What touching you makes me feel - hedonic and autonomic responses in promoting an affective touch

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Abstract

Interpersonal touch is intrinsically reciprocal since it entails a person promoting and another receiving the touch. While several studies have investigated the beneficial effects of receiving an affective touch, the affective experience of caressing another individual remains largely unknown.

Here, we investigated the hedonic and autonomic responses (skin conductance and heart rate) of people when they promote an affective touch. We also examined whether interpersonal relationship, gender, and eye contact modulate these responses. As expected, caressing the partner was perceived more pleasant then caressing a stranger, especially if the affective touch occurred together with mutual eye contact. Promoting an affective touch to the partner also resulted in a decrease of both autonomic responses and anxiety levels, suggesting the occurrence of a calming effect. Additionally, these effects were more pronounced in females compared to males, indicating that hedonic and autonomic aspects of affective touch are modulated by social relationships as well as by gender.

These findings show for the first time that caressing a beloved one is not only pleasant, but also reduces autonomic responses and anxiety in the person promoting the touch. This might suggest that affective touch has an instrumental role for romantic partners in promoting and reinforcing their affective bonding.

Introduction

Touch is the simplest and most direct of all sensory systems [1]. It has been described as the paramount mean of interpersonal exchange, which plays a crucial role in emotional processing, social interactions, and cognition (Gallace & Spence, 2010). The skin has been defined “a social organ” [4] and whether touch comes from a firm handshake, an encouraging pat on the shoulder, or a gentle caress, it has a strong and direct nonverbal communicative function [5]. The pleasant effects of social touch are mainly determined by a particular type of touch called *affective touch*; a touch resembling a caress, essential for emotions’ communication and social bonds [5]. The a*ffective touch* is a standalone type of tactile experience that relies on an the hyper-specialized somatosensory system, called CT-afferent system, which is activated by slow and gentle strokes (McGlone et al., 2007; McGlone et al., 2012) and a temperature close to the one of the human skin [8]. However, differently from the unequivocal nature of discriminative touch, *affective touch* can have a positive or a negative valence depending on several factors, such as speed and the body’s area in which the touch occurs (Gallace & Spence, 2010; McGlone et al., 2014), socio-cultural norms, context, gender [10], interpersonal relationships, identity of the person providing the touch (Lee & Guerrero, 2001; Ellingsen et al., 2016; Morrison et al., 2010), and nonverbal visual cues [13].

Research conducted across the last few decades has come to the agreement that the pleasant effects produced by *affective touch* vary as a function of the relationship between individuals. Undoubtedly, more frequent physical contact and closeness are observed among romantic partners than strangers. Being touched by one's partner lowers arousal levels by reducing the activity of brain areas involved in alarm processing (Coan et al., 2006; Triscoli et al., 2017), promotes recovery following a stressful event [16], diminishes pain perception, and prompts physiological coupling between partners [17]. On the contrary, being touched by a stranger does not produce the calming and analgesic effects observed between partners and it can rather induce states of anxiety and discomfort (Goldstein et al., 2017; Ellingsen et al., 2016). Indeed, an unexpected touch from a stranger is likely to be experienced as discomforting and unpleasant (Sussman & Rosenfeld, 1978).

Another relevant aspect reported to modulate the hedonic experience of *affective touch* is the gender of the subjects involved in the social interaction. Russo and colleagues (2020) have reported a gender asymmetry in the evaluation of *affective touch* with females showing higher sensitivity, pleasantness, and accuracy in communicating feelings and emotions via touch than men. For example, women respond more negatively than men when touched by a different-gender stranger [22]. Females also tend to find less pleasant a touch from a male stranger than a male friend, while men are equally comfortable with a touch from either a woman stranger or a woman friend [23]. Nonetheless, studies on the modulatory effect of gender on *affective touch* are dated [24], often inconsistent [25] and mainly based on participants' subjective rating.

Recent studies have also pointed out the possible contribution of visual cues as a factor that might come into play during *affective touch* (Ellingsen et al., 2016; Sailer & Leknes, 2022). Among several social cues, eye contact has been considered a rich source of social information that promotes social interactions in both human [27] and non-human primates [28]. Eye contact has been argued to play a leading role in strengthening emotional sharing between individuals and evoking positive affective reactions [29]. Nevertheless, the meaning of eye contact is subordinated to contextual factors and to interpersonal relationships (Emery, 2000; Dal Monte et al., 2016); an eye contact with a familiar person, but not with a stranger, can enhance affection, attention, and social inclusion [32]. Although eye contact is a key feature of social interaction and in daily life often *affective touch* occurs together with eye contact exchange, only a few studies have assessed the link between eye gaze and touch (Meier et al., 2020; Kerr et al., 2019), and their relationship still remains largely understudied.

However, previous research focusing on the influence of interpersonal relationship, gender, and eye contact only considered the person receiving an *affective touch*; how these factors drive the hedonic and autonomic responses on the person promoting an *affective touch* has been largely neglected.

To fill in this gap, with a series of experiments we investigated the hedonic and physiological responses on the person promoting an *affective touch*. In Experiment 1, we examined whether the interpersonal relationship (Partner vs Stranger), gender (Male vs Female), and visual feedback (Eye Contact vs Non-eye Contact) could modulate both the subjective experience and the autonomic responses of the person promoting an *affective touch* (hereafter also referred to as the "giver"). We measured hedonic responses while concomitantly tracking electro-dermal and cardiac activity. We hypothesized that participants would perceive more pleasant to caress their partner than a stranger, especially when the touch occurred during an eye contact exchange. On the contrary, stroking a stranger would result in an increase of autonomic responses as well as an increase of anxiety levels, and these effects might vary as a function of the giver's gender as well as eye contact condition. To investigate whether the physiological responses observed in Experiment 1 could have been driven by eye contact alone or by any anticipatory effects, we conducted Experiment 2 where we manipulated these two variables. In Experiment 2 we first assessed whether *affective touch* combined with eye contact produced a larger autonomic response than eye contact alone, then if such effect was larger with a stranger compared to the partner, and finally whether there were any gender differences. Moreover, to control that the increase in skin conductance observed during *affective touch* was related to touch and not driven by any anticipatory effects due to the instruction participants received, we varied the instruction's timing and removed any count-down so that participants could not predict the beginning of the touch. We hypothesized a stronger autonomic response when participants were engaged in an *affective touch* as compared to just mutual eye contact, as well as a higher hedonic experience when interacting with their partners as compared to a stranger. Additionally, we predicted that the increase in skin conductance during an *affective touch* would have been both independent from and larger than the physiological activity during the instruction period, thus, ruling out the possibility that the increase in skin conductance observed during *affective touch* could be driven by an anticipatory effect.

Results

Experiment 1

Fifty participants (25 females) engaged in an ecological interactive *affective touch* paradigm (Fig. 1a) while electro-dermal and electro-cardiac activities were tracked from the experimental subject (i.e., the giver) for the whole experiment. The experimental session included two blocks. The giver was invited to promote an *affective touch* over the receiver's forearm, who was the giver's partner in one block and a stranger (an opposite-gender confederate; Fig. 1b) in the other block. Since we were also interested in investigating the impact of mutual eye contact on *affective touch*, we employed two conditions: Eye Contact condition and Non-eye Contact condition (Fig. 1c), randomized within each block. As represented in Fig. 1d, at the beginning of each trial the giver was presented on the computer screen with the instruction for the upcoming touch together with a 5-second count-down. Then, the giver was invited to promote an *affective touch* to the receiver that lasted 36-second (6 consecutive strokes). Next, a Visual Analog Scale (VAS) was presented on the screen and the subject was asked to rate the pleasantness of the touch he/she had promoted. At the end of each block participants were asked to fill in the STAI-Y1 questionnaire to assess changes in their anxiety levels after promoting a touch to the partner (*Post-Partner*) and after promoting a touch to a stranger (*Post-Stranger*) compared to the beginning of the experimental session (Fig. 1e).

Hedonic responses

We first assessed whether the interpersonal relationship, gender, and eye contact could modulate the hedonic response on the person promoting an *affective touch*. The mixed-factors analysis of the variance (ANOVA) on subjective rating (VAS scores on pleasantness) having Other (Partner vs Stranger) and Gaze

(Eye contact vs Non-eye Contact) as within-subject factors and Gender (Males vs Females) as between-subject factor, showed a main effect of Other [$F_{(1, 48)} = 114.29$, $p < 0.001$, $\eta_p^2 = 0.705$], indicating that participants rated more pleasant to stroke their partner than a stranger. We also found a main effect of Gaze [$F_{(1, 48)} = 21.49$, $p < 0.001$, $\eta_p^2 = 0.309$], meaning that promoting an *affective touch* to another person is rated as more pleasant when touch is accompanied by mutual eye contact compared to non-eye contact. Crucially, a significant interaction Other*Gaze [$F_{(1, 48)} = 42.43$, $p < 0.001$, $\eta_p^2 = 0.469$] indicated that mutual eye contact enhances the perceived pleasantness of the *affective touch* compared to Non-eye Contact with the partner [$t_{(49)} = 7.60$, $p < 0.001$] but not with a stranger [$t_{(49)} = 0.22$, $p = 0.83$] (Fig. 2a). No other significant main effects or interactions were found.

