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A novel approach to affect induction using dynamic social stimuli

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ABSTRACT

Humans are inherently social beings who depend on successful social interactions. Understanding how different social stimuli elicit emotional responses is crucial for both psychological and physiological research. This study aimed to develop and validate dynamic stimulus material depicting social interactions and perspective-taking. Specifically, it examined whether emotionally charged video sequences of brief hand interactions elicit affect-specific subjective and psychophysiological response patterns.

A total of 81 healthy participants (42 female, 39 male) viewed video clips of hand interactions across four emotional contacts (Love, Neutral, Pain, and Rejection) and three perspectives (Agent, Interaction partner, and Observer). Participants rated arousal and valence using the Self-Assessment Manikin (SAM), while electrodermal activity (EDA) and heart rate (HR) were simultaneously recorded as psychophysiological indicators.

Analyses revealed significant effects of the stimuli on both subjective affect ratings and psychophysiological reactivity. SAM ratings of arousal and valence varied across emotional contacts, with perspective additionally influencing arousal. Subjective arousal was highest for Pain and Rejection, with both the Agent and Observer perspective eliciting higher arousal than the Interaction partner perspective. For subjective valence, Love was rated most positively, Pain most negatively. Similar significant effects of emotional contact, perspective, and their interactions were also observed in psychophysiological measures (EDA, HR), with Rejection inducing the highest EDA and HR. These findings demonstrate that the newly developed stimuli effectively induce distinct affective responses, providing a valuable tool for future research on affect perception and processing.

1. Introduction

Humans are social beings who rely on communication and social interaction (Fiske, 2018). Social interactions refer to the exchange of actions and reactions between individuals that enable communication and the formation of relationships (Goffman, 2023; Hoppler et al., 2022). These interactions not only foster human relationships and social cohesion (Kawachi and Berkman, 2000; Schiefer and Van der Noll, 2017) but also have a significant impact on mental health (Sun et al., 2020; Umberson and Karas Montez, 2010; Wickramaratne et al., 2022). A lack of social interaction or inappropriate interactions can lead to feelings of loneliness, isolation or social dysfunction, often resulting in a deterioration in mental health (Brown et al., 2021; Kawachi and Berkman, 2001), as seen during the COVID-19 pandemic (Buecker and Horstmann, 2021; Clair et al., 2021; Werner et al., 2021).

Social interactions inherently evoke emotions, not only through verbal exchanges but also via non-verbal cues. In particular, facial expressions have been extensively studied as affective signals (Franz et al., 2021; Mancini et al., 2018). However, physical touch also plays a crucial role in social communication and can elicit emotional responses. Research has shown that touch can convey comfort or affection (Hertenstein et al., 2006; Portnova et al., 2020). Whether we experience or merely observe these emotions is of little consequence (Meffert et al., 2013; Peled-Avron et al., 2016; Schirmer et al., 2015), as witnessing observing touch-based interactions can also elicit affective reactions. This highlights the value of including touch as a stimulus modality in the study of socio-emotional processing.

To study affective reactions to social stimuli in an experimental setting, ecologically valid stimuli are essential. Visual stimuli such as images (Bradley and Lang, 2007) are widely used to induce emotions, as they have proven effective in various studies examining emotional responses (Abdel-Ghaffar et al., 2024; Mauss and Robinson, 2009).

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However, these stimuli only provide a snapshot of an affective state, often overlooking the dynamic, interactive nature of social interactions in real-life contexts. While static visual stimuli are prevalent in research, they fail to capture the fluid and interactive nature of real social exchanges. This dynamic aspect is crucial for understanding emotions, especially since physical touch plays a significant role not only in experiencing interactions but also in observing them (Hertenstein et al., 2006; Schirmer et al., 2015). Indeed, films can be used to present naturalistic, dynamic social interactions, which can provide a reasonable approximation of real-life situations (Schaefer et al., 2010; Sonkusare et al., 2019).

To overcome the limitations of conventional affective stimuli, it is essential to consider alternative, more universal and ecologically valid modalities. Established modalities such as facial expression, posture, and vocal tone - despite their expressiveness - have methodological limitations. For example, spoken language requires translation and cultural adaptation, which can introduce ambiguity. Facial expressions, while rich in emotional content, typically rely on a frontal, posed format and lose clarity from non-frontal perspectives (Schirmer and Adolphs, 2017), limiting their ecological validity and cross-cultural generalisability. A different approach has introduced dynamic video-based paradigms, which is also recommended by some researchers (Aluja et al., 2015; Chen et al., 2020) to increase realism and ecological validity. Such paradigms have already been applied in different contexts. For instance, Nan et al. (2022) demonstrated associations between neural dynamics and anxiety using emotional video stimuli, while Giesbrecht et al. (2010) presented emotional film clips to patients with depersonalisation disorder and healthy controls, while measuring skin conductance, revealing altered autonomic dynamics. Similarly, Leppanen et al. (2022) employed film-based paradigms to investigate social-cognitive biases in clinical samples. These findings underscore how dynamic stimuli can reveal atypical patterns of affective processing in different populations. Another established example of dynamic and standardised video material is the Body-Threat Assessment Battery (BTAB; Braithwaite et al., 2020). It consists of green-screen video clips depicting body-threat scenarios, presented either from a first-person point of view or from the perspective of an external observer. These videos have been shown to be highly effective in eliciting skin conductance responses (SCRs), thus demonstrating the value of dynamic materials in enhancing ecological validity. More recently, the BTAB was also applied in neuromodulation research (Joshi et al., 2024), highlighting its translational potential. Taken together, these lines of research highlight the potential of dynamic and standardised stimuli to increase ecological validity in the study of affective processing, and they further point to their particular suitability for examining emotional reactivity in clinical samples.

Although such paradigms highlight the advantages of dynamic and ecologically valid stimuli, comparatively little attention has been given to the significance of touch-based interactions in everyday social situations. For example, hand-based interactions offer a highly universal, non-verbal format that can convey relational meaning with minimal interpretative variance (Hertenstein et al., 2006; Gallace and Spence, 2010). They can express a wide range of relational dynamics - such as intimacy, dominance, care, aggression, or cooperation - without relying on facial cues or verbal content. A gentle stroke, a handshake, or a firm grip can each communicate different social intentions, often immediately and intuitively (App et al., 2011; Suvilehto et al., 2015). Recent research suggests that the meaning of social touch is often intuitive and quantifiable, regardless of culture or context, supporting its use as a powerful way for emotional communication (McIntyre et al., 2022).

Furthermore, hand-based interactions can be presented from multiple visual perspectives - including first-person, third-person, and observer views - without compromising their emotional salience. This flexibility is more difficult to achieve with facial stimuli, which are spatially constrained and prone to misinterpretation outside the standard frontal format (Schirmer and Adolphs, 2017). As a result, video stimuli based on hand interactions are not only emotionally rich and socially meaningful, but also highly adaptable for use in different research designs, populations and clinical contexts. Taken together, these features make hand-based interactions a compelling tool for studying affective and social processes. Their universality, ecological validity, and adaptability make them particularly well-suited for use in diverse research designs, participant populations, and clinical contexts.

