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Touch as a Stress Buffer? Gender Differences in Subjective and Physiological Responses to Partner and Stranger Touch

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Abstract
Interpersonal touch buffers against stress under challenging conditions, but this effect depends on familiarity. People benefit from receiving touch from their romantic partners, but the results are less consistent in the context of receiving touch from an opposite-gender stranger. We propose that there may be important gender differences in how people respond to touch from opposite-gender strangers. Specifically, we propose that touch from an opposite-gender stranger may only have stress-buffering effects for men, not women. Stress was induced as participants took part in an emotion recognition task in which they received false failure feedback while being touched by a romantic partner or stranger. We measured subjective and physiological markers of stress (i.e., reduced heart rate variability) throughout the experiment. Neither stranger's nor partner's touch had any effect on subjective or physiological markers of stress for men. Women, however, subjectively experienced a stress-buffering effect of partner and stranger touch, but showed increased physiological markers of stress when receiving touch from an opposite-gender stranger. These results highlight the importance of considering gender when investigating touch as a stress buffer.

Keywords Touch · Gender · Subjective stress · Heart rate variability

Introduction

Accumulating research indicates that interpersonal physical proximity, in particular touch, contributes to well-being (for a review, see Jakubiak & Feeney, 2017). Moreover, in challenging contexts, touch appears to buffer stress reactions (e.g., Coan et al., 2017; Ditzen et al., 2019). However, the benefits of touch seem to depend on the relationship between the individuals involved (e.g., Saarinen et al., 2021). While it may be beneficial to receive touch from a very familiar person, such as one's romantic partner, it could be far less beneficial from an unfamiliar person, such as a stranger. Past results have been inconsistent

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as to the benefits of receiving touch from strangers, suggesting the potential presence of a moderating factor. Here, we suggest that one factor may be gender. We predicted that men and women would experience similar stress-buffering benefits when receiving touch from an opposite-gender romantic partner, but only men would experience stress buffering effects when receiving touch from an opposite-gender stranger. Therefore, the present study examined whether there was an interaction between familiarity (i.e., romantic partner versus a stranger) and the target's gender (man versus woman) on the stress-buffering benefits of receiving physical touch.

Touch and Well-Being

Throughout the lifespan, touch is a common and important interpersonal behavior, especially within close relationships (Beltrán et al., 2020; Cascio et al., 2019). Touch is not only associated with psychological, physical, and relational well-being, but also *causally* increases well-being (for a review, see Jakubiak & Feeney, 2017). There is strong evidence for the benefits of receiving touch from a familiar person, like one's romantic partner, when it comes to psychological well-being. Daily touch behaviors predict subsequent increases in momentary positive affect for both the giver and the receiver (Debrot et al., 2021). Moreover, daily touch frequency predicts partner psychological well-being six months later (Debrot et al., 2013).

These benefits seem to be particularly notable in stressful situations (for a review about the calming effect of touch, see Eckstein et al., 2020). Partner touch reduces the subjective experience of strain (i.e., the individual reaction to stressors; Dewe et al., 2012) assessed both globally (Floyd et al., 2009) and at the daily level (Burleson et al., 2007). Moreover, during a stress induction, in which participants had to recount a personal moment of stress, people who received touch from their romantic partner felt less stressed and more self-confident after the discussion; and these effects hold even for imagined touch (Jakubiak & Feeney, 2019b). In two experiments, participants provided lower pain ratings and reported less stress when imagining that their partner was touching them in stress-inducing situations (Jakubiak & Feeney, 2016). Likewise, participants exhibited less subjective and observer-coded strain in a real or imagined conflict discussion with their romantic partner when they touched them or imagined touching them (Jakubiak & Feeney, 2019a).

