels of positive attitude/emotion orientation.

Study 2: The Mannequin Experiment

Design & Materials: Using a quasi-experimental design (Shadish et al., 2002) with a nonrandom, convenience sample Study 2 utilized props to represent human interaction, consistent with previous research (James, 1932; Little, 1968). The props consisted of three artists' mannequin dolls (named A, B, and C) and were used in different scenarios designed to simulate various social interactions. Consistent with this study's experimental design the independent variable (IV) utilized to manipulate participant responses was the positioning of the mannequins' legs and feet according to the bipedic gesture model (Fig.1 and Fig. 2). The subsequent dependent variable (DV) was participants' choice of mannequin according to which they felt was the most or least liked in each scenario. A total of 15 scenarios distributed across 19 web pages was administered online to participants using a proprietary survey tool (SurveyGizmo$_{TM}$).

Experimental controls included; (i) use of a blind control whereby participants were not informed of the full reasoning behind the scenarios until the end of the experiment. (ii) Each scenario being displayed to each participant in the same order without use of counterbalancing to control for order effects. (iii) The selection of a design of mannequin that was minimalistic, gender neutral, and lacking in dress or adornments that might be construed as indicative of status or culture. And (iv) the avoidance of anthropomorphizing the dolls by using human names (e.g. 'Bill', or 'Ingegerd') but instead opting for the use of ambiguous referents 'A', 'B' and 'C'. The latter two controls being employed to counter bias potential in participants' responses.

Participants: A total of 91 participants attempted the Mannequin Experiment of whom 61 (35 females / 26 males) completed all 15 scenarios. In terms of age 39.3% of participants were aged between 25 and 34 years, 41% aged between 35 and 54 years, and the remainder outside of these ranges. Participants originated from eleven different countries with the majority from the UK (47.5%), Sweden (29.5%), and the US, Canada and Australia (combined: 11%). Other nationalities included Cuba, Germany, Hungary, Iraq, Malaysia and Russia (combined: 12%).

Procedure: Three 15cm tall artists' mannequin dolls were arranged into 15 different scenes; four seated and eleven standing, depicting different social interaction scenarios. Each scenario was staged so that bipedic gestures displayed liking and a positive attitude/emotion orientation between the three mannequins.

Fig. 4: Scenario 1 from the Mannequin Experiment depicting standing bipedic gestures in simulated social interaction.

Questions were constructed using a forced choice response format ('Our Mannequins are having a chat – from this image who is Mannequin A more interested in and liking more? Is it…[a] Mannequin B, or [b] Mannequin C' – see Fig. 4 above). These were uploaded onto a proprietary online survey tool which was used to administer the experiment and to collate responses.

Analysis was conducted using the χ^2 'goodness of fit' test to determine statistical significance. This approach was taken as 14 of the 15 scenarios provided participants with only a limited choice of responses; one of which followed the experimental prediction. As participants had a 50/50 chance of selecting a 'correct' response (the DV) the χ^2 'goodness of fit' test enabled a determination of whether responses were occurring by chance or as a result of an underlying variable (the IV).

Fig. 5: Scenario 14 from the Mannequin Experiment depicting seated bipedic gestures in simulated social interaction.

Ethical Considerations: Participants were advised that they could withdraw at any time, that participation was anonymous and confidential, and full explanations were provided to achieve informed consent. The final page of the online survey tool also invited further general feedback and one such request was received.

4. Results

The results from the present investigation are arrange around its two studies.

Study 1: Corpus Analysis

Grouped Data	n = number participants	$\bar{x}$ Attitude Scores	Bipedic Gesture Change (frequency)	Negative Foot Pointing ($\bar{x}$ seconds)	Negative Leg Crossing ($\bar{x}$ seconds)
Highest Attitude Score	10	30.8	17.6	123.6	54.5
Lowest Attitude Scores	10	14.2	19.8	170.6	89.9
Female Participants	10	21.6	16.2	144.6	61.8
Male Participants	10	23.4	21.2	149.1	82.6
Highest Scoring Females	5	29.8	15.6	120.2	23.2
Highest Scoring Males	5	31.8	19.6	127.0	85.8
Lowest Scoring Females	5	13.4	16.8	169.0	100.4
Lowest Scoring Males	5	15.0	22.8	171.2	79.4

Table 1: A summary of findings obtained by using the adapted units of analysis. Columns denoting seconds reflect total cumulative time spent in that bipedic gesture/posture. Frequency represents a count of changes in bipedic position.

Table 1 (above) summarises findings from the present investigation's first study. The 'Attitude Score' reflects the average score obtained from participants' self-report questionnaire in terms of gauging liking and degree of positive attitude/emotion orientation to their respective conversation partner. A high 'attitude' score reflects positive orientation, a low 'attitude' score reflects a negative attitude/emotion orientation.

The frequency and duration of certain observed bipedic gestures proved to be statistically significant upon analysis.