These results show that the hedonic experience of promoting an *affective touch* is stronger when participants promote an *affective touch* to their partners and that such effect is enhanced when mutual eye contact occurred during the interaction.

Autonomic (skin conductance) responses

We next investigated whether the differences observed at the hedonic level were reflected on the giver's electro-dermal activity (EDA) (Fig. 2b-c**)**. The same mixed-factors ANOVA design used for VAS was run on EDA mean and showed a significant main effect of Gaze [$F_{(1, 48)} = 107.02$, $p < 0.001$, $\eta_p^2 = 0.690$; Fig. 2d], meaning an higher skin conductance level when an *affective touch* is accompanied by mutual eye contact as compared to non-eye contact. Even though the main effect Other did not reach statistical significance [$F_{(1, 48)} = 3.68$, $p = 0.061$; Fig. 2e] as expected, we found a significant interaction Other*Gaze [$F_{(1, 48)} = 12.48$, $p < 0.001$, $\eta_p^2 = 0.206$; Fig. 2f] indicating that autonomic responses during an *affective touch* vary as a function of both eye contact and the identity of the interacting person. In fact, only when an *affective touch* was accompanied by an eye contact, participants showed a higher level of skin conductance with a stranger compared to their partner [$t_{(49)} = 2.62$, $p = 0.012$]. This difference was instead absent during non-eye contact interactions [$t_{(49)} = 0.28$, $p = 0.78$]. Interestingly, we also observed a significant interaction Other*Gender [$F_{(1, 47)} = 7.493$, $p = 0.009$, $\eta_p^2 = 0.135$; Fig. 2g] indicating that only Females showed larger EDA mean when stroking a stranger compared to the partner [$t_{(24)} = 2.69$, $p = 0.013$]. This difference was not present in Male participants [$t_{(24)} = 1.48$, $p = 0.15$]. No other significant main effects or interactions were found.

These results show that promoting an *affective touch* to a stranger increases autonomic responses, and such effect is enhanced when mutual eye contact occurs during the interaction. Furthermore, the gender of the giver plays a significant role; females, but not males, show a greater increase in skin conductance when caressing a stranger compared to their partners.

Autonomic (heart rate) responses and subjective measures (self-report)

The mixed factors ANOVA on heart rate (beats per minute) averaged across the whole experimental blocks, with Other (Partner vs Stranger) as within-subject factor and Gender (Males vs Females) as between-subject factor, showed a significant Gender*Other interaction [$F_{(1, 46)} = 8.79$, $p = 0.005$, $\eta_p^2 = 0.160$; Fig. 3a]. This interaction, similarly to skin conductance's results, showed that only Female participants displayed a faster heart rate while promoting an *affective touch* to a stranger than to the partner [$t_{(23)} = 3.04$, $p = 0.006$], while Male participants did not show any differences in heart rate depending on the receiver's identity ($t_{(23)} = 1.16$, $p = 0.26$).

Next, using a self-report measure (State-Trait Anxiety Inventory-STAI-Y1) we assessed changes in anxiety levels related to an *affective touch.* The mixed factor ANOVA on the State-Trait Anxiety Inventory scores showed a main effect of Other [$F_{(1, 47)} = 46.83$, $p = < 0.001$, $\eta_p^2 = 0.499$; Fig. 3b]. As expected, we found a general increase in anxiety levels after promoting an *affective touch* to a stranger (4.08 ± 0.97) [$t_{(48)} = 4.19$, $p < 0.001$] and a decrease after promoting it to the partner (-2.88 ± 0.97) [$t_{(48)} = -2.6$, $p = 0.005$]. These results confirm that promoting *affective touch* to the partner produces calming effects, while promoting it to a stranger enhances anxiety. Additionally, we found a significant interaction Other* Gender [$F_{(1, 47)} = 4.14$, $p = 0.048$, $\eta_p^2 = 0.081$]. Both Males [$t_{(24)} = 3.98$, $p < 0.001$] and Females [$t_{(23)} = 5.53$, $p < 0.001$] showed a significant difference between caressing a Stranger and the Partner; however, for Male participants neither promoting an *affective touch* to the partner nor to the stranger significantly increased or decreased anxiety levels compared to their baseline [$\Delta_{Partner} = -2.4 \pm 1.34$, $t_{(24)} = -1.79$, $p = 0.09$; $\Delta_{Stranger} = 2.52 \pm 1.35$, $t_{(24)} = 1.86$, $p = 0.08$]. On the contrary, both effects were present in Females, for whom stroking the partner produced significantly calming effects, while promoting *affective touch* to a stranger raised their anxiety levels [$\Delta_{Partner} = -3.38 \pm 1.44$, $t_{(23)} = -2.35$, $p = 0.028$; $\Delta_{Stranger} = 5.71 \pm 1.35$, $t_{(23)} = 4.23$, $p < 0.001$]. Importantly, Males and Females did not differ in their anxiety level at baseline [$t_{(47)} = 0.401$, $p = 0.691$]. Additionally, Males and Females did not differ in their personal attitude toward social situations involving touch in everyday life, [as measured by the STQ; $t_{(48)} = -1.32$, $p = 0.193$], nor in subjective perception of the quality of their relationship [as measured by the DAS; $t_{(48)} = 0.31$, $p = 0.761$], nor in their level of distress when interacting with others [as measured by the SIAS; $t_{(48)} = -0.89$, $p = 0.373$] (see Methods section for details on questionnaires).

Overall, both skin conductance and heart rate measures reveal a larger autonomic activation in females compared to males when they had to promote an *affective touch* to a stranger. Crucially, these findings reflect the STAI-Y1 questionnaire results, in which only females reported a significant increase in their level of anxiety with a stranger and a reduction of anxiety after promoting an *affective touch* to their partner.

Experiment 2

To control that the hedonic and skin conductance responses observed in Experiment 1 were not driven by eye contact per se nor by any anticipatory effects linked to the trial's instruction, in Experiment 2 (N = 18 participants; 10 Females), we manipulated the aforementioned two variables. With an experimental setting similar to Experiment 1, in one block the giver promoted an *affective touch* to the subject's partner forearm while in the other block he/she stroked the forearm of a stranger (an opposite-gender confederate). As we were interested in investigating whether *affective touch* combined with eye contact produced a larger skin conductance response than eye contact alone, we employed two conditions: Touch + Eyes condition (Fig. 4a) and Eye Contact condition (Fig. 4b). Moreover, to confirm that the increase in skin conductance observed during *affective touch* was related to *affective touch* and not driven by any anticipatory effects, we varied the instruction timing (5, 10 or 15-second) and removed any count-down so that participants could not predict the beginning of the touch (Fig. 4c).

Hedonic responses

The mixed-factors ANOVA on subjective rating having Other (Partner vs Stranger) and Touch (Touch + Eyes vs. Eyes Only) as within-subject factors and Gender (Males vs Females) as between-subject factor showed a main effect of Other [$F_{(1, 16)} = 53.16$, $p < 0.001$, $\eta_p^2 = 0.769$], indicating that participants rated as more pleasant to stroke their partner than a stranger. We also found a significant interaction Other*Gender [$F_{(1, 16)} = 8.03$, $p = 0.012$, $\eta_p^2 = 0.334$] indicating that Females perceived as more pleasant to promote an *affective touch* to their partner than Males [$t_{(16)} = -1.95$, $p = 0.035$]. Crucially, a significant interaction Other*Touch [$F_{(1, 16)} = 15.97$, $p = 0.001$, $\eta_p^2 = 0.499$] indicated that an *affective touch* when combined with a mutual eye contact was perceived more pleasant than just an eye contact only with the partner [$t_{(17)} = 5.95$, $p < 0.001$] but not with a stranger [$t_{(17)} = 1.29$, $p = 0.215$]. No other significant effects or interactions were found.

These results, in line with those reported in Experiment 1, show that participants perceive as more pleasant to interact with their partners as compared to strangers. Crucially, the results also suggest that the pleasantness of promoting *affective touch* is enhanced by eye contact, but only when interacting with the partner.