In addition to subjective experiences of stress, many studies indicate that partner touch reduces stress-related physiological activation, in particular a more favorable neural activation in response to a physical threat (Coan et al., 2006, 2017). Eckstein and colleagues (2020) propose that, besides the neural mechanisms underlying the calming effects of touch, the latter has a stress-dampening effect via two main axes of stress hormones, the hypothalamic–pituitary–adrenocortical (HPA; mostly assessed via cortisol) and the sympathetic–adrenomedullary (SAM) system, which influence the heart rate response. Supporting the HPA-axis pathway, research evidenced that spontaneous partner touch accelerates cortisol recovery after a social stressor in the lab (Ditzen et al., 2019), and after a stressful experience in daily life (Schneider et al., 2023). Research also supports the effect of touch through the SAM system. For example, instructed partner hugs decrease blood pressure (Light et al., 2005). In a female sample, Ditzen et al. (2007) found that positive physical partner contact before experiencing social stress led to significantly lower heart rate responses. Similarly, warm partner contact prior to a social stress induction was related to lower blood pressure and heart rate reactivity to the stressor (Grewen et al., 2003). Further, research indicated that *being stroked* by one's partner reduces heart rate, an effect not found for *stroking* the partner or self-stroking (Triscoli et al., 2017a, 2017b).

Some studies have also shown a beneficial effect of touch on the parasympathetic branch of the autonomic nervous system. The main component of this system is the vagus nerve, whose activity is often non-invasively measured via heart rate variability (HRV), i.e., variability in the time between heart beats. In a subsample of student couples, Conradi and colleagues (2020) showed that holding hands after conflict discussions increased post-discussion HRV. Other studies have found that HRV increased after massage interventions (Edwards et al., 2018; Lindgren et al., 2010) and brush stroking (Triscoli et al., 2017a, 2017b). However, to the best of our knowledge, none of the studies using HRV as an outcome compared touch from people with different levels of familiarity.

The benefits of receiving touch from romantic partners do not consistently generalize to touch with less familiar individuals. For example, two studies demonstrated greater attenuation of the stress-based neural responses when touch was provided by a spouse as opposed to a stranger (Coan et al., 2017). Another study showed a greater pain reducing effect (Kreuder et al., 2019) and a more pleasant perception (Kreuder et al., 2017) of touch when participants believed their partner was touching them as opposed to a stranger. Effects of stranger touch are not uniform across indicators, however. Vrana and Rollock (1998) found that being touched by an experimenter reduced heart rate, a sign of physiological calming, but increased skin conductance, a sign of physiological arousal. These inconsistent findings about receiving touch from a stranger suggest the presence of a potential moderator. Gender could be a moderator, as we argue below.

Gender Differences in Touch

Emotional and physiological benefits of receiving touch from a familiar person, such as a romantic partner, appear to be similar for men and women. Indeed, daily touch is associated with a similar improvement of momentary affective state for both men and women (Debrot et al., 2013, 2017). Receiving touch also reduces cortisol secretion, accelerates cortisol recovery, and decreases heart rate and blood pressure during stress exposure in a similar way for men and women (Ditzen et al., 2008, 2019). Moreover, after a four-week touch intervention, both men and women exhibit similar increases in oxytocin and decreases in cortisol and alpha-amylase (Holt-Lunstad et al., 2008).

At the same time, within couple relationships, some gender differences have been noted. Within Holt-Lunstad and colleagues' (2008) study, men benefited more from a touch intervention for their blood pressure than women. Major and colleagues (1990) reported that men are more likely to touch their partners, when they are not in highly ritualized contexts (e.g., greeting or leave-taking settings), though men tend to initiate touch more in casual relationships, whereas women do so more in married relationships (Guerrero & Andersen, 1994). In addition, meta-analytic evidence shows that women appraise touch as more pleasant than men (Russo et al., 2020). Generally, though, touch appears to be beneficial across genders when received from one's romantic partner.

When considering touch between strangers, the picture becomes more complex. For example, touch from an opposite-gender stranger was considered as unpleasant by women, but quite pleasant by men (Heslin et al., 1983). These differences hold even in the case of coercive touch; Struckman-Johnson and Struckman-Johnson (1993) found that, when rating vignettes in which participants were asked to imagine receiving an unsolicited genital touch from an opposite-gender college acquaintance, women anticipated strong negative effects, whereas men did not. Also, Kirsch et al. (2018) showed that men perceive a caressing touch from a female experimenter as rewarding, whereas women do not. Further, in the work context, workers perceived women's touch as more benevolent and men's as more indicative of romantic attraction (Lee & Guerrero, 2001), and, in a shopping context, accidental touch by an unknown consumer was perceived negatively by both genders, especially when the toucher was male (Martin, 2012). Similarly, Suvilehto and colleagues (2015) found that, across different types of relationships, people allowed touch from women on larger parts of the body than male touch. However, studies that examined touch from an opposite-gender stranger when making a request found that both genders were more likely to respond positively to the request when touched (Brockner et al., 1982; Guéguen, 2007, 2010).