Despite the importance of touch in interpersonal communication (Cascio et al., 2019), few studies have explored its role as an emotional signal (Hertenstein et al., 2009; McIntyre et al., 2022; Saarinen et al., 2021; Stack, 2004). To systematically study emotional responses to hand-based interactions, emotionally and socially meaningful categories are needed. Meffert et al. (2013) used different types of social touch interactions in a functional magnetic resonance imaging (fMRI) setting to explore affective responses in psychopaths and healthy controls. Participants viewed videos showing positive and negative interactions between two hands. Results revealed distinct neural circuits, with healthy controls showing increased responses in emotion- and empathy related regions (including the anterior insula, cingulate cortex, and somatosensory cortex). In contrast, participants with high psychopathy scores exhibited reduced activation, suggesting blunted emotional resonance. While Meffert et al. (2013) provided valuable insights into neurofunctional differences between psychopaths and healthy controls, this study is limited by the use of videos that did not focus exclusively on hand interactions and were filmed from a single observer perspective, potentially limiting ecological validity and generalisability to more complex social interactions. Additionally, while fMRI provides insights into regional brain activation patterns, it does not allow for precise discrimination of emotional valence. This highlights the need for alternative methods to measure affective responses.

To adequately measure affective reactions, a theoretical model is required that accounts for the complexity of emotional states. Russell (1980) provides a suitable framework, describing emotions in a two-dimensional space defined by valence (pleasantness of perception) and arousal (intensity of perception). These dimensions allow for the classification of emotional states and an understanding of them as continuous variables. Subjective self-report and psychophysiological methods are used to quantify these dimensions. A well-established instrument for collecting subjective affective ratings is the Self-Assessment Manikin (SAM; Bradley and Lang, 1994), which captures cognitive representations of affective experiences when viewing visual stimuli (Bradley and Lang, 1994).

To complement subjective data and obtain objective data, the activation of the autonomic nervous system (ANS) can be assessed. Research on emotions indicates that affective stimuli can automatically activate both central and peripheral responses in the ANS (Hagemann et al., 2003; Kreibig, 2010). Psychophysiological measures offer an advantage over other markers, such as SAM ratings, as they are objective and less prone to intentional distortion (Boucsein, 2012; Ferreira and Saraiva, 2019; Mauss and Robinson, 2009), providing a reliable indicator of emotional responses. Common indices of ANS activation include electrodermal and cardiovascular responses (Bradley and Lang, 2000; Bhoja et al., 2020). Electrodermal activity (EDA) is considered as a reliable physiological indicator of arousal due to its sensitivity to emotional stimuli. Studies show that changes in skin conductance, mediated by sympathetic nervous system activity, typically correlate with increased arousal in emotional contexts (Boucsein, 2012; Bradley et al., 2001; Kreibig, 2010; Hyde et al., 2019). In contrast, heart rate (HR) can reflect the valence of emotions, with increased HR associated with negative emotional states and decreased HR typically linked to positive emotions (Boucsein, 2012; Bradley and Lang, 2000, 2007). However, the relationship between HR and emotional valence is more complex. While Bradley and Lang (2000) report a triphasic HR response – initial deceleration followed by acceleration, then a return to baseline – other studies (Bradley et al., 2001) describe a quadratic response pattern for aversive stimuli. Despite these varying models, the accelerative component of HR reliably captures the emotional valence of stimuli (Boucsein, 2012; Lang, 1995) and allows differentiation between positive and negative stimuli. These physiological markers enable a differentiated analysis of both arousal and valence, emphasising their relevance for understanding affective reactions (Bhoja et al., 2020; Bradley and Lang, 2000; Bradley et al., 2001). By integrating subjective and objective data, a more comprehensive and valid analysis of affective responses can be achieved.

The present study addresses the limitations of previous research approaches by using newly developed stimulus material that depicts dynamic social interactions, while combining well-established psychophysiological markers with subjective participant ratings. The aims/hypotheses of the study were: 1) to examine whether the developed stimuli (hand interaction videos) are subjectively perceived differently in terms of arousal and valence, depending on the type of emotional interaction and person-perspective, and 2) to assess whether EDA and HR correlate with such changes in arousal and valence. If differences in affective reactions were observed at both levels, this would suggest the high validity of the material, allowing its use in future studies with clinical samples.

2. Materials and methods

2.1. Participants and sample size determination

Using a repeated measures ANOVA with a small effect size of $f = 0.1$, a significance level of $\alpha = 0.05$, and a desired power of $1 - \beta = 0.80$, an a priori power analysis conducted with G*Power (Faul et al., 2007) indicated a minimum required sample size of $N = 47$. To account for potential dropouts, a target sample size of $N = 60$ was set. A small effect size was chosen to ensure sufficient sensitivity to detect differences in affective and psychophysiological responses, which are typical of emotion induction studies. Given the novelty of the stimulus and the exploratory nature of validating its effects, this conservative approach was deemed appropriate. As physiological data are susceptible to artefacts, we recruited more participants than required to ensure a sufficient number of analysable cases. This was a precautionary measure rather than an attempt to artificially inflate statistical power, as excessively large samples risk detecting trivial effects (Cohen, 2023). To address this issue, we emphasized effect sizes when interpreting the results.

This validation study was conducted at the Clinical Institute of Psychosomatic Medicine and Psychotherapy at the University Hospital Düsseldorf. The general exclusion criteria were as follows: under the age of 18, insufficient proficiency in the German language, psychiatric or neurodegenerative disorders, acute alcohol or drug abuse and uncorrected visual impairment. Participants were recruited through flyers at the Heinrich Heine University Düsseldorf, social media and word-of-mouth. Psychology students from Heinrich Heine University who took part received study credits, while other participants were compensated with a €20 expense allowance. All participants provided written informed consent for the procedures approved by the local Ethics Committee (Heinrich-Heine University of Düsseldorf, registration number 2023–2378). The trial was registered in the German Clinical Trials Register (DRKS00033563).