Autonomic (skin conductance) responses and subjective measures (self-report)

Next, we assessed whether *affective touch* produced a different skin conductance response with respect to eye contact only. We also aimed to investigate whether such effect was larger with a stranger compared to the partner and if there were any gender differences. Thus, we ran a mixed factors ANOVA on EDA mean, with Other (Partner vs. Stranger) and Touch (Touch + Eyes vs. Eyes Only) as within-subject factors and Gender (Male vs. Females) as between subject factors. We found a significant main effect of Touch [$F_{(1, 16)} = 20.27$, $p < 0.001$, $\eta_p^2 = 0.559$], with Touch + Eyes condition showing larger values than the Eyes Only condition, suggesting that *affective touch* is accompanied by a larger skin conductance response than eye contact only (Fig. 4d). We also found a significant interaction Other*Touch [$F_{(1, 16)} = 4.66$, $p = 0.046$, $\eta_p^2 = 0.225$], indicating that the autonomic responses vary as a function of the receiver's identity. Promoting an *affective touch* to a Stranger compared to the Partner resulted in an increase in autonomic response [$t_{(17)} = 2.33$, $p = 0.034$] whereas this difference was absent during Eyes Only condition [$t_{(17)} = 0.05$, $p = 0.964$], indicating that larger EDA values with a Stranger than with the Partner were observed only when *affective touch* was involved, and not with eye contact alone (Fig. 4e). Lastly, we found a significant triple Other*Touch*Gender interaction [$F_{(1, 16)} = 9.64$, $p = 0.007$, $\eta_p^2 = 0.376$] (Fig. 4f). To disentangle this triple interaction, we ran two separate ANOVAs, one for Males and one for Females respectively, with Other (Partner vs Stranger) and Touch (Touch + Eyes vs. Eyes Only) as within-subject factors. For Male participants we only found a significant main effect of Touch [$F_{(1, 7)} = 5.60$, $p = 0.050$, $\eta_p^2 = 0.445$], with Touch + Eyes condition showing larger EDA values than the Eyes Only condition (Fig. 4f **inset**). As for Male participants, for Female participants we found a significant main effect of Touch [$F_{(1, 9)} = 19.30$, $p = 0.002$, $\eta_p^2 = 0.682$], with Touch + Eyes condition showing larger values than the Eyes Only condition; however, we also found a significant Other*Touch interaction [$F_{(1, 9)} = 37.68$, $p < 0.001$, $\eta_p^2 = 0.807$], showing that a significant difference in EDA response between Partner and Stranger was present only for the Touch + Eyes condition [$t_{(9)} = -2.82$, $p = 0.020$], and not for the Eyes Only condition [$t_{(9)} = 1.14$, $p = 0.285$]: this interaction suggests that larger EDA values with the stranger are observed only when *affective touch* is present, and not with eye contact alone (Fig. 4f). Moreover, in line with the findings of Experiment 1, participants reported higher levels of state anxiety after interacting with a stranger compared to their partner [$F_{(1, 16)} = 8.83$, $p = 0.009$] (Fig. 4g). No other significant effects or interactions were found.

Overall, these results show that *affective touch* produces a larger skin conductance response than eye contact alone, thus excluding that the effects observed in Experiment 1 were merely driven by mutual eye contact. Additionally, with Experiment 2 we replicated the results reported in Experiment 1. We found that a larger autonomic response occurs when an *affective touch* is given to a stranger compared to the partner and that this difference is enhanced with mutual eye contact, with stronger effects in female compared to male participants.

To confirm that the increase in skin conductance observed during *affective touch* was related to the touch and not driven by any anticipatory effects due to the instructions given to the participants, in Experiment 2 we also randomly varied the instruction time (5, 10, and 15 seconds; Fig. 5a-b) and removed any count-down from the monitor, so that participants could not predict the beginning of the touch. We targeted the first peak occurring after the end of the instruction period (i.e., during *affective touch*) and then tested whether the immediately preceding trough (i.e., the peak onset) occurred before or after the beginning of the *affective touch* (time zero), independently of the duration of the instructions. For all the three different timing used (5, 10, and 15 seconds) the peak onset occurred significantly after the beginning of the *affective touch* [for 5 seconds instructions: $t_{(17)} = 4.48$, $p < 0.001$ [mean = 1.25 sec; 95% confidence interval (CI) = ± 0.59 sec]; for 10 seconds instructions: $t_{(17)} = 3.89$, $p < 0.001$ (1.33 sec ± 0.72 sec); for 15 seconds instructions: $t_{(17)} = 3.40$, $p = 0.002$ (1.71 sec ± 1.06 sec)]. Similar results were observed when the analyses were performed separately for Partner and Stranger. These results show that phasic EDA activity during the trial is independent from EDA activity during the instructions and demonstrate that in our paradigms the skin conductance response during *affective touch* is not driven by any anticipatory effect.

Finally, we asked whether the skin conductance responses observed during the *affective touch* were not only independent from, but also larger than, those observed during the instruction's presentation. For each instruction time (5, 10, and 15-second) we calculated the difference between mean EDA activity during the affective touch and during the instruction period. The t-test on the difference between *affective touch* related activity and instruction related activity with the Partner (Fig. 5c) showed that this difference was significantly larger than zero [$t_{(17)}$ = 3.12, p = 0.003]; the same was true for the trials with affective touch delivered to the Stranger [$t_{(17)}$ = 3.34, p = 0.002] (Fig. 5d). These results show that the physiological responses are greater during the promotion of an *affective touch* than during the baseline. Thus, our findings suggested both an independent and a stronger autonomic response during an *affective touch* as compared to the instruction period.

Discussion

Affective touch plays a key evolutionary role in socio-emotional interactions, produces calming effects, promotes social bonding, and strengthens affiliative behaviors (Hertenstein et al., 2006; Cascio, 2010; Underdown et al., 2010). In the present study, our primary goal was to examine the hedonic experience and the autonomic responses on the person promoting an *affective touch.* Specifically, we were interested in investigating whether and to which extent the relationship between the giver and the receiver, the giver's gender and the occurrence of mutual eye contact could modulate hedonic and autonomic responses during an *affective touch.* We found that participants reported as more pleasant caressing their partners than a stranger and that this effect was enhanced when mutual eye contact occurred during the interaction. At the physiological level we observed that the skin conductance responses varied not only based on the interpersonal relationship between the two interacting participants (partner vs stranger), but also as a function of both the person's gender promoting the touch and the exchange of eye contact. Indeed, the difference in skin conductance between partner and stranger, with higher skin conductance activity when stroking a stranger compared to the partner, was enhanced when mutual eye contact occurred during the interaction. Additionally, we found that females showed a greater increase in skin conductance when caressing a stranger compared to caressing their partners, while this difference was not present for male participants.

These results show for the first time that promoting an *affective touch* is accompanied by context-specific hedonic experiences and elicits autonomic reactions in the person promoting it, and not only in the person receiving it, as the existing literature has previously shown. These findings also suggest that different social variables, such as giver's identity, gender and eye contact are encoded by the autonomic nervous system and can modulate the physiological responses in the person promoting an *affective touch*. Moreover, with Experiment 2 showing that the skin conductance increase during an *affective touch* was both independent and larger than the one measured during the instruction period, the possibility that the increase in skin conductance observed during an *affective touch* was driven by an anticipatory effect is excluded.

Subjective responses

At the hedonic level we found that promoting an *affective touch* to the partner was perceived as more pleasant than promoting it to a stranger. This finding goes beyond previous studies which found that etero-directed touch is more pleasant than self-directed touch [37,38] and revealed that the pleasantness of an etero-directed *affective touch* depends on the type of relationship between the giver and the receiver [15]. From the receiver's point of view, it has been reported that the degree of pleasantness of receiving an *affective touch* can vary as a function of the type of relationship; for instance, people are less comfortable being touched by a friend than by their partner [39], and even less by a stranger [12,18]. It is also well documented that humans are more prone to exchange social touch with people with which they share a close and intimate relationship [39] and that the beneficial effects of being touched are only present if the giver is a romantic partner [16,17]. However, tactile affective exchange is a mutual dyadic behavior, and our results, by supporting the notion that promoting an *affective touch* to the partner is perceived as more pleasant than promoting it to a stranger, complement previous studies that have investigated beneficial effects of *affective touch* only from the receiver's point of view.

Although most studies have avoided investigating the role of visual feedback between participants during *affective touch*, for example by separating participants with a curtain [15,37], we sought to understand how such variable might impact the experience of the person promoting an *affective touch.* We found that when an *affective touch* was accompanied by a mutual eye contact it further enhanced its pleasantness. Eye contact has been argued to play a major role in strengthening emotional sharing between individuals and evoking positive affective reactions [29]. In fact, the meaning of an eye contact is subordinated to contextual factors [30,40] and a direct gaze exchange with a familiar person can evoke positive affective reactions [32]. Thus, the enhanced pleasantness reported by a giver when an *affective touch* to his/her partner is combined with an eye contact could trigger an intrinsic hedonic reward and reinforce the motivational tendency to engage with a beloved one in an affective interaction.