Regarding physiological responses to touch from strangers, two studies indicate that same-gender touch has higher stress-buffering consequences for women than for men. First, Brockner et al. (1982) found that men had greater increase in heart rate than women when touched by a same-gender experimenter. Second, heart rate decreased more strongly among women than men after being touched by a same-gender experimenter (Vrana & Rollock, 1998). No gender difference was reported, however, regarding the stress-buffering effect of an unknown woman's touch on the cortisol response (Dreisoerner et al., 2021). Importantly, in neither case were participants systematically touched by a stranger of the opposite gender.

This set of studies suggests that, among strangers, women's touch is perceived more positively than men's, and that men perceive touch from opposite-gender strangers more favorably than women. A possible explanation is that women have been shown to communicate more positive emotions via touch (sympathy and happiness), while some negative emotions (e.g., anger) are only communicated when a man is present (Hertenstein & Keltner, 2011). Moreover, those gender differences may also have some origins in historical differences in power dynamics in which men held greater power. Less powerful individuals (such as women; Carli, 1999) typically experience more negative affect, behave in more inhibited ways and pay more attention to others' interests (Keltner et al., 2003). For women, receiving touch from a man may have taken on more coercive or forced elements, such as touch generally does in daily life in public spaces. Indeed, Uggen and Blackstone (2004) demonstrated that gender was linked to specific sexual harassment behaviors (generally, perpetuation for men and victimization for women), including unwanted touch. To our knowledge, no study has yet investigated how the level of familiarity among touchers interacts with gender to predict the reaction to touch. Therefore, we sought to fill this gap.

Taken together, these results indicate that gender differences might emerge in the context of opposite-gender stranger touch. In many ways, gender may act as a suppressor effect, making it difficult to identify whether touch generally offers benefits in the context of strangers. We hypothesized that touch from a familiar person, such as a romantic partner would have similar stress-buffering effects for men and women, but touch from an unfamiliar person, such as a stranger, would only provide stress-buffering effects for men, not for women.

The Current Study

Participants took part in an experiment in which we induced stress by providing false failure feedback (van den Hout et al., 2001). The task, introduced as measuring a critical skill for academic and professional success, consisted in recognizing emotional expressions.

High professional performance is highly valued in our post-industrialized cultural context (Walker & Caprar, 2019) and failing a relevant task could be particularly stressful, especially for people aiming at a higher education degree, like students. Moreover, evaluations are part of students' daily life and, as they are typically motivated to succeed in them, they might thus be particularly sensitized to this type of stress. Participants either received touch (a hand on the shoulder) from a romantic partner, a stranger, or none in a between-person design. We chose a behavior that could be standardized and still be suitable for both the stranger and the partner condition, so that any potential differences could not be attributed to different behaviors. Additionally, the behavior had to allow the participant to conduct the experimental task undisturbed. A recent study indicates that CT-optimal touch (i.e., gentle stroking) is less preferred over a more static touch behavior for emotion regulation, especially in intense situations (Sened et al., 2023). We measured the subjective experience of stress with self-reported affective responses and an objective marker of stress with heart rate variability (A. P. Allen et al., 2014; Thayer et al., 2012). We focused on high frequency heart rate variability (HF-HRV) because it has been used in past work (e.g., Conradi et al., 2020), giving us other findings with which to compare our own. In addition, HF-HRV, which indexes vagal activation within the parasympathetic branch of the autonomic nervous system, is more flexible and dynamic in response to acute stressors, such as our task, compared to measures from the sympathetic branch (e.g., skin conductance levels). The vagus nerve can quickly withdraw, leading to HF-HRV decreases during stressful situations, which allow for increases heart rate that allow the body to access greater metabolic energy (Porges, 2007). In addition, increased vagal activation has been implicated in caretaking and touch (Wilhelm et al., 2001). Therefore, greater HF-HRV would indicate alleviated stress in response to touch whereas lower Hf-HRV would indicate greater stress.

