Proceedings of the 5th International Conference on International Law and Legal Policy
DOI: 10.54254/2753-7048/2026.36996

The "Warmth of Silicon": The "0.5 Dilemma" in Human Emotional Interaction and the Ethics of Silicon-Based Completion

Mian Wu

Division of Transdisciplinary Undergraduate Programmes, Hong Kong Baptist University, Hong Kong, China
23218711@life.hkbu.edu.hk

Abstract. Whether people can offer one another a mutual and complete emotional response in intimate relationships is a basic question for understanding the structural limits of interpersonal emotional interaction. This article argues that such responses are rarely achieved in practice. Moreover, this gap reflects a structural limitation rather than a moral failure. Through a survey of 50 adults and 10 semi-structured interviews, this study develops, on that basis, the core concept of the "0.5 Dilemma". Participants supplied approximately half of the scale's maximal emotional responses in attentiveness, self-disclosure, commitment stability, psychological transparency, emotional resonance, emotional maintenance, and reciprocal giving. The average normalised sufficiency score was .48, with a standard deviation (SD) of .06, significantly below the .50 midpoint, $t(49) = -2.15$, $p = .037$. The emotional gap was largest on the attention dimension, while commitment stability showed the highest normalised sufficiency. Participants aged 40 and over reported less sufficiency than younger individuals. The interviews revealed distraction caused by competing mental load, silence to protect the other, and waning empathy. The paper then argues that the claim that emotionally expressive androids are "deceptive" is based on an unrealistically full picture of human interaction and proposes three ethical limits for silicon-based completion: transparency, social facilitation, and autonomy.

Keywords: Emotional interaction, social robots, empathy, deception, human-robot interaction

1. Introduction

When having in-depth conversations with partners, parents or close friends, people often find it difficult to remain completely present throughout the entire communication process. This kind of communication requires simultaneous attentional involvement, self-disclosure, emotional responsiveness and psychological understanding.

In daily intimate relationships, there is often a gap of varying degrees between the actual emotional response provided by a person and the standard response they consider ideal. This gap does not necessarily mean a decrease in affection or the failure of a relationship. On the contrary,

© 2026 The Authors. This is an open access article distributed under the terms of the Creative Commons Attribution License 4.0 (https://creativecommons.org/licenses/by/4.0/).

DOI: 10.54254/2753-7048/2026.36996

this article interprets it as a limitation on an individual's attentional resources, emotional energy and capacity for interaction. It should be noted that this paper uses "carbon-based" to refer to human beings embodied in biological bodies and "silicon-based" to refer to artificial agents whose core is chip-based computation. "The warmth of silicon" and "silicon-based completion" are analytical expressions proposed here for the supplementary response an artificial carrier can provide where human emotional supply falls short, and neither term presupposes that machines have subjective emotional experience.

At the same time, two developments in robotics are converging on machines that appear to close that gap. The first involves the mechanical imitation of the human body. The Polish-American firm Clone Robotics has presented Protoclone, an android with a polymer skeleton, roughly a thousand fluid-driven artificial muscles, more than two hundred degrees of freedom, and about five hundred sensors [1]. The second is the computational imitation of human feeling. AheadForm, a Chinese startup, develops robotic heads that produce fine facial expressions in real time using self-supervised learning and dozens of micro-motors, driven by an emotion model the company calls CharacterMind [2]. The underlying research has already been published. A robot face with 26 degrees of freedom can predict a person's smile approximately 839 milliseconds before it appears and smile at the same moment, making the expression more like sharing than copying [3].

The ethical implications of this advancement have been widely criticised. Turkle worries that technologies that mimic care but do not offer it would make people settle for less than genuine connection [4]. Scheutz warns that the emotional connection based on robots is one-sided and built on a false premise [5]. These criticisms can be grouped under the label of deception: because robots cannot produce genuine care, their caring behaviour may be treated as pretence, inducement, or emotional misdirection.

This article accepts the critical value of the deception objection but questions the idealised picture of human interaction on which it rests. This view holds that human emotional interaction is complete, honest and symmetrical. Robot interaction is merely imitation. Based on the original survey and interview data, this paper develops and tests the concept of the 0.5 Dilemma. In an ongoing intimate relationship, people tend to give about half of the maximum emotional response represented by the scale. Section 2 considers the objection from deception. The methods are described in Section 3. The quantitative and qualitative results are presented in Sections 4 and 5. Section 6 discusses what follows for relationships and for the ethics of emotional machines. Section 7 states the limits of the study.