Moreover, participants reported lower levels of anxiety after promoting an *affective touch* to their partner compared to a stranger, thus confirming that the beneficial calming effects of *affective touch* between romantic partners are present also in the person who promotes the touch. This finding is consistent with evidence showing that in romantic couples touch improves affectivity, increases well-being, and promotes profound bonding [41]. Indeed, receiving an *affective touch* from a partner helps regulating emotional responses [14], increases the feeling of been supported during distress [16] and attenuates pain perception [17]. The link between hedonic and calming effects of *affective touch* seems to rely on to the role of specific afferent fibers, the C-Tactile, which have been argued to mediate both pleasure [42] and stress reduction effects during *affective touch*[43]. Thus, our results suggest that also in the person promoting an *affective touch* the anxiety relief might be closely linked to the positive hedonic aspects.

Physiological responses

Together with the subjective hedonic experience and self-report anxiety level, we investigated the physiological responses by recording and tracking skin conductance and heart rate in the person promoting an *affective touch.* We found that caressing the partner compared to a stranger resulted in a general lower skin conductance activity. Skin conductance is a well-known indicator of autonomic arousal associated to affective states [44]; thus, our results could reflect a lower level of arousal when interacting and caressing the partner and an increased arousal with a stranger. Previous studies have reported several positive effects of *affective touch* between two partners both at the psychological [41] and physiological level [17]. Although based on the person receiving an *affective touch*, these observations have suggested that touch influences homeostatic modulation and conveys social meanings such as closeness and intimacy [45,46], by promoting positive effects on the person receiving it by eliciting C-Tactile fibers [47]. However, other studies also suggested that, at an inter-individual level, touch alone can mediate a co-adaptation of autonomic activities between interacting individuals [17] and thus may influence the giver as well. In line with this possibility, we found evidence that the modulating effect of *affective touch* on arousal is not restricted to the person receiving it, but it can also function as an input capable of modulating the physiological state of the giver itself. Additionally, to rule out that the physiological responses observed were not driven by any anticipatory effect, we conducted a second experiment and we reported both an independent and a stronger autonomic response during an *affective touch* compared to the period immediately preceding it.

Interestingly, we observed a gender asymmetry in autonomic responses in the person promoting an *affective tou*ch. Both skin conductance and heart rate activity suggested that in females, but not in males, stroking the partner reduces the arousal whereas *affective touch* promoted to a stranger increases autonomic responses. Similarly to skin conductance, a lower heart rate corresponds to a lower state of distress [48]; hence, our results strongly suggest that females benefit from the calming effect of promoting an *affective touch* to their partners. These physiological measures are supported by self-report anxiety states (STAI-Y1 questionnaire) which indicated that only females experienced an increase in anxiety after promoting an *affective touch* with a stranger and decreased anxiety after the interaction with their partner. The gender effect observed in our study align with previous findings reporting that touch from an opposite-sex stranger is more avoided [49] and perceived more unpleasant by women than by men who, on the contrary, report that it may be a quite pleasant experience [23]. Thus, our results are in line with what has been previously reported, providing new evidence on gender differences at the physiological level also when an *affective touch* is promoted.

Differences at the physiological levels were also observed when we manipulated the presence of mutual eye contact between the two participants. Indeed, *affective touch* and face-to-face interaction are two central elements of social exchanges [34] and eye contact itself has already been shown to have a strong communicative and affective value [29,50] and to produce increases in physiological activation (e.g., Helminen et al., 2011; Hietanen et al., 2008; Myllyneva & Hietanen, 2015; Pönkänen et al., 2011). We found that during an affective tactile interaction the physiological effects of an eye contact strongly depends on the relationship between the two people involved, with a greater physiological activation with a stranger than the partner. A direct eye contact with a stranger can evoke unpleasant and stressful reactions [30,32,40] and therefore increase level of arousal. Thus, an eye contact interaction with a stranger might be processed as a potential social threat hence eliciting rapid sympathetic responses, whereas an eye contact with a partner might be processes as a calming source of wellbeing reflecting a general down-regulation of autonomic alertness by readily recruiting a parasympathetic activation. As in everyday life an *affective touch* often occurs together with an eye contact exchange, with our second experiment we ruled out the possibility that autonomic responses when promoting an *affective touch* to either the partner or a stranger could be driven uniquely by an eye contact exchange. Indeed, we found that *affective touch* produced a larger physiological response than eye contact alone.

In conclusion, our results are the first showing that an *affective touch* interaction elicits autonomic reactions in the person promoting it, and not only in the person receiving it, as previously shown. Our findings highlight that the act of caressing a beloved one promotes a calming effect as well as an enhanced hedonic experience, and that such interaction is even more pleasant if accompanied by mutual eye contact. The autonomic system seems to encode and map the subjective experience with a greater decline in heart rate and skin conductance when caressing a partner compared to a stranger, which however are also modulated by both gender and mutual eye contact. On the other hand, interacting with a stranger while promoting an *affective touch* not only has been reported to be less pleasant and to increase anxiety levels but it is also accompanied by a general increase in the arousal level, although mediated by gender and eye contact between the two interacting participants. Thus, these findings suggest that the pleasantness of *affective touch* is not an isolated construct; it rather changes as a function of different and crucial social variables such as the relationship between the two individuals, the gender of the person promoting the touch, and mutual eye contact. Crucially, the hedonic experiences are mapped onto the autonomic responses of the person promoting the *affective touch.*

Methods

Experiment 1

Participants

Fifty participants involved in a heterosexual relationship for at least six months were recruited, and participate to the study accompanied by his/her partner. Our sample included 25 females (M = 24,2 years, SD = 2.52) and 25 males (M = 25,24 years, SD = 2.65). Four confederates (2 females and 2 males) played the role of the stranger. All experimental procedures were approved by the Bioethical Committee of the University of Turin and conducted in accordance with the ethical standards of the 2013 Declaration of Helsinki.

Experimental Design, setting, and task

During the experimental session participants sat in front of each other diagonally shifted in allocentric position (Fig. 1a). The receiver's right forearm was positioned on the table so that the giver could promote an *affective touch* with his/her right dominant hand. The giver was facing a computer screen located approximately 80 cm away, where trial-by-trial instructions were displayed. Before the beginning two Ag-AgCl non-polarizable electrodes were attached to the medial phalanges of the index and the ring fingers of the non-dominant hand by velcro straps. Electrodermal activity (EDA) was recorded for the whole experimental session by using an MP160 biosignal amplifier working with a specific acquisition module for electrodermal activity EDA100-C (Biopac Systems, Inc.). The gain parameter was set at 10 µSiemens (µS)/Volt and the signal sampled at 500 Hz with a 0.05 Hz high pass filter. Additionally, electrocardiogram (ECG) pre-gelled shielded electrodes were applied with a Lead II montage using the standard limb electrode placement (Lin et al., 2022). ECG was recorded by using an MP160 biosignal amplifier working with a specific acquisition module for electrocardiogram ECG100-C (Biopac Systems, Inc.). The gain parameter was set at 1000 (± 10 mV), and the signal sampled at 500 Hz with a 150 Hz low pass and a 0.05 Hz high pass filters.

The experimental session was divided into two blocks in which participants (i.e., the givers) were invited to promote an *affective touch* to a receiver. In one block, the receiver was the giver's partner; in another block, the receiver was a stranger (an opposite-gender confederate; Fig. 1b). Each block consisted of 18 consecutive trials. In 8 trials the participant was asked to deliver the *affective touch* to the receiver while looking at him/her in the eyes (Eye Contact condition); in another 8 trials, the participant was asked to deliver the *affective touch* to the receiver while looking at a fixation cross on the screen (Non-eye Contact condition; Fig. 1c). The remaining two trials were catch-trials in which participants were asked to touch their own forearm, with the aim of preventing habituation to etero-directed touch.

At the beginning of each trial the giver received on the screen the instruction for the upcoming touch (e.g., "Touch with Eye Contact") together with a 5-second count-down. Then, a 36-second fixation cross appeared on the screen and during this time the giver was invited to promote an *affective touch*. Next, a Visual Analog Scale (VAS) was presented on the screen for 14 seconds, and the subject had to rate the pleasantness of the touch he/she had promoted on a scale ranging from − 10 (Unpleasant) to 10 (Pleasant) by means of the computer mouse. Lastly, at the end of each trial a 5-second black screen was shown on the computer monitor, representing the inter-trial interval (ITI) (Fig. 1d).

Procedure

After being introduced to the study, each participant read and signed the consent form. Before the experimental session started, the area of touch (approximately 24 cm) was marked on both partners' and confederates' forearms. The touch was performed with the right hand (with index, middle and ring fingers) and executed in form of stroking movements with a speed of approximately 4 cm/s, which is the speed known to promote an *affective touch*[47]. Participants were trained to perform a light bidirectional touch to the forearm of the experimenter (from the end of the forearm to the wrist and in the opposite direction) with the help of a metronome, ringing every 6-second to indicate when to reverse the direction of touch. Following the training, each subject completed two experimental blocks: one with his/her partner and one with a stranger (confederate). At the end of each block participants were asked to fill in the STAI-Y1 questionnaire (see Questionnaires section for details) to assess changes in anxiety levels after promoting a touch to the partner (*Post-Partner*) and after promoting a touch to a stranger (*Post-Stranger*), compared to the beginning of the experimental session (Fig. 1e). The experiment had a total duration of about 40 minutes for each participant. Within each block, the order of trials presentation was pseudo-randomized, and the order of blocks presentation was counterbalanced across participants.