First, we expected a main effect of touch (both from strangers and romantic partners compared to receiving no touch) in reducing the stress response (Hypothesis 1). Second, we expected that this effect would be stronger in the condition where touch was provided by a romantic partner (as opposed to a stranger; Hypothesis 2). Third, we expected that gender would interact with relationship familiarity (romantic partner versus stranger) such that there would be no gender differences in the response to partner touch, but men would benefit more from opposite-gender stranger touch than women (Hypothesis 3). We compared all conditions to a no touch condition, but also tested the effect of gender within each level of familiarity and the effect of familiarity for each gender to tease apart the role of each variable (familiarity and gender of the target) when receiving touch from a person of the opposite gender.

Methods

Participants

We conducted the recruitment in two phases. In the first phase (pre-covid), we recruited participants by giving a short presentation in several well-attended university classes (first-year med school, law, etc.), posting announcements and posters, sending emails to several colleges, and distributing (electronic) flyers. In the second phase (post-covid), we recruited in a first-year psychology student class, by snow-ball effect and via social media posts. We informed that the study was testing a new method for assessing an emotional competence task that could potentially be incorporated in a new procedure to select university students.

To participate: a) participants had to be in a romantic heterosexual relationship for at least three months, b) both partners had to participate, c) they had to be between 18 and 40 years old, d) they had to have a high school degree. We excluded from participation people who had a serious illness, had a diagnosed mental disorder, took psychoactive drugs, or were parents. To determine the sample size, we conducted a power analysis for ANCOVAs using G*Power (Buchner et al., 2014). Based on an α-level of 0.05, a sample size of 211 participants was recommended to obtain a power of 0.80 to detect a medium effect size (Coan et al., 2006). One hundred and eleven couples (222 participants) took part in the study. Their ages ranged between 19 and 36 years ($M = 23.30$, $SD = 3.27$), with relationship duration ranging from three months to 10 years ($M = 30.55$, $SD = 24.26$ months). This sample was used for the analyses with subjective stress as an outcome. However, due to problems in reading the original files, only 153 participants could be used in the analyses with HRV as an outcome.

Procedure

The present procedure was approved by the local state ethics committee. If participants met the criteria, both partners came to the lab together. A research assistant informed them that the study aimed to test a new procedure to select university students by assessing their emotional competence. To increase the personal relevance of the task, they emphasized the importance of emotional competence, not only for individual and relational well-being, but also for academic and professional success. In fact, this is highly relevant for the students' social image and success and is thus more likely to provoke a stress reaction in case of failure (Dickerson et al., 2004). To justify that someone would touch them during the task, we told them that we also investigated whether another person's presence could affect performance. Participants then signed the informed consent form.

To exclude participants who would be particularly psychologically vulnerable to the stressful nature of the task, participants completed the Brief Symptom Inventory (BSI; Franke, 2000). We sought to exclude participants above the clinical cut-off for students (> 63). However, because of this sample's high average BSI value ($M = 53.01$, $SD = 29.01$; 36% above cut-off), we provided feedback on their score and let participants decide whether to participate (see Supplementary Material B). They also received an informational flyer about psychotherapeutic support options and signed a second informed consent. Everyone choose to participate. Next, participants completed the subjective affective state measures and a visual analog scale (VAS) assessing their performance expectations for the emotion recognition task.

We then randomly assigned participants to one of three experimental conditions: partner touch ($N = 79$), stranger touch ($N = 79$), or no touch (control; $N = 64$). To maximize data collection, both partners of the couple took part in the stressful task, so couples were also a priori randomly assigned to one of the following groups: a) male in the partner touch condition, female in the stranger touch condition, b) female in the partner touch condition, male in the stranger touch condition, and c) both partners in the control condition. Next, for groups a) and b), the partner assigned to the stranger touch condition performed the experimental task while being touched by a research assistant of the opposite gender. The other partner then performed the experimental task, while being touched by their partner. In the control condition, we randomly assigned the completion order of the experimental task. For a complete overview of the study design, see Supplementary Material D.