2. The deception objection and three problems with it

The deception objection consists of three claims, each of which is contestable.

The ontological claim concerns the inner status of machines. Machines lack consciousness and subjective experience – qualia, as Nagel puts it – so their caring may be regarded as hollow mimicry without moral significance [6]. The limitation of this view lies in that it entirely links the moral value of an action to the inner state of the agent. However, it pays little attention to the actual experience of the recipient, the sense of the relationship and the emotional benefits. A meta-analysis of randomised controlled trials reported that social robot interventions significantly reduced depression and loneliness among older residents in long-term care institutions [7]. If ethics refuses to count these effects because the source of interaction has no inner life, then it quietly ceases to be about human well-being. Users of companion chatbots described deepened relationships over several months and reported real emotional benefits, even though they were still fully aware that their partner was software [8].

DOI: 10.54254/2753-7048/2026.36996

The relational claim concerns authenticity. Because robot love is algorithmically generated and one-sided, it is often regarded as inauthentic. However, this assumes that human-to-human interaction is genuine, sufficient, and symmetrical. That assumption is seldom tested. This is the empirical question this paper tackles and the data below suggest the assumption is too generous.

The cognitive claim concerns anthropomorphism and empathy. Human-like robots "hijack" empathy and exploit human perceptual systems. Yet social responses to non-human entities are a general feature of human cognition rather than a rare malfunction. Anthropomorphic cues are central to how users build relationships with conversational systems, and perceived authenticity shapes how attached they become [9]. Anthropomorphism is therefore not simply a malfunction, although it can also exaggerate what a system is and distort moral judgements about it [10]. In literary reading, readers likewise have real emotional responses to fictional characters, yet such responses are not normally classified as deception. The more decisive condition is whether the user clearly knows that the interaction partner is a machine and is able, in that informed state, to decide whether to invest emotionally. Danaher holds that unless the machine or its creator intentionally conceals its nature, the robot behaviour that evokes emotions is not dishonest [11]. Experimental evidence supports this distinction. People are more likely to accept a robot that misrepresents the outside world rather than one that hides its own capabilities. They hold developers responsible for the deceptions they reject [12]. These points do not prove that emotionally expressive robots are ethically acceptable. On the contrary, they suggest that the accusation of deception cannot be resolved until the fullness of human emotional interaction is established.

3. Method

This study adopts a convergent mixed-methods design. Quantitative and qualitative data were collected in parallel, and then integrated, compared and cross-validated in the analysis stage [13].

In the survey, fifty adults completed an online questionnaire about the most important intimate relationships in their lives. The participants were aged from 22 to 55 years old, with a mean (M) age of 38.54 years and a standard deviation (SD) of 10.18. Twenty-five participants identified as male, 22 as female, 1 as another gender, and 2 did not respond. The focal relationship for 32 people was a spouse, for 6 a dating partner, for 2 a close friend, and for 10 an adult parent-child relationship.

The questionnaire consisted of 60 items and was scored on a 5-point scale, divided into 7 subscales: attention (16 items), self-disclosure (7 items), commitment stability (6 items), psychological transparency (6 items), emotional resonance (12 items), emotional maintenance (6 items), and reciprocal giving (7 items). Twenty-one items were scored in reverse. Internal consistency was .91 for the full scale and ranged from .65 to .85 for the subscales, which is acceptable for short subscales in exploratory work.

Each subscale score represents the average of items ranging from 1 to 5. The overall sufficiency score is calculated as the unweighted average of the scores of the seven subscales. The total score was then normalised to a scale from 0 to 1 as the normalised sufficiency score (BS): $BS = (M - 1) / 4$. Therefore, 1.00 represents the ideal "one-to-one" response, and the gap score (BT), calculated as $BT = 1 - BS$, represents the remaining gap value. Thus, .50 has a clear meaning: at this point, the participants provide half of the maximum response described by the scale.

In the interviews, ten adults took part in semi-structured interviews of 20 to 30 minutes, with the interview schedule organised around the seven emotional dimensions used in the questionnaire, so as to explain the subjective experience behind the quantitative results. Participants (P01–P10) were aged 24 to 52, and their focal relationships included dating partnerships, spousal relationships, one long-term friendship, and two parent-child relationships. All gave written or recorded informed

DOI: 10.54254/2753-7048/2026.36996

consent, were told they could stop at any time, and were assured that recordings would be anonymised. Transcripts were analysed thematically following the phases described by Braun and Clarke, with the seven dimensions used as initial organising categories and sub-themes generated inductively within them [14].