Questionnaires

Before the experimental session started, participants were required to fill out four self-report questionnaires: the Social Touch Questionnaire (STQ), a 20-item questionnaire that explores the personal attitude toward social situations involving touch in everyday life [56]; the Dyadic Adjustment Scale (DAS), a 32-item questionnaire that measures an individual's perceptions of their relationship with an intimate partner [57]; the Social Interaction Anxiety Scale (SIAS), a 19-items questionnaire that measures distress when meeting and talking with others [58]; and the State-Trait Inventory (STAI-Y1) a 40 items questionnaire assessing anxiety state ([59]. The STAI-Y1 was filled two additional times during the whole experiment: after the block with the partner and after the block with the stranger (see below for details).

Data processing and data Analyses

Hedonic subjective measures

Pleasantness rating from the giver (VAS) was analyzed with a 3-way mixed factors ANOVA with Other (Partner vs Stranger) and Gaze (Eye contact vs Non-eye Contact) as within-subject factors and Gender (Males vs Females) as between-subject factor. Significant interactions were followed up by Bonferroni-corrected t-tests for either dependent (Other and Gaze factors) or independent (Gender factor) samples and values of $p < 0.05$ were considered significant.

Autonomic measures - Skin conductance

The EDA data were filtered online using a 0.05 Hz high pass filter, then processed and analyzed offline using Matlab (release 2021a, The MathWorks, Inc.). Raw data were linearly detrended and numerically zeroed by subtracting the minimum EDA value within each recording window [60]. Next, we extracted the mean of the signal as an indicator of phasic skin conductance activity occurring during the epoch [61,62]. Lastly, the extracted mean values were normalized within each subject by means of an ipsatization [63] to control for interindividual variability: for each trial, the analyzed physiological measure was z-scored by subtracting the mean of all trials in all conditions for a given subject and divided by the standard deviation of all trials and conditions for that subject. Within-subject z transformations have the advantage of minimizing the impact of outlier values, because means are centered at zero and the within-subject variability is put on a common metric [63,64]. We analyzed the EDA activity for each trial (0–36 second) with a 3-way mixed factors ANOVA with Other (Partner vs Stranger) and Gaze (Eye contact vs

Non-eye Contact) as within-subject factors and Gender (Males vs Females) as between-subject factor. Significant interactions were followed up by Bonferroni-corrected t-tests for either dependent (Other and Gaze factors) or independent (Gender factor) samples and values of $p < 0.05$ were considered significant.

Autonomic measures - Heart rate

ECG heart rate (Beats Per Minute, BPM) data were averaged separately for each block (i.e., partner and stranger) and the recording time was 18 min for each block. For this interval and for each participant, the mean heart rate was calculated. For BPM, 4 out of 50 participants (i.e., 2 couples) were excluded from analyses due to bad sensor data. Data were normalized within each subject by means of an ipsatization [63], as reported above for EDA measures. BPM changes were analyzed with a 2-way mixed factors ANOVA with Other (Partner vs Stranger) as within-subject factor and Gender (Males vs Females) as between-subject factor. Significant interactions were followed up by Bonferroni-corrected t-tests for either dependent (Other factor) or independent (Gender factor) samples of $p < 0.05$ were considered significant.

Subjective measures

In order to assess the overall changes in state anxiety levels after promoting *affective touch* to the partner or to a stranger, we computed the difference (delta, Δ) between the respective post-block STAY-Y1 and the baseline STAY-Y1. This delta was computed as $STAI\text{-}Y1_{(Post-Stranger)} - STAI\text{-}Y1_{(Baseline)}$ for the stranger and as $STAI\text{-}Y1_{(Post-Partner)} - STAI\text{-}Y1_{(Baseline)}$ for the partner. Thus, positive values indicate an increase and negative ones indicate a decrease in anxiety state compared to the baseline. To investigate any difference in state anxiety changes, we ran a 2-way mixed factors ANOVA with Other ($\Delta_{Partner}$ vs $\Delta_{Stranger}$) as within-subject factor and Gender (Males vs Females) as between-subject factor. Also, to explore any increase or decrease in the anxiety after each experimental block, we compared each of the four conditions against zero to investigate a significant increase or decrease compared to baseline. One female subject was excluded from analyses due to missing data.

Experiment 2

Participants

Eighteen participants involved in a heterosexual relationship for at least 6 months were recruited for this experiment accompanied by his/her partner. Our sample included 10 females (M = 23,10 years, SD = 3.66) and 8 males (M = 23,12 years, SD = 3.52). As in Experiment 1, four confederates (2 females and 2 males) played the role of the stranger. All experimental procedures were approved by the Bioethical Committee of the University of Turin and conducted in accordance with the ethical standards of the 2013 Declaration of Helsinki.

Experimental Design, setting, and task

The experimental setting was similar to the one described in Experiment 1. Before the beginning of the experimental session, we positioned electrodes for recording EDA from the giver in the same locations and with the same parameters used in Experiment 1. The experimental session was divided in two blocks.

In one block, the receiver was the subject's partner, whereas in the other block the receiver was a stranger (an opposite-gender confederate) (Fig. 1b). Each block consisted of 20 consecutive trials. Because we were interested in investigating the differences at both the hedonic and physiological level between eye contact and *affective touch*, in 9 trials participants were asked to interact with the receiver by promoting an *affective touch* while looking at him/her in the eyes (Touch + Eyes condition) (Fig. 5a), while in other 9 trials participants were asked to interact with the receiver by merely engaging eye contact (Eyes-Only condition) (Fig. 5b). The remaining two trials were catch-trials in which the participants were asked to look at a fixation cross on the screen (on one trial) or to stroke their forearm while looking at a fixation cross on the screen (on the second one).

At the beginning of each trial the giver received on the screen the instructions for the upcoming trial. Instructions could either last 5, 10 or 15-second, and no visual count-down was presented on the screen (Fig. 5c**)**. Thus, in each trial participants could not predict when the experimental condition would have started. Participants were instructed to start the trial as soon as instructions disappeared from the screen. Then, similarly to Experiment 1, a 36-second fixation cross appeared on the screen: during this time, the giver was invited to promote either an *affective touch* while looking at the receiver in the eyes (Touch + Eyes condition) or to only engage in a mutual eye contact with the receiver, without promoting any affective touch (Eye Contact-only condition). Next, a Visual Analog Scale (VAS) was presented on the screen for 14 seconds, and the subject was asked to rate the pleasantness of the *affective touch* or eye contact he/she had promoted on a scale ranging from − 10 (Unpleasant) to 10 (Pleasant) by means of the computer mouse. Lastly, a 5-second black screen representing the inter-trial interval (ITI) was shown at the end of each trial (Fig. 5b).

Procedure

After being introduced to the study, each participant read and signed the consent form. Then we asked participants to fill in the STAI-Y1 questionnaire for assessing their anxiety state. The STAI-Y1 was filled two additional times during the whole experiment: after the block with the partner and after the block with the stranger (see below for details). Before the experimental session started, the area of touch (approximately 24 cm) was marked on both partners' and confederates' forearms. The touch was performed with the right hand (with index, middle and ring fingers) and executed in form of stroking movements with a speed of approximately 4 cm/s. Participants were trained to perform a light touch, lasted for 36-second, to the forearm of the experimenter bidirectionally with the help of a metronome, ringing every 6-second and indicating to reverse directionality of touch (from the end of the forearm to the wrist and in the opposite direction). They were also trained to perform an eye contact with the experimenter that lasted for 36-second with the help of a metronome (the same used for *affective touch* condition). At the end of each block participants were asked to fill in the STAI-Y1 to assess change in anxiety levels, compared to the beginning of the experimental session, after interacting with the partner (*Post-Partner*) and with a stranger (*Post-Stranger*).

The experiment had a total duration of about 40 minutes for each participant. Within each block, the order of trials presentation was pseudo-randomized, and the order of blocks presentation was counterbalanced across participants.

Data processing and data Analyses

Hedonic subjective measures

Pleasantness rating from the giver (VAS) was analyzed with a 3-way mixed factors ANOVA with Other (Partner vs. Stranger) and Touch (Touch + Eyes vs. Eyes Only) as within-subject factors and Gender (Males vs Females) as between-subject factor. Significant interactions were followed up by Bonferroni-corrected pairwise t-tests for independent samples and values of $p < 0.05$ were considered significant.