A research assistant applied sensors to the skin in a Lead II configuration to gather ECG signals. We collected physiological signals using Biopac's MP150 or Student Lab PRO 7.7.7 data acquisition systems (Kremer et al., 2010). After connecting participants to the system to assess the physiological parameters, we instructed them to sit quietly while listening to relaxing music to assess their baseline heart rate variability for ten minutes. Then, the partner, a confederate of the opposite-gender, or nobody, sat next to the participant and put their hand on the participant's shoulder for the entire duration of the task. We simply asked the confederate or the partner to put their hand on the participant's shoulder and to keep it there until the latter finished the task. We informed participants that the other person was looking in the opposite direction (to prevent the participant from feeling judged about their failure feedback). Participants read the instructions for performing the experimental task (see Supplementary Material E). During the task, stimuli were presented via Matlab (2013). As stimuli, we used the Karolinska Directed Emotional Faces (Lundqvist et al., 1998) that includes 36 distinct identities (18 males, 18 females) each displaying six facial expressions (fear, anger, disgust, joy, sadness, and surprise) and a neutral expression, modified to manipulate the signal strength (degree of blurredness; Rodger et al., 2015). We selected images that had a degree of blurredness close to the adult recognition threshold for each emotional expression (Rodger et al., 2015), to have a difficulty level that made a hit or a miss credible.

First, participants completed one practice block with non-blurred images where they received real direct feedback about their performance (wrong vs. right and time needed to complete). Then, they completed the eight experimental blocks. In each block, seven pictures corresponding to the seven emotional expressions (joy, fear, disgust, anger, surprise, sadness and neutral) appeared on a screen. Participants first saw a neutral screen with a fixation cross appearing for 500 ms, then the emotional expression stimulus for 500 ms, and then a screen with the written seven emotional expression options positioned in a circle until the participant's response, for a maximum of 10 s. After each block, participants received false feedback about their performance; a first screen with a graph showed their scores of the last block, and from the second block onward, a second screen with a graph showed their mean scores of the whole task. For both screens, a second graph showed the mean scores of a reference group that was clearly better (see Supplementary Material F). On average, participants needed 5 min 31 s to complete the nine blocks. Next, participants filled in the subjective affective state measures a second time and a VAS regarding their expectations for their performance in a similar test in the future, as well as two VAS assessing how surprised and disappointed they were about their results (see van den Hout et al., 2001). Finally, we debriefed participants about the procedure (see Supplementary Material G).

Measures

Manipulation Check

To verify the success of the stress induction, participants indicated their expected success on an emotion recognition task compared to a general reference group. The scale was completed before and immediately after the test. On the second occasion, the participant was asked to give expectancy scores regarding their performance at a similar test in the near future. This manipulation check was designed and successfully applied in previous studies (van den Hout et al., 2000; van den Hout et al., 2001). The manipulation is considered to have worked if participants significantly decreased their expectancy scores.

Subjective Stress

We assessed the momentary affective state with three measures in order to obtain a robust assessment. First, we used the 10-item I-PANAS-SF, which assesses positive and negative affect (Thompson, 2007; German translation based on Krohne et al., 1996; French translation based on Nicolas et al., 2014), ranging from 1 = *not at all or little* to 5 = *extremely*. Second, we used the Self-Assessment Manikin (SAM; Bradley & Lang, 1994), which assesses the valence and arousal dimensions of current affect on a first scale ranging from 1 = *very good* to 9 = *very bad* (reverse coded) and on a second scale ranging from 1 = *very agitated* to 9 = *very calm* (reverse coded), respectively. Third, we used a single item momentary self-esteem measure (*self-confident*, ranging from 1 = *not at all or little* to 5 = *extremely*).

Given the numerous items assessing momentary affective state, and because not all may be adequate in the current context (e.g., hostile), we a priori decided to conduct an Exploratory Factor Analyses (EFA) with z-transformed variables of the 13 items at both pre- and post-test to select the most relevant items. Solutions at pre- and post-test differed. We chose to select the best solution at post-test since the measure of stress at this time-point was particularly relevant for answering the research question and because, as none of the original items assessing mood differed between conditions at pre-test (all $ps < 0.18$), post-scores are more interpretable. Hence, we selected the first factor, which included seven out of the 13 items, $\alpha = 0.80$ (at pre-test $\alpha = 0.72$): nervous, low affective valence, ashamed, upset, affective arousal, anxious, and low self-confident.[1]

Physiological Stress

We used high-frequency heart rate variability (HF-HRV) as our primary measure of stress. HF-HRV is the portion of HRV that is sensitive to the modulation of respiration and is thought to be an index of vagal tone, which itself is an indicator of stress vulnerability and reactivity (Larkin et al., 2016; Porges, 1995). Decreases in HF-HRV are often used as a marker of stress.

