Could next generation androids get emotionally close? 'Relational closeness' from human dyadic interactions

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Abstract— **Studies of human–human interactions indicate that the relational dimensions encoded nonverbally between people include intimacy/involvement, status/control, and emotional valence. In assessing nonverbal behaviour a key issue concerns the correct level or unit of behaviour to code. Low-level codes, such as head nods, eyebrow flashes, and smiles, are concrete enough to be specified objectively. However, a coding scheme based on them may not match the phenomenology of lay people's experiences of natural interactions. A high-level code, such as *values intimacy*, reliably distinguishes secure and insecure attachment styles but is underspecified at the concrete, bodily level. This paper considers what level of behaviour codes may realistically be mapped onto next generation androids. New 'mid-level' behaviour codes are offered based on an experimental study of relational closeness in human dyadic interactions. These provide act specifications for a possible benchmark of relational closeness. The appropriateness of certain relational behaviours by androids is considered.**

I. Introduction

Could next generation androids get relationally close to people? Future androids will have to simulate human appearance and behaviour to the degree that they can sustain natural relationships with people [1]. Such 'relationships' may be only temporary or fleeting, but they will be of sufficient quality to elicit authentic interpersonal responses. The android will be treated, if only temporarily, as human because the person in interaction has momentarily 'forgotten' it is not. These androids will not have personalities as such; far from being self-determining and capable of lifestyle choices, they will not even exhibit the most basic characteristic of life: a competency for self-preservation in a 'natural habitat.' We propose, however, that the advanced simulation of relational acts by a very human-like body, will provoke genuine interpersonal experiences in humans. The present paper presents findings from a study of dyadic interactions between strangers and romantic partners and provides 'act specifications' for intimate and non-intimate behaviours. Verbal and nonverbal communications usually complement and amplify each other during natural person-to-person interactions. The subdivision for research purposes, however, is not entirely spurious. A critical difference between verbal and nonverbal signals is the relation between sign and referent. In speech this relation is arbitrary and has to be learned, whereas many nonverbal communications are understood directly because they elicit a physiological response. Nonverbal signals from the face, voice, posture, gesture, interpersonal distance and positioning, have bodily effects on the other person, distinct from the effects of linguistic information [2]. The immediate physical and physiological impact of the other's body is felt as *presence* – the 'bodying over' of information as an *act* of communication [3]. Appropriate bodily acts from the android with a very human-like body should substantiate presence by eliciting a physiological response from the person during a simulated interaction. We can imagine realistic affective interchanges with Thrun's 'personal service robots,' capable of tracking gaze, holding gaze, and mimicking posture and facial expression [4]. Behavioural synchronisation is a powerful communicative experience which has been used to explain how we "hit it off" immediately with some people and "never get it together" with others [5].

During live interactions we are attuned to the interpersonal affordances of others. We decipher personality, interpersonal dispositions, and motives, not as ends in themselves, but rather because we wish to predict and manage the interpersonal consequences of our interactions. The primary relational dimensions communicated nonverbally between people are intimacy/involvement, status/dominance, and emotional valence [6]. Interpersonal motives also differ between the sexes with men tending to work for status and control and women towards intimacy and affiliation [7]. These findings suggest that the quest for benchmarks may initially be constrained to specific behaviours which encode 'relational motives,' whose purpose is to affect an interpersonal outcome.

We may begin to frame the benchmark problem by considering Sternberg et al.'s prototypes of socially competent behaviour based on lay people's observations [8]:

Accepts others for what they are;
Admits mistakes;
Displays interest in the world at large;
Is on time for appointments;
Has social conscience;
Thinks before speaking and doing;
Displays curiosity;
Does not make snap judgements;
Makes fair judgements;
Assesses well the relevance of information to a problem at hand;
Is sensitive to other people's needs and desires;

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Is frank and honest with self and others;
Displays interest in the immediate environment.

As they stand these present a daunting prospect for the engineer of social intelligence. These competencies must be translated into specific bodily acts that may be behaviour mapped onto the android body. Current android bodies are far inferior in behavioural capacity to the socially experienced adult. However, even the newborn infant is equipped with behaviours capable of sustaining 'primary intersubjectivity' with its adult caregiver e.g. holding gaze, tracking gaze, and a level of nonverbal reciprocity which has been called 'protoconversation' [9]. Current androids already have a repertoire of facial displays commensurate with that of the human neonate, albeit not yet responsive, but requiring remote control by a human agent [10]. It would not seem beyond the reach of next generation android bodies to implement rudimentary intersubjectivity such as facial and postural mimicry – the precursors of human empathy [11].