Autonomic measures - Skin Conductance

As in Experiment 1, we extracted the mean EDA value of the signal from 0 to 36-second and ipsatized those. Date where then analyzed with a 3-way mixed factors ANOVA with Other (Partner vs. Stranger) and Touch (Touch + Eyes vs. Eyes Only) as within-subject factors and Gender (Males vs. Females) as between-subject factor. Significant interactions were followed up by Bonferroni-corrected t-tests for either dependent (Other and Touch factors) or independent (Gender factor) samples and values of $p < 0.05$ were considered significant.

To investigate the presence of any anticipatory effects in trials where an *affective touch* was promoted (Touch + Eyes condition), we measured the onset latency of the first peak during *affective touch*: for each trial we extracted the latency of the first peak occurring during the experimental condition (i.e., after the instructions had disappeared from the screen); then, we measured when the first preceding trough occurred, i.e., where the same peak had started. Thus, if the peak had started raising *before* the beginning of the *affective touch*, the peak itself would have represented an anticipation-driven phasic response leaking into the trial period, making it a spurious response; on the contrary, if the peak had started raising *after* the beginning of the *affective touch*, it would have represented a pure trial-driven phasic EDA response. Our hypothesis was that the peak would have begun rising only after the beginning of the trial, independently of the duration of the instructions. To test this hypothesis, we ran three separate one-tail 1-sample t-tests, one for each level of instruction duration as we aimed at excluding any anticipatory effect of touch and eye contact in Experiment 1. Peak onset times in 5, 10, and 15 second instructions condition were contrasted against zero (the end of the instruction period). Peak detection threshold was set to 0.01 μS.

Also, to investigate whether EDA activity during *affective touch* was not only independent from, but also larger than the activity during the task instruction, we extracted the maximum value of the EDA signal during the instruction and during *affective touch* period (Touch + Eyes condition). For trials with 5-second baseline, we extracted the whole 5-second baseline signal and the first 5-second of the signal during *affective touch*; the same approach was adopted for trials with 10-second and 15-second instruction. Then, the difference $Max_{AffectiveTouch} – Max_{Instruction}$ was calculated in each time conditions (i.e. 5-, 10- and 15-second instruction duration). Deltas were then contrasted against zero by means of one-tailed 1-sample t-tests for both trials with Partner and Stranger, independently from baseline duration – i.e., aggregating trials with 5-, 10- and 15-second instruction duration. Our hypothesis was to observe positive deltas significantly different from zero, indicating a larger EDA signal during *affective touch* than during instruction.

Subjective measures

In order to assess the overall changes in state anxiety levels after promoting *affective touch* to the partner or to a stranger, as we have done for experiment 1, we computed the difference between the respective post-block STAY-Y1 and the baseline STAY-Y1. Thus, positive scores indicate an increase in state anxiety, negative scores indicate a decrease. We followed the same approach and analysis adopted in experiment 1. Briefly, we first ran 2-way mixed factors ANOVA with Other (Partner vs Stranger) as within-subject factor and Gender (Males vs Females) as between-subject factor. Next, we compared conditions against zero to investigate a significant increase or decrease compared to baseline.

Declarations

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

AUTHOR CONTRIBUTIONS

A.M., M.C., L.P., and O.D.M. designed the study, M.C., F.C., performed the experiments, A.M., M.D., analyzed the data, and A.M., M.C., F.C., S.S., L.P., and O.D.M. wrote the paper.

DATA AVAILABILITY STATEMENT

Behavioral and physiological data presented in this paper will be available upon request to the corresponding author (olga.dalmonte@unito.it).

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Figures

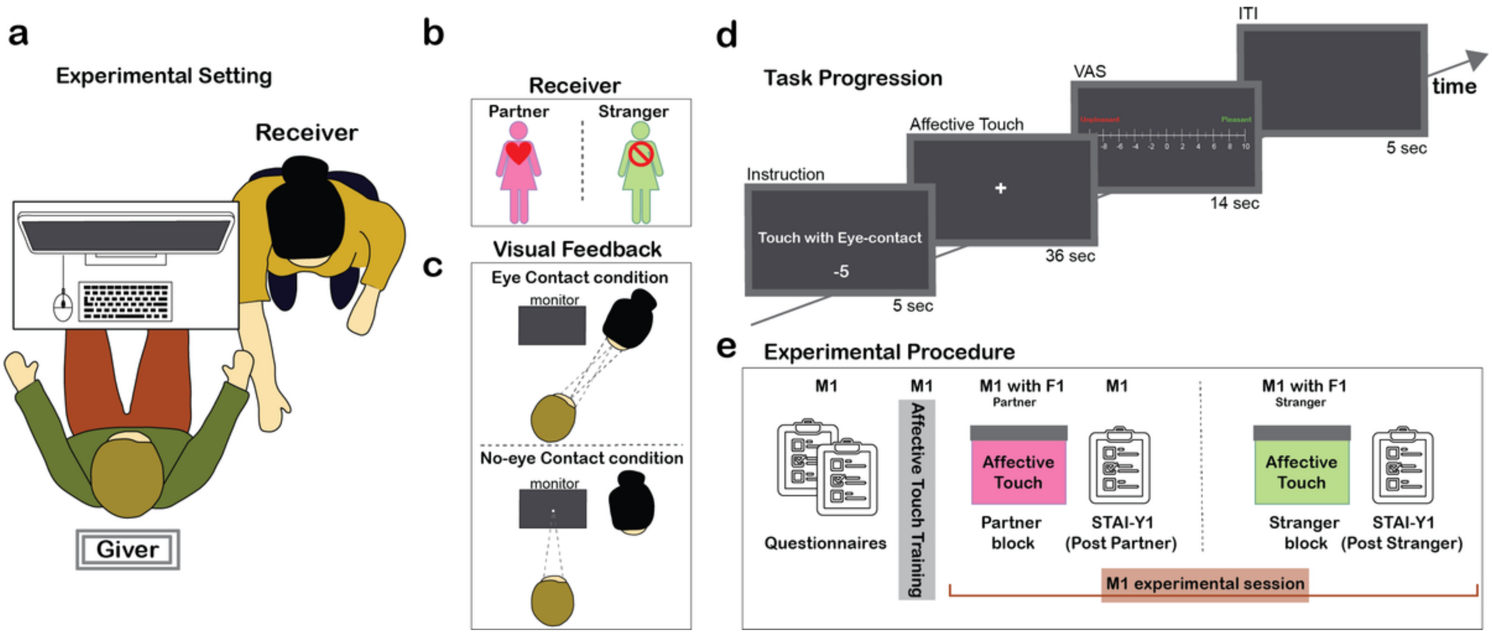

Figure 1

Experimental setting, variables, and task progression.

a) Experimental setting: The participants sat facing each other. Only the giver had a computer screen in front of him/her, showing trial-by-trial instructions. The giver participant gently stroked the right arm of the receiver participant/confederate with his/her dominant hand. b) Receiver's identity: The experiment consisted of two blocks, one with a stranger played by a confederate (left) and one with the giver's partner (right). c) Visual feedback: At the beginning of each trial in each block, participants were asked to give the *affective touch* while either exchanging a mutual eye contact with the receiver (Eye Contact condition; top) or looking at a fixation cross on the screen (Non-eye Contact condition; bottom). The two conditions were presented in a pseudo-randomized order. d) Task progression: Each block consisted of 18 trials lasting 1 minute each: 5s of instructions (promote the *affective touch*with or without eye contact); 36s of *affective touch*; 14s of pleasantness rating on a scale from -10 (unpleasant) to + 10 (pleasant); and 5s of inter-trial interval (ITI; return to baseline). e) Experimental procedure: At the beginning of each experimental session, subjects were invited to fill in four questionnaires (see Methods section). Illustrated an example sequence of one experimental session: before the beginning of the experimental session, M1 performed an *affective touch* training; then he completed the partner block and filled in the STAI-Y1 again (post Partner). After a break, M1 performed the stranger block and filled in the STAI-Y1 a third time (post Stranger).