2.2. Material

2.2.1. Stimuli

For the experimental paradigm, 24 self-produced hand interaction videos served as stimulus material. All participants viewed the 24 short video clips with two moving hands. One hand was visibly larger, and belonged to a male adult ("agent"); the other hand was smaller and belonged either to a woman or a girl ("interaction partner"). The videos varied in terms of perspective (Agent, Interaction partner, and Observer), contact (Love, Rejection, Pain and Neutral) and interaction partner's age (Woman's vs. Girl's hand). In the Love contact, the agent respectively caressed the interaction partner's hand. In the Pain contact, the agent pinched the interaction partner, while in the Rejection contact, the interaction partner rejected the agent with her hand. In the Neutral contact, the agent's hand moved close to the interaction partner's hand without touching. Building on previous work of Meffert et al. (2013), the selected emotional categories (Love, Rejection, Pain) reflect fundamental social functions often conveyed through touch in everyday interactions. In the agent perspective, participants viewed the videos from the viewpoint of the male adult agent. In the interaction partner perspective, participants saw the videos from the viewpoint of the female interaction partner, while in the observer perspective, they observed the interaction as a third party from the side. The videos were produced under standardised environmental conditions (same light for all videos, iPhone 12 used) to ensure consistency across stimuli. All actors in the videos were over 18 years old, and no physical harm was inflicted during the production of the stimuli. The girl's hand in the videos belonged to a staff member at the Institute, ensuring the appearance of a child's hand while maintaining ethical production standards. The hand gestures were performed by trained staff members who followed a standardised script for each emotional category. The actors were instructed to perform the gestures in a natural and consistent manner to ensure authenticity across videos. Furthermore, the emotional content of the hand interactions was validated through pretests, in which 13 staff members rated the videos for emotional intensity, accuracy and age of actors before they were used in the experiment. The videos lasted six seconds, which is a commonly used duration in psychophysiological research as it reliably captures stimulus-related HR and EDA responses (Boucsein, 2012; Bradley et al., 2001; Lang et al., 1993). The interaction begins between second two and three. Video snippets representing each contact, perspective and age condition are shown in Fig. 1.

2.2.2. Subjective ratings

The Self-Assessment Manikin (SAM; Bradley and Lang, 1994) was used to subjectively assess affective reactions. It consists of three dimensions: valence, arousal, and dominance, with the current study specifically focusing on arousal and valence. Participants select one of nine figures that most accurately reflects their affective reaction to a given stimulus. These figures are arranged along a continuum, ranging from strongly negative to strongly positive emotional expressions, thus allowing for a nuanced assessment of emotional responses. The arousal scale ranges from *low* to *intense*, while the valence dimension ranges from *unpleasant* to *pleasant*. For clarity, it should be noted that the lower ratings (1–4) represent negative emotional responses, the higher ratings (6–9) correspond to positive emotional responses, and the middle rating (5) is neutral. The SAM demonstrates high validity and reliability ($r = 0.90$ for arousal, $r = 0.89$ for valence; Opladen et al., 2023).

2.3. Procedure

All participants began by completing a socio-demographic questionnaire and several psychometric questionnaires. To identify potential confounding variables that could influence the perception of affect-expressive material and psychophysiological measures (e.g. depression or alexithymia; Di Tella et al., 2020; Mestanikova et al., 2016; Panayiotou and Constantinou, 2017; Sarchiapone et al., 2018; Taylor, 2010), the following assessments were conducted: current emotional state (PANAS; Breyer and Bluemke, 2016), depression, anxiety, and stress (DASS-21; Nilges and Essau, 2021), empathy (IRI—D; Paulus, 2009), alexithymia (TAS-20; Bach et al., 1996), and intelligence (MWT-B; Lehrl, 1969).

Subsequently, the psychophysiological measurements were conducted. Stimulus presentation was programmed using Presentation software (Neurobehavioral Systems, Version 24.0) on a 27-in. screen with a resolution of 1920 × 1080 (144 Hz) at a viewing distance of 60 cm. Participants were comfortably seated in front of the presentation

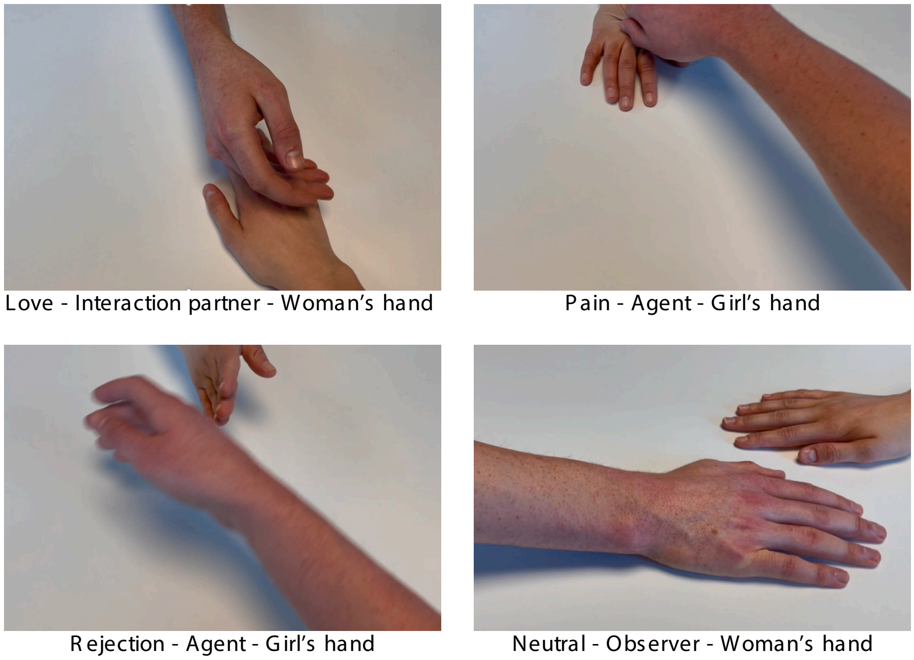

Fig. 1. Snippets of each emotional contact, perspective and age.

computer. Two electrodes were applied to the upper phalanx of the index and middle fingers of the participant's non-dominant hand (Gramann and Schandry, 2009) to measure EDA, and three electrodes were placed on the chest wall according to the modified Einthoven-II system (Gramann and Schandry, 2009) to measure HR.

The experiment began with a five-minute baseline measurement of resting activity, during which participants viewed a white cross centred on the screen. This baseline period was intended to capture participants' resting activity and to allow them to acclimate to the experimental setting, thereby minimizing potential arousal related to the novelty of the situation. Following this, psychophysiological reactions to the hand interaction videos were recorded. Participants were instructed to watch the videos carefully and to take the perspective accordingly to the depicted situation. The videos were presented in a randomised order in the centre of the screen. Each video was followed by a 12-s interstimulus interval (ISI), during which a fixation cross was shown in the centre of the screen. The ISI was followed by a jittered time interval (0 to 3 s) to make it more difficult to predict the next stimulus, thus mitigating expectation effects. This part of the procedure lasted approximately ten minutes.

After the psychophysiological assessment, the videos were shown again, and participants were asked to assess the arousal and valence of each video using the SAM rating. Participants responded by pressing two arrow keys on the keyboard with their dominant hand, moving across the different levels of the rating scales to select the appropriate one. Following the measurement, additional information regarding participants' personal experiences with violence was gathered. The overall study duration was approximately 45 min.

2.4. Study variables and data preparation

The variables of interest were arousal and valence. SAM arousal ratings and EDA recordings were used to operationalise arousal at subjective and objective (psychophysiological) levels, respectively. Similarly, the SAM valence ratings and HR recordings were used to assess valence at subjective and objective levels. Psychophysiological data were recorded using a computer with an upstream amplification system. A BioPac MP150 with one EDA module (model GSR100C) and one ECG module (model ECG100C) served as the amplification system. Hardware filter and amplification settings are listed in Table 1. For EDA measurements, two BioPacTSD203 Ag/AgCl electrodes and Discount Disposables TD-246-4 electrode paste were used. For ECG measurements, BioPac EL503 disposable gel electrodes were applied.