To extract HF-HRV we collected Electrocardiogram (ECG) recordings, which were sampled at 1 kHz, at baseline and during the experimental task. We then selected a three-minute segment of the ECG for each participant during baseline (two minutes after the start of the resting task), and during the experiment (the first three minutes of the stress induction). These three minutes correspond to the minimal time necessary to complete the experimental task ($M = 5.5$ min, $SD = 60$ s, *range*: 3.6–10.4 min.). This three-minute window is sufficient to gain a valid assessment of HF-HRV (Schaaff & Adam, 2013). Interbeat-intervals (IBI, time between R peaks in the QRS complex; J. J. Allen et al., 2007) were then extracted from the 3-min segments of the ECG channel. We manually corrected IBI series for artifacts (e.g., due to any movement or dropped signal). We set an a priori threshold for

[1] We also tested the third hypothesis with different, more classical, operationalization of the subjective affective experience and report them in the Supplementary Material I.

dropping files with more than 20% of the file modified. As a result, we dropped 78 files (17.6%). Next, we imported the IBI data into CMetX software (J. J. Allen et al., 2007), which passes a high-frequency spectral filter associated with respiration (0.12–0.4 Hz) to identify high-frequency HRV and then log transforms the data. CMetX was unable to read 16 files, which we did not use. The final sample included the data from 178 participants at baseline, and 153 participants during the experiment.

Data Analytic Strategy

To check whether the stress manipulation worked, we first conducted paired sample *t*-test comparisons (pre- vs. post-test) in SPSS, version 25 (IBM Corp., 2017) of the scale about the participants' performance expectations at the emotion recognition task and the affective state assessment.

To test our hypotheses, we used multilevel modelling with MLwiN (Rabash et al., 2009) to account for partner interdependence (Kenny & Kashy, 2011). We tested two-level models where partners were nested within couples. Relying on an Actor-Partner Interdependence Model (APIM) framework, we computed two sets of parameters per couple, one for each gender (Kenny & Kashy, 2011). Intercepts were allowed to vary randomly across couples, and residual terms were correlated between partners at the couple level. All models controlled for the outcome measure at baseline and only assessed actor effects.[2]

To test our first hypothesis regarding the role of touch on the outcomes, we first ran APIMs where all the parameters were set equal across genders and conditions. To test the second hypothesis, the experimental condition was a categorical predictor with the control condition as reference. Thus, the resulting parameters indicate the deviation from the control condition. To test the third hypothesis, we released the gender-equality constraints and conducted Chi-Square tests to assess whether each parameter of the model differed significantly by gender. All unstandardized regression coefficients of the APIM models were converted into a correlation coefficient to obtain a standardized estimate of the effect size, following Harrer's (2022) recommendation to use the *esc* package (Lüdecke, 2018) in the open-source statistical software R (R Core Team, 2022).

Results

First, we conducted a manipulation check by testing whether the false failure feedback was successful in lowering participants' expectations regarding their abilities in an emotion recognition task after the test as compared to before. We found support for this, $t(221)=7.84$, $p<0.001$; the difference corresponds to a medium to large effect size of $r=0.47$ (Field, 2009). In addition, we collected subjective perceptions of stress (see Table 1). Compared to pre-test measures, participants reported greater subjective stress after the task, $t(221)=-6.35$, $p<0.001$, corresponding to a medium effect size of $r=0.39$ and a lower HF-HRV, $t(221)=8.76$, $p<0.001$, corresponding to a large effect size of $r=0.60$. These analyses confirm the success of our manipulation (see van den Hout et al., 2001). We then

[2] [2]Even though testing for partner effects would not make much sense within the present design, we opted for a multilevel modelling because we deemed important to account the dependency of partners.