4. Quantitative findings

The mean overall emotional sufficiency on the five-point scale was 2.93 (SD = 0.25), giving a normalised score of BS = .481 (SD = .061) and a gap of BT = .519. A one-sample t test showed that the normalised sufficiency score was significantly below the .50 midpoint, $t(49) = -2.15$, $p = .037$. Individual scores ranged from .335 to .620, and 62% of participants fell below .50. In other words, within this sample, participants reported providing slightly less than half of their ideal response, and few participants approached the higher end of the sufficiency scale.

Table 1. Subscale means, standard deviations, and normalised sufficiency (N = 50)

Dimension	M (1–5)	SD	Sufficiency (BS)	Gap (BT)
Attention	2.64	0.34	.409	.591
Emotional resonance	2.85	0.36	.462	.538
Emotional maintenance	2.96	0.38	.490	.510
Reciprocal giving	2.99	0.34	.496	.504
Self-disclosure	3.00	0.38	.499	.501
Psychological transparency	3.00	0.39	.501	.499
Commitment stability	3.05	0.38	.512	.488

As shown in Table 1, two dimensions fell clearly below the scale midpoint. Attention was the weakest, $t(49) = -7.51$, $p < .001$, followed by emotional resonance, $t(49) = -3.02$, $p = .004$. The other five dimensions were not significantly different from the midpoint. Commitment stability was the strongest. These results suggest that the central difficulty lies not in remaining in the relationship, but in remaining fully present within it.

The only demographic variable that showed any clear effect was age. Sufficiency was negatively correlated with age, $r(48) = -.48$, $p < .001$. This study divided the sample at age 40, with those younger than 40 averaging BS = .517 and those aged 40 and over averaging BS = .446, $t(48) = 5.02$, $p < .001$, $d = 1.42$, and the difference was significant on each of the seven dimensions individually. Relationship duration showed a weaker negative association, $r(48) = -.27$, $p = .061$. No significant differences were found between men and women on any dimension (all $p > .25$) and the type of relationship did not significantly impact overall sufficiency, $F(3, 46) = 1.04$, $p = .38$, although, on a purely descriptive basis, parent-child relationships had the lowest mean (BS = .455), a result that should be read with caution given the small size of that subgroup.

Although moderate ($r = .15$ to .49), the seven subscales correlated positively. They may share some common variance, but they are not redundant. One can pay attention, but still withhold. One can be committed, but still not connect.

DOI: 10.54254/2753-7048/2026.36996

5. Interview findings

The interviews explained these figures from the participants' perspectives, with seven themes corresponding to the seven dimensions.

Attention is lost due to competing mental load rather than a lack of interest. Within the interview sample, participants commonly reported being physically present while their attention drifted elsewhere. P02, a software engineer with a young child, described hearing his wife discuss a conflict at work while he was washing a cup. Afterwards he recalled only how the matter had ended, and could not recall the specific source of her distress. She told him that he was "only waiting to give a verdict". P09, a researcher, could repeat her partner's sentences but did not notice that her partner's voice was shaking. These accounts point to limits in available cognitive capacity rather than to a lack of motivation.

Disclosure is edited to protect specific people. None of the interviewees described complete disclosure. P10 did not tell his wife how serious his company's cash-flow problem was. P02 downplayed his job insecurity. P08, a mother, hid her financial worries so that her son would not feel like a burden. The reasons included fear of harming others, being criticised, and showing weakness. Research on companion chatbots points the same way from the other side: users often disclose more freely to an artificial partner precisely because they do not expect to be judged [8].

Commitment was firm, yet fragile and conditional. Consistent with commitment stability scoring highest in the survey, the interviews showed that most participants did not readily call the relationship itself into question. The respondents' confidence in future relationships ranged from 70% to 90%. Doubt appeared only under the pressures of money, disagreements about where to live, fatigue and in-law conflict. Some participants described this in investment terms, that is, balancing what they have built and what they are still owed.

Emotional understanding is different from behavioural understanding. Participants reported that their spouses recognised their routines but did not understand their intentions. P03's competence was interpreted as self-sufficiency, so her husband told her that she could manage anything, which intensified her sense of loneliness. P06 felt misunderstood after being silent about his fear of ageing. P09 masked her tiredness with an abstract argument about personal space. Participants generally blamed themselves as much as they blamed the other person.