ACQ Knowledge (BioPac Systems Inc., biopac.com; Version 3.8.1) served as data acquisition software. An event-related trigger signal marked the stimulus onset, allowing the temporal alignment of the recorded psychophysiological signals with the presented stimuli. The raw data were parameterised using the software PPS-Para, version 2.67 (periphysys.com). The filter settings (Table 1) were set according to the guidelines of Boucsein (2012) and Gramann and Schandry (2009). For EDA, the following stimulus-related, phasic parameters were extracted within 12 s after stimulus onset (6 s during video presentation +6 s after stimulus offset): logarithmic maximum amplitude (logMa) in μS, logarithmic sum amplitude (logSa) in μS and number of spontaneous fluctuations (NS-SCR). HR measures included inter-beat intervals (IBI), beats per minute (BPM) and heart rate variability (HRV) during stimulus presentation. One value per participant was obtained for each video. The current analysis focuses on logMa (as it is considered as the most sensitive psychophysiological indicator of stimulus-induced arousal; Lang et al., 1993) and BPM as dependent variables. All parameterised data underwent a plausibility check and artifact inspection to ensure that only correctly parameterised data were included in the analysis.

Table 1
Filter and amplification settings.

BioPac MP150					
Modul	Gain	LP-Filter	Modus	HP-Filter 1	HP-Filter 2
EDA	5 μΩ/V	1 Hz	–	DC	DC
ECG	2000	35 Hz	R-Wave	0.5 Hz	–

Parametrisation programme				
Modul	NL-Filter	LP-Filter	Amplitude Criterion	Cut-off
EDA	–	5 Hz	0.01 μS	–
ECG	–	70 Hz	0.2 μV	−8 SD / +8 SD

Notes. EDA = electrodermal actvitiy, ECG = electrocardiogram. LP = low-pass, HP = high-pass. DC = direct current.

2.5. Data analysis

Descriptive statistics were reported using frequencies and percentages for categorical data, while continuous data were summarised with means (*M*), medians, and standard deviations (*SD*). Probability density plots were generated to visualize the distribution of SAM arousal and valence ratings. These plots serve descriptive purposes only. No statistical analyses were performed on these values. To assess whether the videos differed in arousal and valence, repeated measures two-way ANOVAs were conducted, incorporating the within-subject factors perspective (Agent, Interaction partner, and Observer) and contact (Love, Pain, Rejection, and Neutral). If the assumption of sphericity was violated, a Greenhouse-Geisser correction was applied. Pairwise comparisons were performed for follow-up analyses, with false discovery rate adjustments (FDR; Benjamini–Hochberg procedure) applied to control for multiple comparisons. Effect sizes are provided as partial eta squared (η_p^2) and Cohen's *d* (Cohen, 1988). Statistical analyses were conducted using R Statistical Software (Version 4.3.1). A *p*-value of <0.05 was considered statistically significant.

3. Results

3.1. Characteristics of the sample

The initial sample consisted of 81 healthy participants. However, two participants were excluded from the analysis due to non-plausible data, resulting in a final sample of 79 participants. The sex distribution was nearly balanced (42 women, 37 men). The age ranged from 18 to 58 years ($M = 23.14$, $SD = 5.26$). Detailed sociodemographic characteristics are presented in Table 2. On a psychometric level (DASS-21), the sample can be characterised as non-depressive ($M = 4.99$, $SD = 4.82$), non-anxious ($M = 4.00$, $SD = 3.88$), and not stressed ($M = 8.91$, $SD = 6.49$). TAS-20 scores for alexithymia were also unremarkable ($M = 39.00$, $SD = 8.44$), indicating no signs of alexithymia. In addition, participants showed an average empathy score on the IRI-D ($M = 42.20$, $SD = 5.86$). They scored within the average range of intelligence ($M = 27.6$, $SD = 3.66$) as measured by the MWT-B.

3.2. Arousal and valence on a subjective level

On a descriptive level, the contact Neutral was perceived as the least arousing, followed by the contact Love. In contrast, the contact Pain and Rejection elicited the highest levels of arousal (see Fig. 2). A two-way repeated measures ANOVA revealed significant main effects of contact, $F(2.01, 157.01) = 94.16$, $p < .001$, $\eta_p^2 = 0.55$, 95 % CI [0.48, 1.00], and perspective, $F(1.64, 127.93) = 8.14$, $p = .001$, $\eta_p^2 = 0.09$, 95 % CI [0.03, 1.00], for subjective arousal. Additionally, a significant interaction of contact and perspective was detected, $F(4.75, 370.43) = 4.68$, $p < .001$, $\eta_p^2 = 0.06$, 95 % CI [0.02, 1.00]. Descriptively, the observer perspective elicited the highest arousal in the contacts Rejection, Love, and Neutral, whereas the agent perspective resulted in the strongest arousal for the contact Pain (see Fig. 3). Post-hoc tests for the main effect of perspective revealed significant differences between the agent and interaction partner perspectives, as well as between observer and interaction partner perspectives, but not between agent and observer perspectives. Both the agent and observer perspectives elicited significantly higher arousal compared to the interaction partner perspective. Post-hoc tests for the main effect of contact indicated that all contacts differed significantly from one another in subjective arousal (see Table 3). Post-hoc tests for the interaction revealed that the observer and agent perspective elicited significantly higher arousal than the interaction partner perspective in the contacts Rejection, Love and Neutral (all $t(78) > 2.18$, all $p < .037$), while no difference between agent and observer perspective were detected (all $t(78) > -1.40$, all $p > .177$). In contrast, for the contact Pain, the agent perspective elicited significantly higher arousal than the interaction partner ($t(78) = 3.87$, $p < .001$) and the observer perspective ($t(78) = 2.33$, $p = .026$). A complete overview of all post-hoc tests is provided in Supplementary Table S1.

On a descriptive level, subjective valence differed across the emotional contacts. The contact Neutral was predominantly rated as neutral (median 5), while the contact Love was perceived as more positive (median 6). In contrast, the contacts Rejection (median 4) and Pain (median 2–3) were generally rated as negative (see Fig. 2). In terms of inferential statistics, a significant effect of contact, $F(1.95, 152.31) = 90.77$, $p < .001$, $\eta_p^2 = 0.54$, 95 % CI [0.47, 1.00], as well as a significant interaction between contact and perspective, $F(4.95, 385.74) = 6.59$, $p < .001$, $\eta_p^2 = 0.08$, 95 % CI [0.03, 1.00], were found. Post-hoc tests confirmed that all contacts differed significantly in valence (see Table 3). Compared to the other perspectives, the contacts Love and Neutral were perceived significantly more positive from the agent's perspective, while Rejection and Pain received significantly more negative ratings in the agent's perspective (see Fig. 3). This descriptive finding can be found on an inferential statistical level in the contact Rejection (all $t(78) < -2.45$, all $p < .020$) and Love (all $t(78) > 2.58$, all $p < .015$; see all post-hoc tests in Supplementary Table S2). There was no significant main effect of perspective on subjective valence, $F(2, 156) = 0.40$, $p = .670$.