In this paper we address how social competencies are translated by the human body into visible acts, thus enabling others to judge ostensibly the social competence of actors. We focus on proximal interpersonal acts: bodily actions which have an immediate interpersonal impact, in contrast with those that require actions coordinated across time and space. We may begin to apply a criterion of 'embodifiability' to Sternberg et al.'s prototypes in order to attempt to specify more concretely the bodily enactment of the social competence. For example, *Is on time for appointments* is concrete but cannot be physically act specified in any form proximal to the body. *Has* a *social conscience* is related to 'conscientiousness,' though again, no proximal bodily acts that encode conscientiousness have as yet been identified [12]. *Accepts others for what they are* is clearly linked with the personality dimension 'openness.' Openness is associated with increased interaction quality between interaction partners. The association is mediated by visual attention – the acts of 'looking at the partner while listening,' and 'holding gaze' [13]. *Makes fair judgements* and *assesses well the relevance of information to a problem at hand* are both social skills which are likely to require deep social embeddedness within a human culture, and therefore lie beyond our scope. However, *displays curiosity* and *displays interest in the immediate environment* may both be act-specified to some degree. For example, *turning the head towards others present,* reliably specifies 'gregariousness' [14], and therefore provides a possible benchmark for androids equipped with advanced bodily responsivity.

Next generation androids are unlikely to approach the ontological status defined as the 'subject of a life' [15]. Therefore it would be premature to speculate on 'android personalities.' However, we may expect these androids to make significant inroads into interface technologies that enhance human–robot interactions [16]. In this domain, benchmarks for socially competent behaviour may be informed by psychological studies of person-to-person interactions. A key issue is the correct level or unit of behaviour to code, and which of these are relevant for mapping onto androids. Micro-level behaviours such as head nods, eyebrow flashes, and smiles, are already mappable within existing technologies. Ishiguro's android, for example, is equipped with 43 air-actuators in its body and head, making it capable of realistic facial expressions, gestures, and head and trunk movements [10]. High-level behaviours, however, such as *values intimacy* (a criterion behaviour for secure attachment in humans), or *devalues or minimises events that cause painful feelings* (a criterion for dismissing attachment) [17], require behavioural sophistication beyond the reach of androids of the next generation.

A 'mid-level' coding scheme has been devised recently which attempts to specify comprehensively the behaviours which mediate human personality [18]. The 64 mid-level behaviours of the Riverside Behavioural Q-sort e.g. *tries to control the interaction*, are sufficiently concrete to be reliable, while sufficiently general to reflect the phenomenology of ordinary experience. These mid-level codes correspond closely to the ordinary evaluations of lay judges of personality, and thus require minimal training to discern.

Could mid-level codes constitute benchmarks for next generation androids? In the present study a set of relational codes are presented, designed to distinguish the intimate behaviours of romantic partners from the non-intimate behaviours of strangers. The objective is to propose a set of act specifications for relational closeness that are sufficiently concrete to be behaviour-mapped onto androids equipped with advanced bodily responsivity. We sidestep the challenges of reciprocity and contingency, and propose that even in simulation mode, such acts will provoke profound interpersonal responses from humans. Relational closeness is offered as a benchmark for developing people-oriented androids. In summary, the present study devises nonverbal relational codes which are i) embodied (based on concrete bodily acts); and ii) specified at a level which is psychologically meaningful to the ordinary observer. We present preliminary findings from a test of the coding scheme on a sample of interacting dyads comprising strangers and romantic partners.

II. Coding Nonverbal Behaviour Between Strangers and Close Relationship Partners

A split-screen videotaping procedure was used to record short unstructured interactions between strangers and between partners in established romantic relationships. The aim of the study was to devise a set of act specifications defining intimate and non-intimate interaction behaviour.

Participants. The 56 participants of the study were students of the University of Edinburgh or their acquaintances who participated on a voluntary basis. The 28 participants comprising the 14 *strangers dyads* had not met before the experiment. The 28 participants comprising

the 14 *couple dyads* were established partners in a romantic relationship.

Videotaping procedure. The participants were greeted by separate experimenters who took them to separate doors and explained that the door led to a small room where they would meet a stranger or their partner. They were to converse for 4 minutes on any topic of their choosing. The two doors were on opposite sides of the experimental room. Entry by both participants was timed to be simultaneous, so that they met face to face on entering the room and the initial greeting was recorded. In the room a table was placed centrally with two opposing swivel computer chairs and recording equipment. Two cameras on stands were set at 45 degrees from each other so as to capture the head and body of each participant. The cameras fed a mixer which split the image vertically into two half-screens, one allocated to each camera, before being record by a standard video cassette recorder. The cameras were placed at an unobtrusive distance and zoomed in; all recording equipment was visible to the participants. A small clip microphone on the table recorded sound. A small TV monitor was also visible, and was switched off during interaction. After the videotaped interaction, participants filled out questionnaire measures of attachment style, interpersonal perception, and interaction quality. Attachment style was assessed by the *relationship questionnaire* and *relationship scale questionnaire*. Interpersonal perception was assessed by means of a 16-item questionnaire which assessed the participant's own feelings and their perception of their partner's feelings during the interaction. Interaction quality was assessed by 7 items to evaluate the pleasantness, smoothness, and satisfaction of the interaction.