Empathy often appeared as a temporary response rather than sustained emotional resonance. Drawing on their own experience, participants estimated that the share of their emotional intensity the other person actually registered was roughly 4 to 6 on a 10-point scale (median ≈ 5), which converges strikingly with the survey estimate of .46 for this dimension. P01 wanted to be held after a failed promotion, and was given a plan to fix her résumé. P08 gave her son a revision timetable when he wanted to hear that his disappointment made sense. P09's account illustrates the decline of empathic responsiveness over repeated discussions of the same problem. On the first day, her partner's empathy was around 8 or 9 out of 10. However, when she kept coming back to the same problem, it dropped to around 5 points. This is an everyday version of the empathy fatigue long recorded in caring professions.

Maintenance should be intentionally designed. All long-term participants described the shift from excitement to routine, and some even developed certain rituals to resist this change. Participants usually described a familiar assumption: once a relationship becomes stable, maintaining emotions no longer requires continuous effort.

When people give emotionally, they tend to consciously assess, to a greater or lesser extent, the time and emotional energy they invest as well as the possible responses from the other party.

DOI: 10.54254/2753-7048/2026.36996

Participants watch before investing. Their fear is not a single loss, but a long-term imbalance and being taken for granted. At this point, a communal relationship begins to be scored like an exchange. Several women in the sample described it as invisible emotional work.

6. Discussion

6.1. What the 0.5 Dilemma is

The data from the survey and interviews converge. The survey shows that the average sufficiency score is 0.48 points, while the interview score for empathy is approximately 0.5 points. This pattern does not necessarily imply poor relationship quality. Most participants reported good interpersonal relationships. Fatigue, distraction, competing roles and self-protection are related to this gap.

6.2. Why the gap matters

This pattern has three consequences. The first consequence is relational loneliness. This kind of loneliness is not primarily physical loneliness, but rather a feeling of being unmet in intimate relationships. Second, the accumulation is slow. Any single instance of reduced reactivity may be very small. However, the need for belonging is a fundamental and continuous need [15]. Over time, these half-responses may gradually weaken the sense of security and satisfaction in an intimate relationship. This erosion is not necessarily triggered by any single identifiable conflict. The third consequence is limited security. When the person offering it is exhausted, defensive and calculating fairness, unconditional acceptance is often described as a prerequisite for growth and is structurally difficult to maintain.

6.3. What silicon could complete

Theoretically speaking, each dimension may correspond to the machine's capabilities. When humans are unable to provide continuous companionship, artificial companions do not experience the fatigue that humans feel. Therefore, they may have an advantage in the continuity of their responses, although this continuity does not equate to the authenticity of emotions. Because artificial partners have no pride to protect, they do not need to change their reactions for self-protection. Rival options do not affect their commitment. They can store interaction data for a long time and, to some extent, help identify a person's deeper emotional concerns rather than just responding to surface conversations. They do not experience empathy fatigue. Therefore, they can respond to repeated stories in the same way as when they were told for the first time. This directly addresses the decline in repetitive empathy responses reported by P09. They do not drift towards routine because of emotional habituation. They can give without first checking what they will receive, eliminating the defensive metering described in P04, P05 and P07.

This does not mean that machines can feel these emotions. This is a statement about what the recipient gets. Research on companion chatbots indicates a similar situation. Users report attention, the feeling of being listened to and companionship, while other goods of interpersonal relationships remain out of reach [8]. The useful question is which goods exist, rather than whether the entire category is legitimate.

DOI: 10.54254/2753-7048/2026.36996

6.4. What silicon cannot replace

The boundaries of an argument are as important as its content. Human care is valuable precisely because it is based on limited energy, changeable emotions and free choices. Human love is valuable partly because it can be withdrawn, but it is often sustained. Attention is costly, but it is still provided. Empathy is limited and honest. Recent evidence makes the risk concrete. Users of companion apps may develop emotional dependence on the system, and the harms mirror patterns found in human relationships [16]. These results do not fully address Turkle's concern that people might prefer easier relationships [4]. Completion should cover the structural gaps that humans cannot bridge, rather than replace what humans do uniquely well.

6.5. Three ethical limits

Transparency requires the machine to state its nature at the start of the interaction and at any point where the person interacting with it might reasonably forget. This makes the interaction an informed emotional investment, and it is the condition that separates permissible from impermissible robot behaviour on Danaher's analysis [11].

Social facilitation means that, when use begins to replace human relationships, the system should monitor patterns of over-dependence and encourage renewed human contact. If the goal is to fill the 0.5 gap, a design that isolates people defeats itself [16].

Autonomy requires personalisation to be based on informed consent, with rights to know what is being stored, to delete it and to end the relationship at any time. A "permanent loyalty" from which users cannot exit is difficult to regard as genuine companionship, and comes closer to a restriction on the user's emotional autonomy.