Table 2
Demographic data from participants.

	Participants ($n = 79$)	
	n	%
Age		
Mean	23.14	
SD	5.26	
Sex		
Women	42	53.2
Men	37	46.8
Sexual orientation		
heterosexual	69	87.3
homosexual	7	8.9
other	3	3.8
Born in Germany		
Yes	77	97.5
No	2	2.5
Relationship status		
Single	38	48.1
In partnership	39	49.4
Married	2	2.5
Children		
Yes	1	1.3
No	78	98.7
Educational level		
< 12 years	1	1.3
≥ 12 years	78	98.7
Professional qualification		
Articled	29	36.7
Polytechnic	6	7.6
University degree	32	40.5
Without degree	12	15.2
Employment		
Employed, full-time	5	6.3
Employed, part-time	12	15.2
Job seeker	2	2.5
Pupil/student/apprentice	60	75.9
Psychotropic drug intake		
Yes	5	6.3
No	74	93.7
Psychotherapy		
Yes	11	13.9
No	68	86.1
Medicaments		
Yes	19	24.1
No	60	75.9
Handedness		
Right	70	88.6
Left	9	11.4

Notes. *SD* = standard deviation.

3.3. Arousal and valence on a psychophysiological level

3.3.1. Descriptive pre-analyses

Before analysing stimulus-related SCR, we conducted two descriptive responsivity checks. First, we examined non-stimulus-related spontaneous fluctuations (NS-SCR) as an indicator of tonic arousal. On average, participants exhibited between 1.34 and 2.72 NS-SCRs across perspectives and conditions (see Table 4). The highest frequency was observed in the observer perspective during rejection ($M = 2.72$, $SD = 1.92$), while the lowest occurred in the interaction partner perspective during pain ($M = 1.34$, $SD = 1.38$). These values indicate that participants produced a sufficient number of NS-SCRs, confirming adequate overall SCR. Secondly, we calculated the efficacy of the stimuli, defined as the percentage of trials that elicited a detectable SCR across participants. On average, efficacy was 76.6 % for Rejection trials, 72.4 % for Love trials, 71.5 % for Neutral trials and 69.4 % for Pain trials.

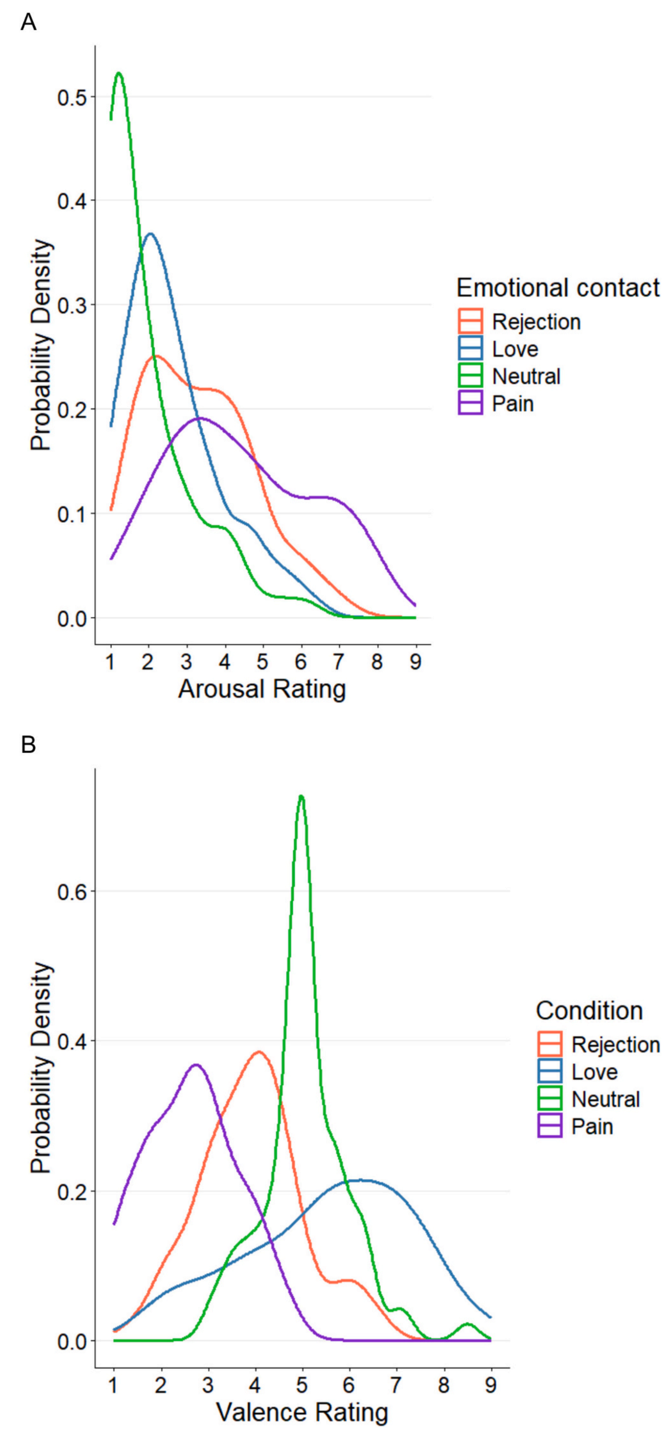

Fig. 2. Distribution of the SAM ratings. *Notes*. Probability density represents the relative likelihood of a given value occurring. A represents the distribution of the SAM arousal. B represents the distribution of the SAM valence. Higher values on the scale indicate greater perceived arousal. Values between 1 and 4 are interpreted as low arousal, a value of 5 corresponds to moderate arousal, and values between 6 and 9 indicate high arousal. A value of 5 on the scale is interpreted as neutral, values <5 (1–4) as negative, and values >5 (6–9) as positive.