Behavioural coding. Two judges independently coded 27 behaviours from each 4 minute interaction. Specific behaviours which seemed especially likely to distinguish between couples and strangers were identified. The codes were devised after a detailed examination of a sample of the video footage, and in consultation with previous coding schemes designed to assess personality and attachment behaviours during short interactions [13][19].

III. Results

The 27 nonverbal behaviour codes derived by the present study are shown in Table 1. Two independent judges rated the behaviours on 7-point rating scales which ranged from 0 (very little) to 6 (almost always). Inter-rater reliability was assessed by computing intra-class correlation coefficients for each set of ratings. Coefficients for the 27 behaviours ranged from 0.63 (for *direct gaze*) to 0.96 (for *touching partner*). Behaviours with coefficients below 0.75 were considered unreliable and excluded from further analysis. In total 8 behaviours were excluded: direct gaze, attentiveness, matching and mirroring, smiling, facial pleasantness, body posture, being quiet, and turn taking. For the remaining 19 behaviours, the average of the two

TABLE I
NONVERBAL BEHAVIOUR CODES WITH OPERATIONAL DEFINITIONS

NONVERBAL BEHAVIOUR		Code description
Intimacy (close involvement)		
1.	Direct gaze	Looking directly at partner
2.	Touching partner	Body contact with partner
3.	Engaging the common space	Placing a part of the body within table perimeter
4.	Lean forward	Head forward of vertical line with hips
5.	Body orientation	Degree to which upper body directly faced partner
Altercentrism (centering on the other)		
6.	Back-channeling	Vocal utterances or head nods supporting partner
7.	Attentiveness	Visual attention, listening and generally attentive
8.	Matching and mirroring	Reciprocating action, movement or posture
Creating meaning / sharing interest		
9.	Drawing attention to 3rd object	Remarking on object in the room
10.	Drawing attention to own body	Remarking on own body
11.	Focus attention on partner's body	Remarking on partner's body
Adaptors (adapting body to circumstance)		
12.	Touching self	Face, arms, hand: touching or rubbing
13.	Preening	Preening of hair
14.	Head and trunk shifts	Adjusting body or head position
Animation / affect (level of bodily excitement)		
15.	Hand gestures	Gesturing in support of vocal utterance
16.	Smiling	Mouth raised at edges
17.	Relaxed laughing	Natural laughter that is not anxious
18.	Facial pleasantness	Cheerful or positive expression
Social anxiety (signs of tension and nervousness)		
19.	Body posture	Open/relaxed or closed/blocked
20.	Fidgeting	Stereotyped head or limb movements, swinging in chair
21.	Nervous utterance	Laughter, vocalisation or action
Physical security (signs of security)		
22.	Being quiet	Intentional silence
23.	Talking without looking	Not looking at partner when talking
24.	Complete open body	Lean back, arms behind body, legs relaxed
Interaction management		
25.	Loquaciousness	Degree to which locution flows
26.	Turn taking	Degree to which participant hesitates before talking
27.	Disengaging	Breaking contact, proximity, or conversation

judges scores for each behaviour were used in all subsequent analyses.

A. Stranger versus couple behaviour

Differences between strangers and couples were assessed by means of t-tests between the mean scores of the 19 behaviours for the two groups. Couples touched their partners more than strangers did, $t(54) = 4.94$, $p<.01$, engaged the common space more (delineated by the table) $t(54) = 5.05$, $p<.01$, leaned forwards, $t(54) = 4.69$, $p<.01$, oriented their bodies towards their partner, $t(54) = 4.39$, $p<.01$, drew attention to objects in the room, $t(54) = 1.59$, $p<.01$, drew attention to their own body, $t(54) = 2.44$, $p<.05$, focused attention on their partner's body, $t(54) = 2.92$, $p<.05$, and showed the complete open body posture, more than strangers did, $t(54) = 2.77$, $p<.05$. Strangers made comparatively more back-channeling responses, $t(54) = 1.52$, $p<.05$, fidgeted more, $t(54) = 1.66$, $p<.05$, and made more nervous utterances, $t(54) = 1.96$, $p<.05$.

The differences suggest distinct interpersonal goals underpin the behaviours of the two groups. Strangers appear to attempt to progress and to regulate the conversation, through the use of support and tension reducing mechanisms. Couples showed more physical security and external interest, making meaning and sharing experience, and going beyond the immediate concern of managing the conversation.