7. Conclusion

The study was small and exploratory. A sample of 50 survey respondents and 10 interviewees is insufficient to support claims about the general population. Cultural contexts are likely to affect both self-disclosure and expectations of empathy. All measures relied on self-report data collected at a single time point. Therefore, the study provides no information about change within relationships over time, and only one member of each relationship was surveyed. The .50 benchmark is an operational choice associated with the scale midpoint, not an independently measured "ideal," and three subscales had reliabilities below .70. Future work should collect self-ratings and partner ratings from both members of a relationship, adopt a longitudinal tracking design, and compare emotional sufficiency across cultural backgrounds, relationship types, and age groups.

With this caveat in mind, the central finding remains important. In this sample, people gave approximately half of the maximum emotional response represented by the scale to their closest relationships, and they were least able to give attention and emotional resonance – the two dimensions that machines may be well positioned to support in principle. This does not answer whether emotionally expressive robots are ethical. It does reveal that the standard by which they are rejected—a picture of human interaction as complete and symmetrical—is not the standard that human beings actually meet. Understanding the limitations of carbon-based emotions does not mean scorning human love. The remaining ethical question is what forms of artificial emotional support can be developed along with human care without undermining its unique value.

DOI: 10.54254/2753-7048/2026.36996

References

[1] Interesting Engineering. (2025, February 20). Watch creepy humanoid robot twitch and move with human-like skeleton. *Interesting Engineering*. https://interestingengineering.com/innovation/video-worlds-first-humanoid-lifelike-muscles

[2] Tangermann, V. (2025, September 20). Alarming new video shows robot making incredibly realistic facial expressions. *Futurism*. https://futurism.com/the-byte/video-aheadform-robot-realistic-facial-expressions

[3] Hu, Y., Chen, B., Lin, J., Wang, Y., Wang, Y., Mehlman, C., & Lipson, H. (2024). Human-robot facial coexpression. *Science Robotics, 9*(88), eadi4724.

[4] Turkle, S. (2011). *Alone together: Why we expect more from technology and less from each other*. Basic Books.

[5] Scheutz, M. (2011). The inherent dangers of unidirectional emotional bonds between humans and social robots. In P. Lin, K. Abney, & G. A. Bekey (Eds.), *Robot ethics: The ethical and social implications of robotics* (pp. 205–221). MIT Press.

[6] Nagel, T. (1974). What is it like to be a bat? *The Philosophical Review, 83*(4), 435–450.

[7] Yen, H.-Y., Huang, C. W., Chiu, H.-L., & Jin, G. (2024). The effect of social robots on depression and loneliness for older residents in long-term care facilities: A meta-analysis of randomized controlled trials. *Journal of the American Medical Directors Association, 25*(6), 104979.

[8] Skjuve, M., Følstad, A., Fostervold, K. I., & Brandtzaeg, P. B. (2021). My chatbot companion: A study of human-chatbot relationships. *International Journal of Human-Computer Studies, 149*, 102601.

[9] Pentina, I., Hancock, T., & Xie, T. (2023). Exploring relationship development with social chatbots: A mixed-method study of Replika. *Computers in Human Behavior, 140*, 107600.

[10] Placani, A. (2024). Anthropomorphism in AI: Hype and fallacy. *AI and Ethics, 4*(3), 691–698.

[11] Danaher, J. (2020). Robot betrayal: A guide to the ethics of robotic deception. *Ethics and Information Technology, 22*(2), 117–128.

[12] Rosero, A., Dula, E., Kelly, H., Malle, B. F., & Phillips, E. K. (2024). Human perceptions of social robot deception behaviors: An exploratory analysis. *Frontiers in Robotics and AI, 11*, 1409712.

[13] Creswell, J. W., & Plano Clark, V. L. (2018). *Designing and conducting mixed methods research* (3rd ed.). SAGE.

[14] Braun, V., & Clarke, V. (2021). *Thematic analysis: A practical guide*. SAGE.

[15] Baumeister, R. F., & Leary, M. R. (1995). The need to belong: Desire for interpersonal attachments as a fundamental human motivation. *Psychological Bulletin, 117*(3), 497–529.

[16] Laestadius, L., Bishop, A., Gonzalez, M., Illenčík, D., & Campos-Castillo, C. (2024). Too human and not human enough: A grounded theory analysis of mental health harms from emotional dependence on the social chatbot Replika. *New Media & Society, 26*(10), 5923–5941.