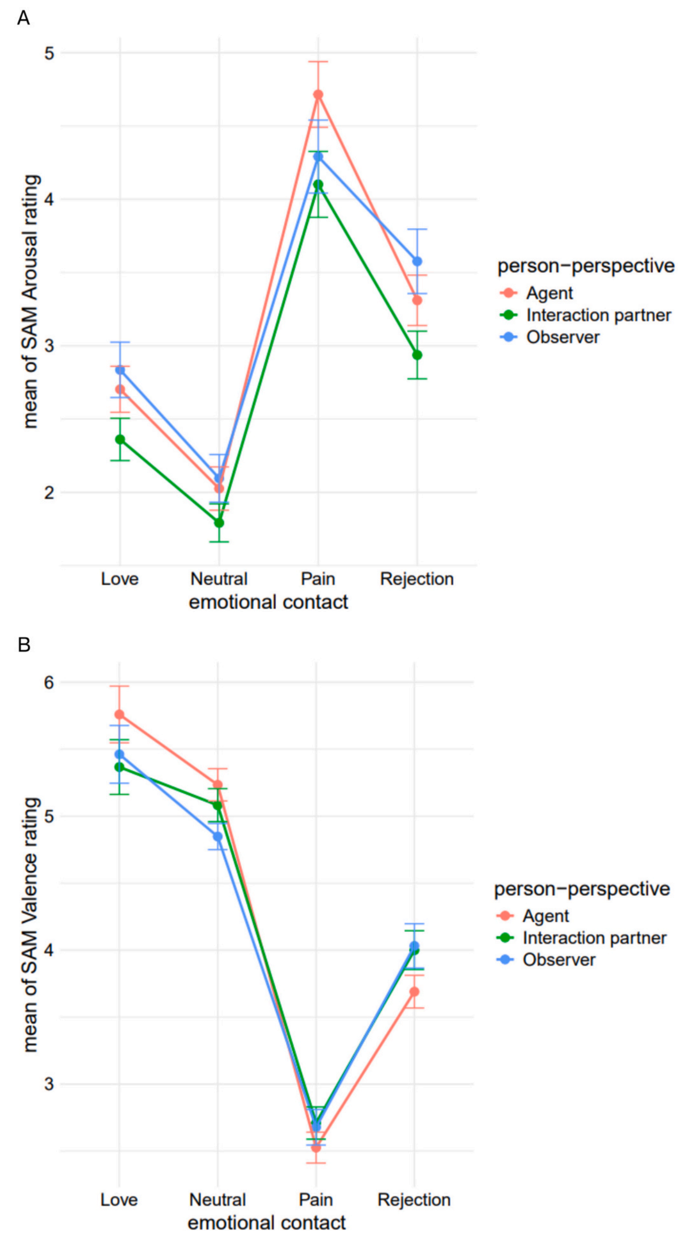

Fig. 3. Mean values of subjective ratings across emotional contacts and perspectives. *Notes.* A represents the mean values of the SAM arousal. B represents the mean values of the SAM valence. Error bars represent the standard error of the mean (SEM).

3.3.2. Inferential statistics

Descriptive statistics for logMa and BPM are presented in Fig. 4. A repeated measures ANOVA revealed significant main effects of contact, $F(2.77, 216.24) = 6.19$, $p < .001$, $\eta_p^2 = 0.07$, 95 % CI [0.02, 1.00], and

Table 3
Pairwise comparisons of contact and perspective for subjective data.

Parameter	contrast	t-Statistics	p-value	Cohen's d
SAM Arousal	Rejection – Love	4.94	< **0.001**	0.42
	Rejection – Neutral	10.53	< **0.001**	0.84
	Rejection – Pain	−8.41	< **0.001**	0.67
	Love – Neutral	5.83	< **0.001**	0.48
	Love – Pain	−9.59	< **0.001**	0.88
	Neutral – Pain	−12.29	< **0.001**	1.19
	Agent – Interaction partner	3.74	< **0.001**	0.27
	Agent – Observer	−0.08	0.936	–
	Interaction partner – Observer	−4.26	< **0.001**	0.30
	Rejection – Love	−6.29	< **0.001**	0.63
	Rejection – Neutral	−7.72	< **0.001**	0.66
SAM Valence	Rejection – Pain	9.55	< **0.001**	0.76
	Love – Neutral	2.20	**0.031**	0.22
	Love – Pain	13.04	< **0.001**	1.30
	Neutral – Pain	17.83	< **0.001**	1.55

Notes. SAM = Self-Assessment Manikin. All *p*-values were corrected for multiple comparisons using the Benjamini-Hochberg FDR procedure.

Table 4
Descriptive statistics of non-stimulus-related spontaneous fluctuations (NS-SCR).

Perspective	Contact	*M*	*SD*
Agent	Rejection	1.70	1.63
	Love	1.71	1.75
	Neutral	1.94	1.59
	Pain	1.75	1.70
Observer	Rejection	2.72	1.92
	Love	1.75	1.50
	Neutral	1.49	1.69
	Pain	1.70	1.63
Interaction partner	Rejection	1.59	1.52
	Love	1.88	1.76
	Neutral	1.72	1.72
	Pain	1.34	1.38

Notes. *M* = mean, *SD* = standard deviation.

perspective, $F(1.92, 149.54) = 11.62, p < .001, \eta_p^2 = 0.13$, 95 % CI [0.05, 1.00], on logMa. Additionally, a significant interaction of contact and perspective was observed, $F(4.55, 354.94) = 5.43, p < .001, \eta_p^2 = 0.07$, 95 % CI [0.03, 1.00]. Post-hoc tests indicated significant differences between agent and interaction partner perspectives, as well as between observer and interaction partner perspectives. Furthermore, the contact Rejection significantly differed from the Love, Pain and Neutral contact in their logMa (see Table 5). Notably, the contact Rejection elicited the highest logMa among all contacts. A complete overview of all post hoc comparisons is provided in Supplementary Table S3.

Regarding BPM, a significant main effect of contact was found, $F(2.26, 126.52) = 6.35, p = .002, \eta_p^2 = 0.10$, 95 % CI [0.03, 1.00]. However, there was no significant difference in BPM among perspectives, $F(1.88, 105.46) = 0.49, p = .602$, nor was there a significant interaction between contact and perspective, $F(4.42, 247.79) = 1.05, p = .387$. Post-hoc tests revealed that the contact Rejection significantly differed from all other contacts in BPM (see Table 5) and was associated with the highest BPM across all contacts.