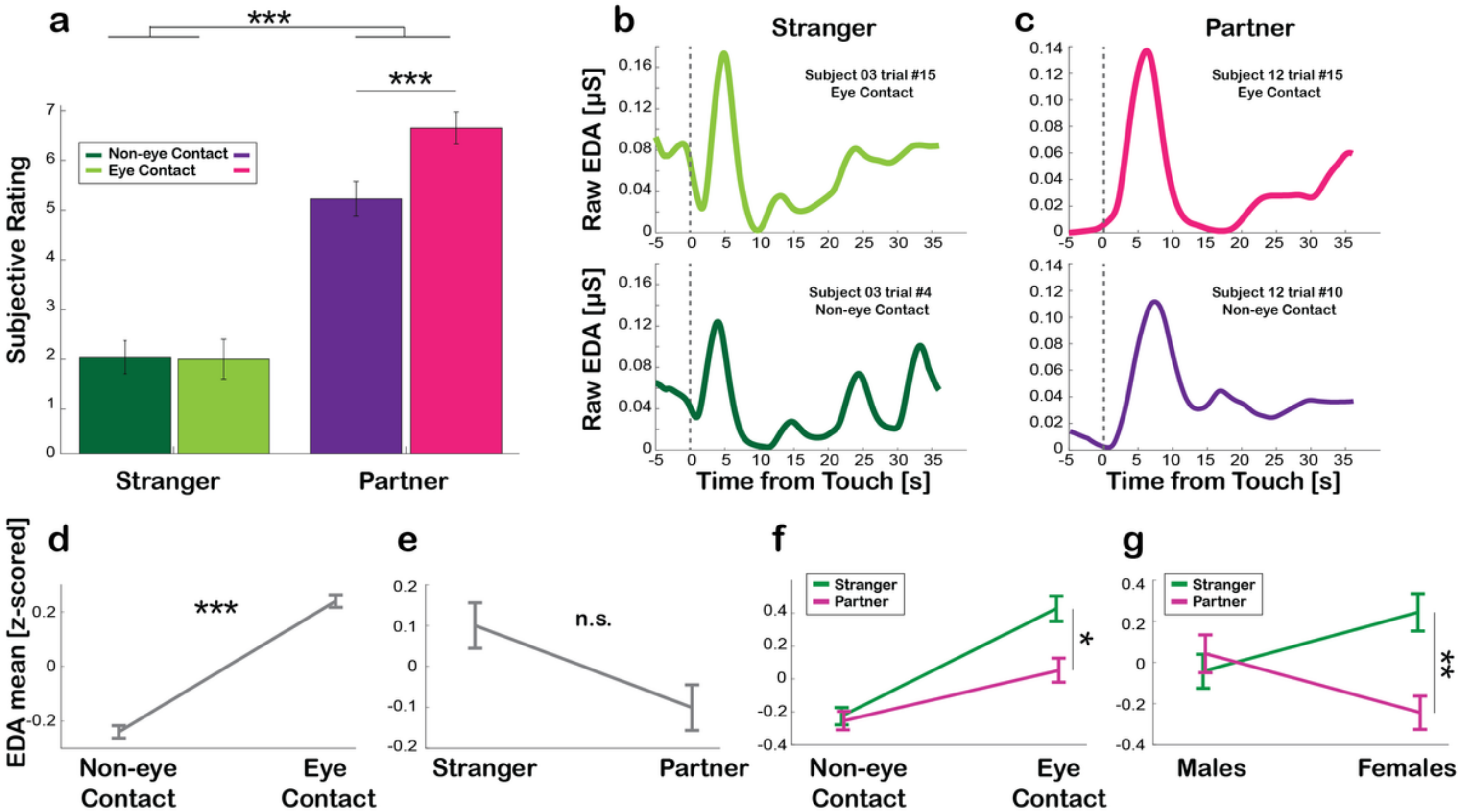

Figure 2

Hedonic and autonomic responses.

(a) Bar plots show the mean pleasantness ratings reported by participants in the four conditions: *affective touch* given to a Stranger without Eye contact (Non-eye Contact condition; dark green), to a Stranger with Eye contact (Eye Contact condition; light green), to the Partner without Eye contact (dark purple) and to the Partner with Eye contact (light purple). Values shown are the mean ± 1 s.e.m. **(b)** Single-trace examples of raw electrodermal activity (EDA) aligned to the time of *affective touch* with a Stranger, with or without Eye contact (light green on the top and dark green at the bottom, respectively). Vertical dotted grey line indicates the beginning of *affective touch*period (36-second duration). **(c)** Single-trace examples of raw EDA activity aligned to the time of *affective touch* with the Partner, with or without Eye contact (light purple and dark purple, respectively), same format as b. **(d)**z-scored mean EDA values during *affective touch* delivered without eye contact (Non-eye Contact condition) and with eye contact (Eye Contact condition). **(e)**z-scored mean EDA values during *affective touch* delivered to a Stranger and the Partner. **(f)**z-scored mean EDA values when *affective touch* was delivered without eye contact (Non-eye Contact condition) and with eye contact (Eye Contact condition) separately for the Stranger (green) and the Partner (purple). **(g)** z-scored mean EDA values when *affective touch* was delivered by Males or Females, separately for Stranger (green) and Partner (purple). Values shown are Z-scored ± s.e.m. Significant results are indicated by asterisk * = p < 0.05; ** = p < 0.01; *** = p < 0.001. n.s. = not significant.

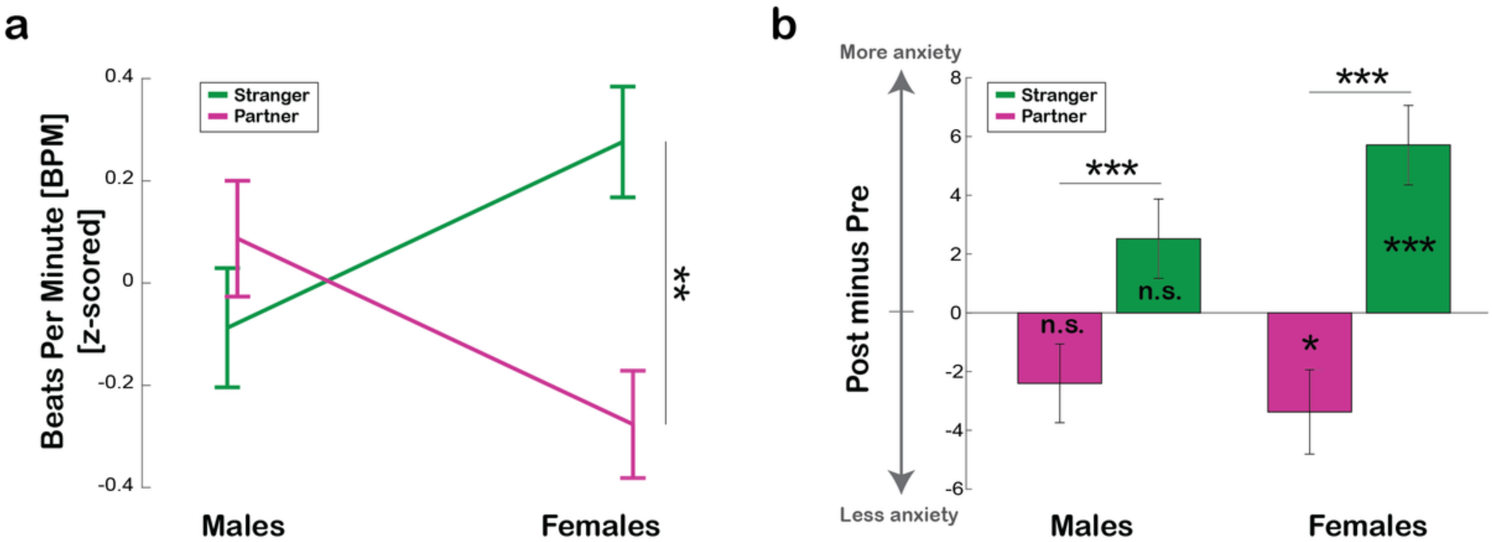

Figure 3

Heart rate and Self-reported anxiety levels.

(a) z-scored heart rate (beats per minute; BPM) when *affective touch* was delivered by Males or Females to either a Stranger (green) or the Partner (purple). Heart rate was extracted considering the whole block duration, for both Partner and Stranger blocks. **(b)** State anxiety variations as measured by State-Trait Anxiety Inventory reported by Males and Females after completing the Stranger (green) and the Partner (purple) blocks; significance values depicted inside the bars indicate the p-values of t-tests against zero for each condition separately. Values shown are the mean ± 1 SEM. Significant results are indicated by asterisk * = p < 0.05; ** = p < 0.01; *** = p < 0.001. n.s. = not significant.