Table 1 Participants' means and standard deviation at baseline and post-test

	Mean	SD	*t*	*df*	*p*-value	*r*	2	3	4	5	6
1. Subjective stress B	1.98	.53					.40***	−.08	−.11	−.19**	−.07
2. Subjective stress PT	2.27	.70	−6.35	221	<.001	.39		−.12	−.10	−.05	−.08
3. HF-HRV B	6.44	.86							.64***	.01	.04
4. HF-HRV T	5.91	.83	5.05	143	<.001	.60				−.05	.06
5. Expectations B	5.82	1.49									.17*
6. Expectations PT	4.71	1.76	7.84	221	<.001	.47					

B = Baseline; PT = Post-test; T = Test phase; Hf-HRV = High-Frequency Heart Rate Variability; Expectations = expectations about own success at an emotion recognition task; r = correlation coefficient effect size; t = value at the t-test for testing differences between baseline and post-test

*** $p < .001$; ** $p < .01$; * $p < .05$

Table 2 Results of the test of the hypotheses

			Subjective stress (N=222)				HRV (N=153)			
			b	SE	p	r	b	SE	p	r
H1	Touch		−.11	.10	.24	−.07	−.17	.12	.16	−.09
H2	Partner touch		−.12	.11	.26	−.08	−.11	.13	.40	−.07
	Stranger touch		−.11	.11	.32	−.08	−.21	.13	.09	−.12
H3	Partner touch	Women	**−.43**	**.14**	**.004**	**−.30**	−.12	.20	.55	−.07
		Men	.13	.14	.35	.11	−.11	.17	.51	−.07
	Stranger touch	Women	**−.37**	**.15**	**.01**	**−.26**	**−.45**	**.20**	**.02**	**−.25**
		Men	−.10	.14	.45	−.08	−.07	.16	.65	−.04

H = hypothesis; b = unstandardized regression coefficient; r = correlation coefficient effect size. The model controls for the partners interdependence. Significant results are in bold

analyzed differences between the experimental conditions at pre-test. There was none, either for subjective stress, $F(2, 219)=0.22$, $p=0.81$, nor for Hf-FRV, $F(2, 175)=0.82$, $p=0.44$.

Next, we tested our first hypothesis that touch would buffer the negative effect of the stress induction, such that participants would feel less stressed and have higher HF-HRV. However, we did not find any difference between the touch conditions[3] and the control condition for subjective stress, $b=-0.11$, $SE=0.10$, $p=0.24$, nor HF-HRV, $b=-0.17$, $SE=0.12$, $p=0.16$. Table 2 summarizes all main results. We then compared each touch condition individually to the control condition (Hypothesis 2). We found no differences in participants' subjective stress when comparing the control condition to touch from a partner, $b=-0.12$, $SE=0.11$, $p=0.26$, nor a stranger of the opposite gender, $b=-0.11$, $SE=0.11$, $p=0.32$. Regarding their HF-HRV, participants did not have a different HF-HRV when touched by their partner, $b=-0.11$, $SE=0.13$, $p=0.40$, as compared to the control condition. When touched by a stranger, participants had marginally lower HF-HRV than in the control condition, $b=-0.21$, $SE=0.13$, $p=0.09$. This corresponds to a small effect size ($r=0.12$) and indicates a trend toward experiencing more physiological stress when touched by an unknown person. We then tested whether partner touch would have a stronger stress-buffering effect than stranger touch. Comparing both touch conditions revealed no significant difference for subjective stress $\chi^2_{diff(1)}=0.03$, $p=0.43$, nor for HF-HRV $\chi^2_{diff(1)}=0.76$, $p=0.19$. These analyses do not support the claim that the stress-buffering effect is stronger when received from a romantic partner compared to a stranger.

Finally, we tested our third hypothesis that there would be an interaction between gender and touch conditions. Compared to the control, the effect of partner touch on subjective stress experience differed significantly by gender, $\chi^2_{diff(1)}=8.36$, $p=0.002$, but not with HF-HRV as an outcome, $\chi^2_{diff(1)}=0.002$, $p=0.48$. When touched by their partner, women had lower post-test subjective stress than women in the control condition, $b=-0.43$, $SE=0.15$, $p=0.004$, indicating a stress-buffering effect of medium size ($r=-0.30$) of partner touch in women. However, this was not the case for men, $b=0.13$, $SE=0.14$, $p=0.35$. Neither

[3] To test this hypothesis, we set the effects of partner and stranger touch equal in the model.