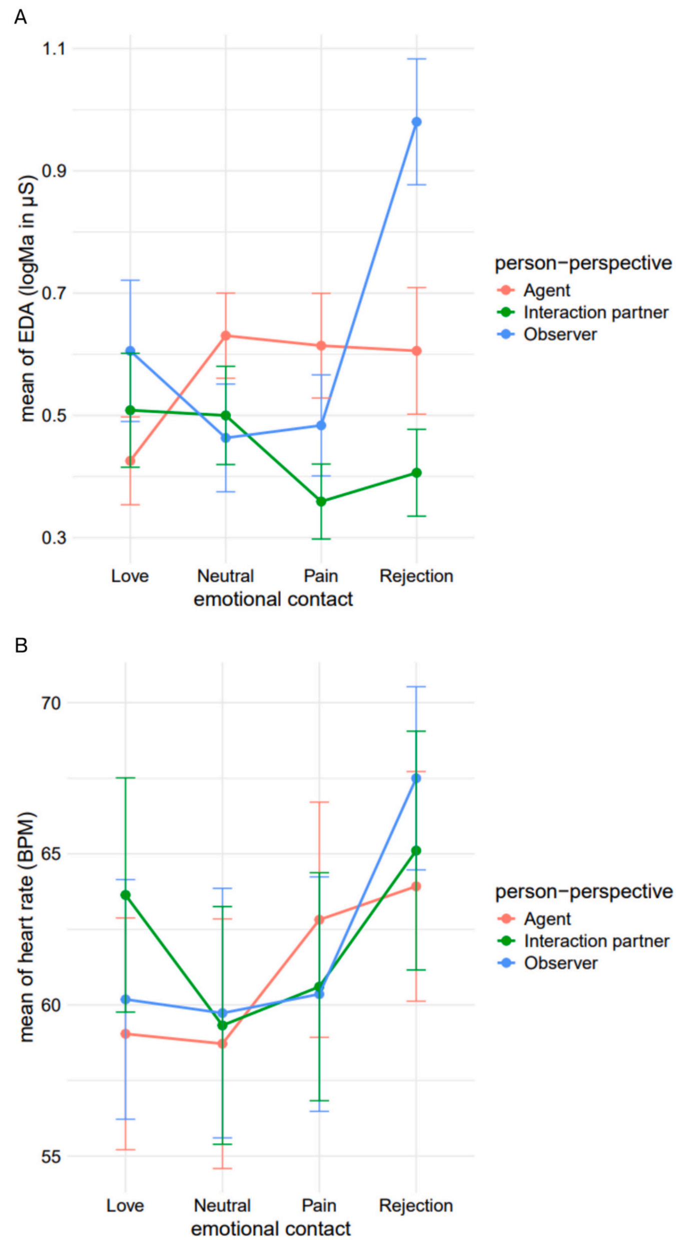

Fig. 4. Mean values of psychophysiological data across emotional contacts and perspectives. *Notes.* A represents the mean values of the logarithmic maximum amplitude (logMa) of electrodermal activity in µS. B represents the mean values of heart rate in beats per minute (BPM). Error bars represent the standard error of the mean (SEM).

Additionally, sex differences were analysed to identify any potential differences in the perception of arousal and valence. However, no significant effects of sex on the perception of the contacts in terms of arousal or valence were found ($p > .050$).

4. Discussion

Social interaction plays a fundamental role in human life, influencing our emotions, perceptions, and behaviours (Goffman, 2023; Hoppler et al., 2022). Given that humans are inherently social beings (Fiske, 2018), understanding how different social stimuli evoke emotional responses is crucial for both psychological and physiological research. The aims of this study were to investigate how the new developed social stimuli – through different emotional contacts and perspectives –

Table 5
Pairwise comparisons of contacts and perspective for psychophysiological data.

Parameter	contrast	t-Statistics	p-value	Cohen's d
logMa	Rejection – Love	3.35	**0.003**	0.12
	Rejection – Neutral	3.33	**0.003**	0.10
	Rejection – Pain	3.40	**0.003**	0.14
	Love – Neutral	−0.42	0.675	–
	Love – Pain	0.60	0.662	–
	Neutral – Pain	1.06	0.438	–
	Agent – Interaction partner	3.51	**0.001**	0.11
	Agent – Observer	−1.50	0.138	–
	Observer – Interaction partner	4.61	**< 0.001**	0.15
BPM	Rejection – Love	3.74	**0.003**	0.15
	Rejection – Neutral	3.29	**0.005**	0.21
	Rejection – Pain	2.63	**0.023**	0.15
	Love – Neutral	1.09	0.338	–
	Love – Pain	−0.22	0.825	–
	Neutral – Pain	−1.58	0.180	–

Notes. logMa = logarithmic maximum amplitude, BPM = Beats per minute. All p-values are corrected for multiple comparisons using the Benjamini-Hochberg FDR procedure.

influence arousal and valence on a subjective level, and whether these perceptions are reflected in psychophysiological measures such as EDA and HR.

Examining the subjective ratings, all contacts are perceived differently in terms of arousal. Negative contacts (Pain and Rejection) elicited greater arousal than the contacts Love or Neutral. This aligns with previous findings that neutral stimuli generally elicit fewer affective reactions (Bradley and Lang, 1994; Bradley and Lang, 2007). Physical pain inflicted by another person and social rejection are both forms of rejection in a social context. These are likely to be perceived as threatening and harmful, leading to greater subjective arousal (Kross et al., 2011; Seidel et al., 2013). Interestingly, contact Pain induced stronger subjective arousal than Rejection, possibly due to the increased body involvement in experiencing pain (Hadjis et al., 2025, Rey et al., 2017). In contrast, the contact Love was associated with lower arousal than the negative contacts, suggesting that positive social interactions may have a calming effect (Romney et al., 2023).

We also hypothesised that perspective would influence emotional arousal, which was confirmed by our results. The agent perspective generally induced higher arousal (regardless of contact) compared to the interaction partner perspective. This distinction reflects the perspective of the male acting figure with whom participants were asked to identify. In contrast, the interaction partner perspective represents the view of the woman or girl involved in the interaction. This finding is consistent with research showing that self-focus as an agent is associated with higher arousal (Panayiotou et al., 2007), whereas lower arousal in the interaction partner perspective may reflect a lack of personal involvement in the action. The similarity between the agent and observer perspectives can be explained by Bandura's social cognitive learning theory (Bandura, 2008), which posits that the mere observation of a behaviour can provoke emotional reactions similar to those experienced during the action itself. As observers, the participants can immerse themselves in the situation and experience similar emotions to those of the agent (Aihara et al., 2015; Milston et al., 2013), resulting in the same level of arousal. Similar findings were reported by Braithwaite et al. (2020) when using the BTAB. Although the authors hypothesised that egocentric perspectives would elicit stronger autonomic responses, this was not the case. However, arousal was lower in the interaction partner perspective in the present study.

There was a significant interaction between contact and perspective in subjective arousal. While the highest arousal emerged in the observer perspective for the contacts Rejection, Love and Neutral, the agent perspective produced the highest arousal for the contact Pain. This finding aligns with previous research showing that pain provokes strong subjective arousal in both perspectives, with a particularly pronounced effect in the agent perspective (Fusaro et al., 2016). For the contact Pain, the agent perspective elicited significantly stronger arousal than the observer perspective. This could be explained by the responsibility for inflicting pain, which may cause moral dissonance and stress (Festinger, 1957). This phenomenon could mirror the emotional reactions observed in the Milgram experiment (Milgram, 1963), where participants experienced emotional distress due to their perceived responsibility for causing harm, even though they were aware that this was part of an experimental set-up. This supports our findings and emphasises the role of moral dissonance and personal responsibility in emotional arousal. Moreover, it suggests that the contact Pain was indeed perceived as arousing and stressful, as intended.