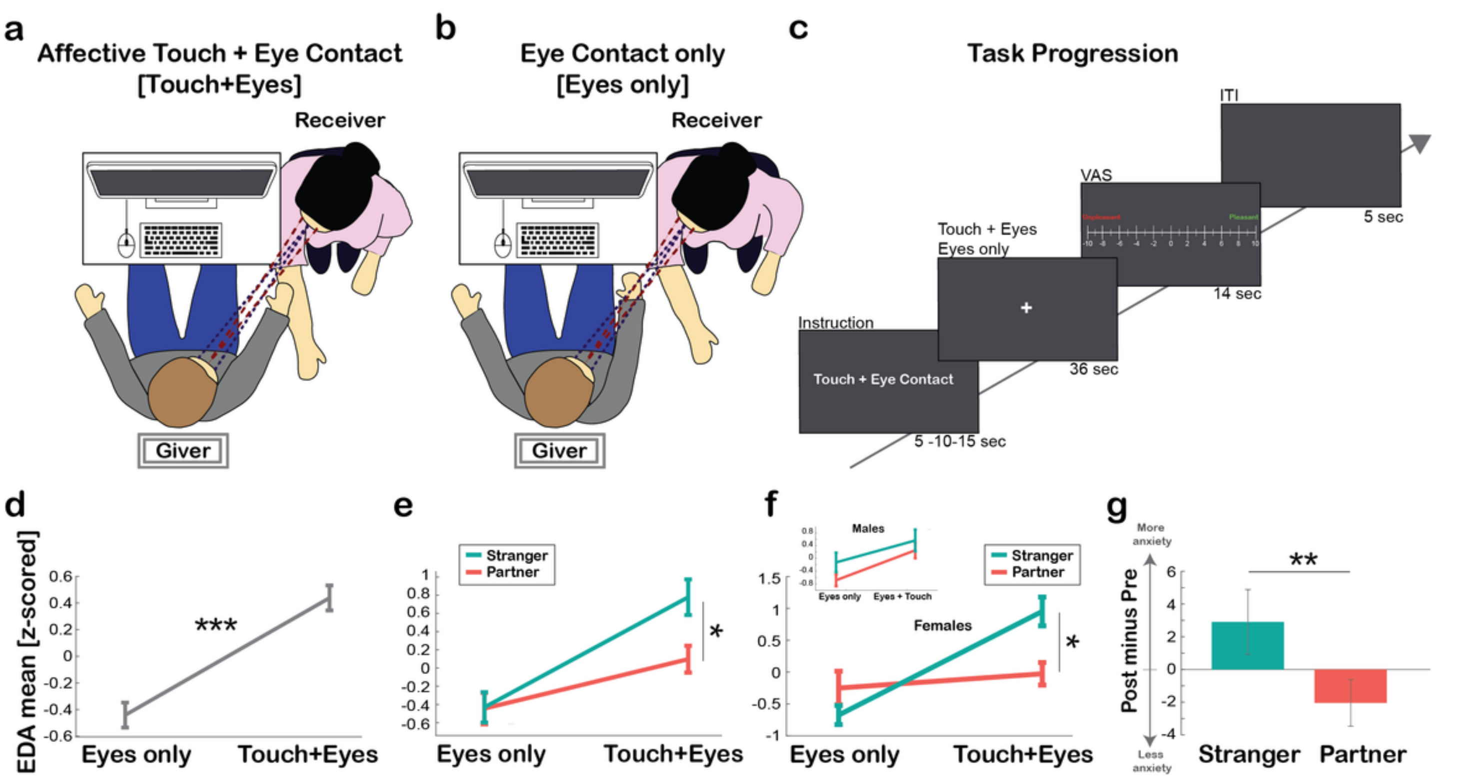

Figure 4

Experimental setting, hedonic and physiological responses.

a) Experimental setting: participants sat facing each other. Only the giver had a computer screen in front of him/her, showing trial-by-trial instructions. The giver participant promoted an *affective touch* on the right arm of the receiver participant with his/her dominant hand while looking at him/her in the eyes (Touch+Eyes). The receiver was either his/her partner or a stranger played by a confederate. **b)** Same format as in **a** but depicting the eye-contact only condition (Eyes Only). **c)** Each block consisted of 20 trials. The instructions presented on the screen had three different presentation times (5, 10 or 15-second), then at the end of the instruction a white cross appeared on the screen indicating the beginning of the experimental condition (i.e., Affective Touch + Eye Contact or Eye Contact only) and lasted for 36-second. After that, a VAS for pleasantness rating was presented for 14-second ranging from -10 (unpleasant) to + 10 (pleasant); and followed by 5-second of inter-trial interval (ITI). **(d)** z-scored mean EDA values during a mutual eye contact exchange and without touch (Eyes Only) and during and *affective touch* and eye contact (Touch+Eyes). **(e)** z-scored mean EDA values during Eyes Only and Touch+Eyes separately for Stranger (light green) and Partner (light red). **(f)** z-scored mean EDA values when Females (main plot) and Male (inset) engaged in a mutual eye contact exchange (Eyes Only) and in an *affective touch* combined with an eye contact (Touch+Eyes) separately for the Stranger (light green) and the Partner (light red). **(g)** State anxiety variations after interacting with a Stranger (light green) and the Partner (light red). Values shown are the mean ± 1 s.e.m. Significant results are indicated by asterisk * = p < 0.05; ** = p < 0.01; *** = p < 0.001.

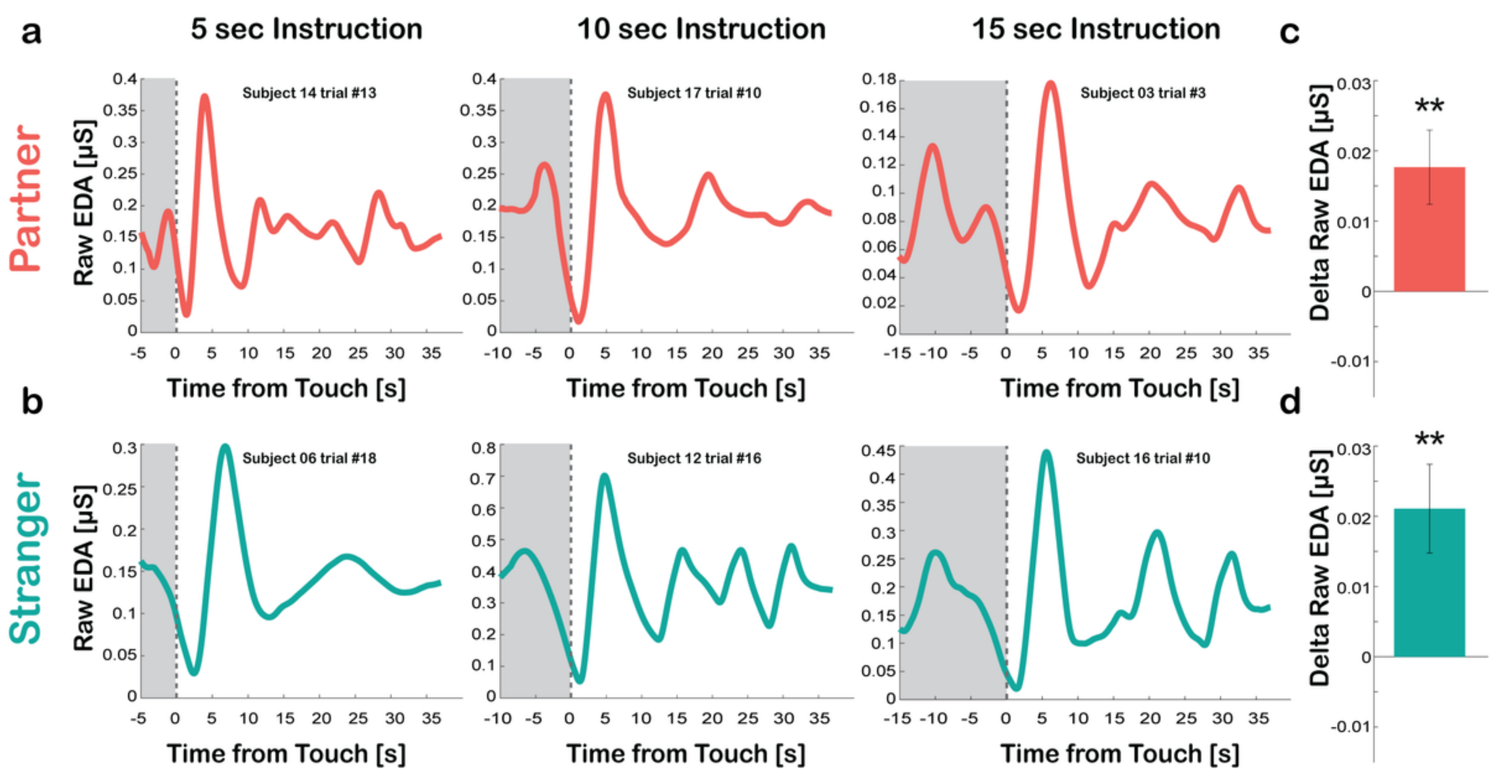

Figure 5

Electrodermal activity during the instruction and during *affective touch*.

(a) Single-trace examples of raw EDA activity aligned to the time of *affective touch* with the Partner. Vertical dotted grey line indicates the beginning of *affective touch* period (from 0 to 36-second). Shaded area represents period after instruction onset (5, 10, and 15-second). **(b)** Single-trace examples of raw EDA activity aligned to the time of *affective touch* with a Stranger, same format as b. **(c)** Delta of raw mean EDA values during *affective touch* with the Partner minus the raw EDA activity during the instructions **(d)** Delta of raw mean EDA values during *affective touch* with a Stranger minus the raw EDA activity during the instructions. Values shown are the mean ± 1 s.e.m. Significant results are indicated by asterisk ** = $p < 0.01$.