B. Sex differences

T-tests revealed 4 behaviours that tended to distinguish between men and women: women smiled more, $t(54) = 2.27$, $p<.05$, made more nervous utterances, $t(54) = 2.14$, $p<.05$, and of marginal significance they to tended laugh more, $t(54) = 1.94$, $p<.05$, and to fidget more, $t(54) = 1.83$, $p<.07$. The finding that women engaged in these behaviours more than men, and that there were no behaviours which men displayed more of than women, is consistent with research on sex differences in expressivity. The results are also consistent with the view that women's interpersonal motives are affiliative – they work harder to manage the interaction, while men's interpersonal motives tend to revolve around status and control.

IV. Discussion

Social robots of today are already sufficiently sophisticated to support anthropomorphic responses from humans. Aibo and Paro, for example, have elicited caring, companionate and sentimental behaviours from children and elderly people [20][21]. If the android can elicit, even temporarily, a sympathetic or empathetic response from a human, then it may be assumed that an interpersonal transaction has been simulated. Such a response might include facial mimicry or gaze behaviour towards the android whose social purposes in the human sphere are established [22]. It then seems a short leap to conceive how such transactions could be elaborated for specialized uses within constrained environments. For example, consider the embodied android counselor/therapist capable of simulating 'sympathetic presence' through facial and bodily acts coordinated with the client's emotional state. A rudimentary sympathetic interaction might resemble, for example, the coordinated affect–attunement sequences seen in mother–infant protoconversation [9].

How appropriate are the act specifications from strangers and couples for relational androids? In the present study couples touched their partners more than strangers did. This was often accompanied by the forward lean, and drawing attention to their own or their partner's body e.g. the hands or hair. Physical touch is a powerful communicative act used to signify sexual desire, warmth/love, playfulness, or friendliness [23]. Touching the partner is therefore unlikely to be an appropriate relational act for androids of the near future. On the other hand, psychotherapists sometimes describe the act of 'holding without touching.' This is achieved through sympathetic presence and inclusion (co-experiencing one's effect on the other). We found strangers engaged in back-channeling (vocal utterances and head nods supporting the other's speech) more than couples did. These sympathetic acts towards the stranger probably create the sense of reassurance, closeness, and being *held*, that is crucial for the navigation of an uncertain and potentially deleterious interpersonal situation. The increased fidgeting and nervous laughter of strangers compared with couples may have been symptomatic of their greater unease. But it is also possible that these were expressed strategically, to show a solidarity with the other person and recognition of the shared predicament which is their common, if temporary, interpersonal ground. We can imagine feeling some degree of comfort and reassurance from the embodied android counselor who back-channels our utterances skillfully. At worst this might feel awkward, but unlike physical touch, it is unlikely ever to seem intrusive.

Couples drew attention to objects in the room and to parts of their own and each other's bodies more than strangers did. We coded these behaviours as drawing attention to a 'third object' to parallel the triadic person-object-person mode of relating, which in human infants, exemplifies 'secondary intersubjectivity.' They engaged each other in 'discovering' and 'showing,' and this was often followed by joint attention to an object or part of the body, and the sharing of experience. Strangers seldom progressed beyond the face-to-face dyadic mode which characterizes 'primary intersubjectivity.' It is probable that among friends (which we did not test), an intermediate level of discovering and sharing would be observed. Whether such relational acts are relevant to androids will depend upon their relational purposes. It is unlikely that next generation androids will become our friends or lovers, and therefore we will rarely require from them the companionate acts of showing, sharing and discovering that characterize the side-by-side relationship.

Gender differences were consistent with the notion that women's interpersonal motives are affiliative. Women tended to laugh, smile, and fidget more, and made more nervous utterances. Men appeared to withhold behaviour more, consistent with their interpersonal motives for status and control. It is obvious that next generation androids will occupy roles subservient to humans. Therefore the behaviour–mapping of affiliative rather than competitive acts will be appropriate. Which particular behaviours will be determined by the specific relational purpose of the android. Roles requiring intimacy and involvement, such as the android counselor or therapist, will be best served by a female-like body capable of attachment/affiliative acts. Though not shown by the present study, the social stereotype that men are more competitive and also cooperative in organised tasks, suggests that the future android with a leadership role will be best served by a male-like body, exhibiting physical security and skilled interaction management.

V. Conclusion

In the present study a behaviour coding scheme was devised to distinguish between the intimate behaviours of partners and the non-intimate behaviours of strangers in identical environments. A new benchmark of relational closeness is proposed as a result. The mid–level act specifications provided by this study should be capable of direct mapping onto next generation android bodies. The study suggests that the dyadic purposes of couples are distinct from those of strangers. Strangers appear to engage in face-to-face processes, while couples tend to engage in side-by-side interactions. Strangers try to progress the interaction by supporting each other nonverbally, while couples create intimacy and share experience through touch, and exploring the environment together. We need to begin to think about the 'relational goals' of the next generation of behaviourally-advanced androids.

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