Regarding the subjective ratings of valence, similar results were observed for the type of contact. All contacts were perceived differently in terms of their subjective valence. Negative contacts, such as Rejection (median = 4) and Pain (median = 2–3), were rated as unpleasant with low valence values, while Neutral was rated as neutral (median = 5), and Love was rated as pleasant with higher valence values (median = 6). As shown by Ocklenburg et al. (2018), physical contact in social contexts is associated with emotional valence. Stroking in contact Love enhances self-esteem and conveys protection, which likely explains its perception as pleasant (Harris and Orth, 2020). Given that humans, as social beings, are fundamentally dependent on positive interactions, the findings of Xie et al. (2023) support the notion that social rejection tends to elicit negative emotional reactions, which accounts for the unpleasant perception of the contact Rejection. The lack of a significant effect of perspective on subjective valence suggests that the evaluation of emotional content remains relatively stable across perspectives. This suggests that the perception of whether an emotion is positive or negative is influenced more by the emotional content of the stimulus than by the perspective from which it is viewed. This supports the validity of our stimulus material in terms of the intended affect of the contact. Furthermore, a significant interaction between contact and perspective was found. Descriptive statistics indicate that the effect of stimulus polarity is particularly pronounced from the agent perspective, where the differences between positive and negative valences are most evident. While the contacts Love and Neutral are perceived more positively from the agent perspective compared to the other perspectives, Rejection and Pain are rated most negatively. These findings highlight the relevance of the agent perspective, which may be attributed to the increased self-focus associated with this perspective (Panayiotou et al., 2007).

Overall, the subjective results consistently indicate that the perspective on the action plays a key role in assessing the intrinsic arousal of the contact. While the agent perspective generally leads to higher arousal, especially for Pain, the observer perspective leads to higher arousal for Rejection, Love and Neutral. In terms of valence, ratings remain stable across perspectives, with contact type being the primary determinant of emotional perception. However, the agent perspective strengthens the differences between positive and negative valences, highlighting the role of self-focus in emotional evaluation.

A similar pattern of findings emerges when examining the psychophysiological results: for EDA, post-hoc tests revealed significant differences in logMa between the agent and observer perspectives compared to the interaction partner perspective. Regarding contact, significant differences in EDA were only found between the contact Rejection and all other contacts. These results are consistent with previous studies (Rahma et al., 2022; Seppänen et al., 2021), which indicate that social rejection leads to a significant increase in EDA. This can be attributed to the strong human need for social belonging (Baumeister and Leary, 2017). Interestingly, in our study, the contact Rejection differed from Pain, showing higher logMa. Rejection is the only contact where the interaction partner's hand becomes active. This unexpected behaviour may have led to a stronger attentional response, possibly accompanied by higher sympathetic arousal (Sokolov, 1963). In addition to the inferential analyses, we examined the efficacy of the stimuli, defined as the percentage of trials that elicited a detectable SCR across participants. On average, efficacy was 76.6 % for Rejection, 72.4 % for Love, 71.5 % for Neutral, and 69.4 % for Pain. These values indicate that all stimulus categories reliably elicited SCRs well above the level of chance and are consistent with responsivity rates for emotional stimuli (Braithwaite et al., 2020). This supports the robustness of our paradigm and indicates that none of the categories fell below the threshold for responsivity. At the same time, stimulus efficacy represents an important consideration when interpreting SCR-based findings, and future research may benefit from systematically reporting both efficacy rates and effect magnitudes.

In terms of valence, perspective did not significantly affect BPM, but contact did. Post-hoc tests revealed a significant difference between the contact Rejection and all other contacts, with Rejection eliciting the highest heart rate. This suggests that the contact Rejection has a negative physiological connotation. This is consistent with the findings of Iffland et al. (2014), who also observed an increase in heart rate in response to social rejection. Furthermore, the unexpected behaviour of the interaction partner in the contact Rejection may explain the increased heart rate observed in this contact compared to the contact Pain (Jang et al., 2015).

Overall, the results suggest that logMa and HR show differential sensitivity to different aspects of the stimuli. LogMa is more sensitive to perspective, with higher activation observed for the agent and observer perspectives compared to the interaction partner perspective. In contrast, HR is primarily sensitive to emotional contact, with Rejection eliciting the highest HR, indicating a strong physiological response to social rejection. This suggests that HR reflects the valence of the contact, whereas logMa is more influenced by the perspective from which the stimulus is perceived and reflects arousal.

Future studies should adopt a perspective-based approach and present the videos multiple times to capture potential habituation effects, which could provide further insights into perceived valence. Furthermore, potential confounders such as age, gender (including the gender of the agent), depression and alexithymia (Bari et al., 2020; Di Tella et al., 2020; Sarchiapone et al., 2018) were not considered in the current analysis. Given that our sample scores fell within normative ranges on these variables, it seems unlikely that these have systematically biased the current results. The lack of a comprehensive analysis of psychological factors and combination of subjective and physiological data represent a limitation of the present study. These variables should be carefully considered and analysed in future research to better understand their potential influence on the outcomes. Although these aspects were not explored here, we were able to demonstrate that the videos elicit distinct subjective and physiological responses, supporting the adequacy of the stimulus material.

Our results, which align with a growing body of research (Braithwaite et al., 2020; Giesbrecht et al., 2010; Joshi et al., 2024; Nan et al., 2022), suggest that the dynamic stimuli used in this study are effective in eliciting distinct affective perceptions and responses at both subjective and psychophysiological levels, highlighting their potential in emotion research. Compared to static picture sets such as the IAPS (Bradley and Lang, 2007), our stimulus material captures the dynamic and interactive nature of social exchanges more realistically. By focusing on hands, it provides a highly universal, non-verbal format that conveys relational meaning with minimal interpretative variance (Hertenstein et al., 2006; Gallace and Spence, 2010). In the context of developments with dynamic video sets (Ack Baraly et al., 2020; Braithwaite et al., 2020; Tully et al., 2024), the present material extends this line of work by systematically covering a broader spectrum of social interactions. These interactions range from positive (Love) to aversive (Pain, Rejection) and neutral interactions, all within one unified paradigm. This diversity enables researchers to address perspective taking and empathy, domains that are not well represented by existing stimulus sets. The findings therefore support the use of the developed hand interaction videos as stimulus material for further studies, especially those involving clinical samples, particularly individuals with difficulties in emotion recognition and social interaction. This stimulus material represents a valuable tool for studying clinical groups, as it can help identify behavioural difficulties and pinpoint specific deficits in social interactions. Future research could further explore its use in clinical settings to deepen the understanding of emotional processing deficits and refine therapeutic interventions accordingly.

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CRediT authorship contribution statement

Anna-Maria Kisić: Writing – review & editing, Writing – original draft, Visualization, Validation, Software, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Ralf Schäfer:** Writing – review & editing, Validation, Supervision, Software, Resources, Methodology, Investigation, Conceptualization. **Kirsten Dammertz-Hölterhoff:** Writing – review & editing, Resources, Funding acquisition. **Mahboobeh Dehghan-Nayyeri:** Writing – review & editing, Software. **Valentina Niccolai:** Writing – review & editing, Methodology. **Ulrike Dinger:** Writing – review & editing, Supervision, Resources, Methodology, Funding acquisition, Conceptualization.

Declaration of Generative AI and AI-assisted technologies in the writing process

During the preparation of this manuscript, ChatGPT (GPT-4; GPT-4.5) and DeepL Write was used for coding support in data analysis and for language assistance in text refining. The AI tool was employed solely to enhance clarity and efficiency, the authors reviewed and edited the content as needed and take full responsibility for the content of the publication.

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Declaration of competing interest

The authors report there are no competing interests to declare.

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Data availability

Data will be made available on request.

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