The ten participants with the highest attitude scores ($\bar{x}$=30.8) displayed less Negative Foot Pointing ($\bar{x}$=123.6 seconds) compared with participants with the lowest attitude scores ($\bar{x}$=14.2) who displayed more Negative Foot Pointing ($\bar{x}$=170.6 seconds). Analysis of this difference revealed a statistically significant effect ($t = -0.784$, $df = 11.67$, $p < 0.05$).

The ten participants with the highest attitude scores ($\bar{x}$=30.8) also displayed less Negative Leg Crossing ($\bar{x}$=54.5 seconds) compared with participants with the lowest attitude scores ($\bar{x}$=14.2) who displayed more Negative Leg Crossing ($\bar{x}$=89.9 seconds). Analysis of this difference revealed a statistically significant effect ($t = -1.011$, $df = 13.693$, $p < 0.05$).

A possible gender effect was observed whereby the five female participants with the lowest attitude scores ($\bar{x}$=13.4) displayed more Negative Leg Crossing ($\bar{x}$ =100.4 seconds) than the females with the highest attitude scale scores ($\bar{x}$=29.8) who displayed 4.29 times less Negative Leg Crossing ($\bar{x}$=23.2 seconds).

It was also observed that male participants changed their bipedic gestures more frequently than female participants. Data related to highest attitude scores ($\bar{x}_{male}$ = 19.6, $\bar{x}_{female}$ = 15.6), lowest attitude score ($\bar{x}_{male}$ = 22.8, $\bar{x}_{female}$ = 16.8) and gender generally ($\bar{x}_{male}$ = 21.2, $\bar{x}_{female}$ = 16.2) all reflected this pattern (Table 1).

However, analysis of the observed gender patterns failed to confirm these as statistically significant effects.

Frequency of Bipedic Gesture Change within comparison groups (e.g. within male/female participants groupings) appeared to exhibit less difference and so appeared more stable.

Study 1: Corpus Analysis

Summary data (Fig. 6, Table 2) and statistical analysis (Table 2) revealed that participants' responses followed experimental predictions contained within of the bipedic gesture model and were highly statistically significant.

The experiment's first depiction of a bipedic gesture, in Scenario 1, elicited 79.1% of responses in line with prediction. Analysis of this data revealed the result to be statistically significant ($\chi^2 = 30.87$, $df = 1$, $p < 0.001$).

Overall, 13 out of 15 of the scenarios produced a statistically significant result of which 12 followed prediction and one followed in the opposite direction to predicted response.

Scenario	n	% of Responses following Prediction	χ^2 value	*p* value
1	91	79.1	30.87	0.0001
2	88	84.1	40.91	0.0001
3	86	73.3	18.60	0.0001
4	84	64.2	6.86	0.0088
5	80	67.5	9.80	0.0017
6	75	76.0	20.28	0.0001
7	72	18.1	29.39	0.0001
8	71	62.0	4.07	0.0437
9	70	70.0	42.33	0.0001
10	70	91.4	48.06	0.0001
11	70	74.3	16.51	0.0001
12	70	81.4	27.66	0.0001
13	61	52.2	0.13	0.7184
14	61	85.5	34.79	0.0001
15	61	43.5	1.17	0.2794

Table 2: Responses for each scenario showing number of participant responses (n), % of responses in line with prediction, and corresponding χ^2 and *p* values.

Table 2 reveals a response fatigue effect where participant mortality is seen to steadily increase throughout the 15 scenarios with 32.9% of those who started failing to complete. It can also be observed from Fig. 6 that the profile of bars on the bar chart is not incrementally increasing or decreasing indicating that the data is free from an order effect.

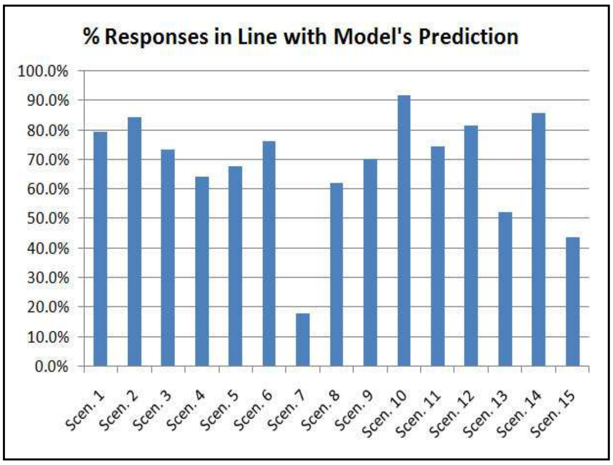

Fig. 6: Chart showing each scenario (1-15) where the blue bars represent the proportion of participant responses in line with bipedic gesture prediction.

5. Discussion

The purpose of the present investigation was to empirically explore and attempt to validate whether simple leg and foot movement and positioning, or bipedic gestures, could express attitude and emotion.

Two studies were conducted where the data and results obtained from both pieces of research supported this contention. Additionally, some insight was provided into methodological problems associated with researching this part of the human body.

Results from the Corpus Analysis study indicate that when an individual meets someone for the first time (in a standing position) their legs and feet will behave in certain ways depending on their attitudinal and emotional orientation to that other person.

Participants from the first study crossed their legs less, and pointed their leading foot away from their conversation partner less, when interacting with a person they later reported liking towards. This lending support to the bipedic gestures of Negative Leg Crossing and Negative Foot Pointing.

Two possible gender effects were also observed where firstly, female participants who liked their conversation partner least displayed nearly four and a half times more Negative Leg Crossing than those female participants who liked their conversation partner most. And secondly, male participants were observed changing their bipedic gesture more often than female participants regardless of positive or negative attitudinal orientation. These results, whilst marked, failed to meet the appropriate thresholds of statistical significance. However, they are suggestive of a possible future path of inquiry alongside other individual differences such as age, personality and culture.

As mentioned methodological problems were encountered and these were caused, in the main, by the surprising complexity of this part of the human body. A pair of legs and feet combined have 120 bones (with more muscles) with which to position and shape a wide range of positions, shapes and postures. These were observed to be performed rapidly and with high frequency. Categorizing and making these fit into a fixed model, or taxonomy, of gestures proved difficult to the extent that from the six basic bipedic gestures only two could be practically measured. Though it should be noted that two of the bipedic gestures were automatically excluded in Study 1 because the corpus used recorded only standing interaction.

These methodological issues are consistent with the experience of previous studies (Dael et al., 2011, 2012; Smith-Hanen, 1977). As well as being consistent with Ekman and Friesen's (1967) commentary and dismissal of this part of the human body as being difficult and not worthy of enquiry. It is perhaps these factors that have resulted in the present absence of research related to bipedic gestures.

In spite of methodological issues experienced in Study 1 the experimental data and results obtained from Study 2 provided empirical support for all six bipedic gestures.

In Study 2's fifteen scenarios bipedic gestures were simulated alongside the manipulation of other nonverbal cues such as gaze, bodily posture, head position, and arm and hand movement (see Fig. 4 and Fig. 5). In twelve of these scenarios where the mannequin's bipedic gesture had been manipulated to display liking and a positive attitudinal/emotion orientation to a specific other mannequin, participants accurately decoded this without prompting and over (or alongside) other nonverbal cues.

Although encouraging various limitations can be identified with Study 2's experimental design. First, the forced choice format only made use of two response options in the scenarios which perhaps had a channeling effect on responses. A more complex design might make use of more response options for participants to use, or alternatively, make use of a likert scale where participants estimate how much mannequin A likes mannequin B or C. An additional improvement includes varying the order of the scenarios for each participant so they respond to each scenario in a randomized and different sequence. Although this counterbalancing control is usually used in treatment of order effects – of which none were observed in the present investigation – their employment might nonetheless have made these very encouraging results more robust.

In respect to the theoretical implications of these findings, and where a taxonomous bipedic gesture model might fit, a return to the start of this investigation's empirical journey is appropriate. As mentioned, Ekman and Friesen's (1969b) pervasive and influential scheme arranges nonverbal behaviour into five distinct categories. A possible theoretical question that arises is whether bipedic gestures are a new, sixth kinesic category to be positioned alongside *Emblems*, *Illustrators*, *Affect Displays*, *Regulators* and *Adaptors*, or whether they are one of these. If the latter, then which of these categories would provide the best fit?

At this stage it is perhaps premature to begin fashioning theoretical implications until more work has been conducted. A perhaps interesting question remains though in respect of whether bipedic gestures would constitute a new and sixth category of kinesics.

Other questions that were encountered in the course of the present investigation include, (i) what are the implications of left or right footedness? Does a left footed person display Negative Foot Pointing with their left foot? (ii) The present investigation's first study used corpus material of first encounter dyadic interaction between approximately similar individuals. What might be the effects of status, culture, gender, age, personality and context to display rules? All of these remain unanswered and perhaps represent interesting questions that can be taken forward within future research.

6. Conclusion & Future Research

The results from the present investigation supports a link between certain leg and foot movements and positions, or bipedic gestures, and the expression of attitude and emotion. However, the findings here only represent a beginning to investigating a part of the human body neglected in the literature concerned with nonverbal, multimodal communication. Replication and further investigation with the inclusion of individual differences, culture, context and status may all prove interesting avenues. Ultimately, it is hoped that the present investigation encourages more empirical research which in turn will add to a neglected body of enquiry.

7. Acknowledgements

The research reported here was submitted as a thesis paper under the MSc. Programme in Communication at the University of Gothenburg in July 2012. Thanks goes to staff and fellow students at the SSKKII/SCCIIL Interdisciplinary Centre as well as at the Department of Applied Information Technology, for all their support, inspiration and guidance.

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