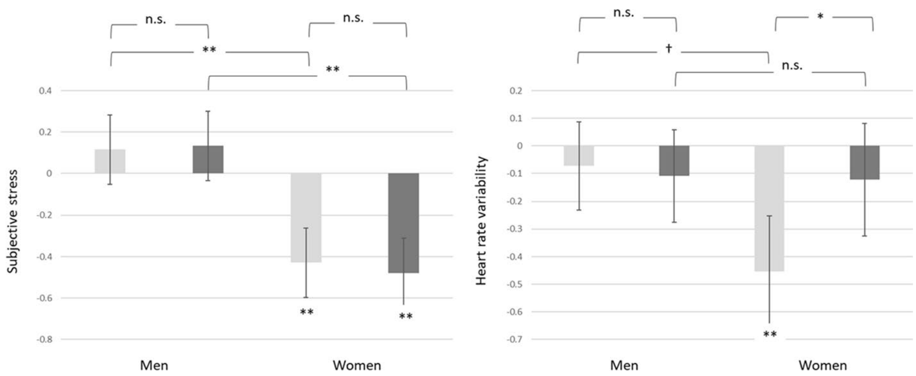

Fig. 1 Mean difference values for the stranger touch (light grey) vs. partner touch (dark grey) conditions for the two investigated outcomes as a function of gender. *Note*. The y-axis represents deviations from the control condition. The bars at the top represent the level of significance of the gender differences within each experimental condition. $^{\dagger}p<.10$; $^{**}p<.01$; $^{*}p<.05$; *n.s.* non-significant

women, $b=-0.12$, $SE=0.20$, $p=0.55$, nor men, $b=-0.11$, $SE=0.17$, $p=0.51$ showed any differences in HF-HRV by condition.

Next, comparing stranger touch to the control, the effect of stranger touch on subjective stress significantly differed by gender, $\chi^2_{diff(1)}=6.08$, $p=0.007$ and there was a marginal effect for HF-HRV, $\chi^2_{diff(1)}=2.28$, $p=0.07$. When women were touched by a stranger of the opposite gender, their subjective stress at post-test was lower than that of women in the control condition, $b=-0.37$, $SE=0.15$, $p=0.01$, again indicating a medium-sized stress-buffering effect ($r=-0.26$). The subjective stress of men in the stranger touch condition did not differ from that in the control condition, $b=-0.10$, $SE=0.14$, $p=0.45$. Regarding the touch of an opposite gender stranger, women had a significantly lower mean HF-HRV during the task than women in the control group, $b=-0.45$, $SE=0.20$, $p=0.02$, indicating a medium sized stress-*enhancing* effect ($r=-0.26$). Again, men's HF-HRV did not differ from the control condition, $b=-0.07$, $SE=0.16$, $p=0.65$.

We additionally tested whether there were condition differences within genders. For men, being touched by their partner or by a stranger made no difference in subjective stress, $\chi^2_{diff(1)}=0.03$, $p=0.43$, or Hf-HRV, $\chi^2_{diff(1)}=0.06$, $p=0.41$. For women, being touched by a partner or stranger made no difference in subjective stress, $\chi^2_{diff(1)}=0.19$, $p=0.33$. However, women's post-test HF-HRV was significantly lower when touched by a stranger as compared to when they were touched by their partner, $\chi^2_{diff(1)}=2.98$, $p=0.04$. Figure 1 depicts the results regarding the gender and condition differences for the two outcomes.

Discussion

The present study investigated the effect of touch by an opposite-gender person varying the level of familiarity with the target (romantic partner vs. stranger) on subjective and physiological stress during a challenging situation and whether these effects differed by gender. To our knowledge, this is the first study doing so, hence allowing a better understanding of the extent to which the stress-buffering effects of touch depends on the level of familiarity between the touching dyads and how gender moderates this effect.

Contrary to our first hypothesis, the results revealed that touch (by either an opposite-gender stranger or partner) did not change the subjective or physiological stress. Exploring further the role of the level of familiarity between dyads (Hypothesis 2), we found no significant difference between partner and stranger touch, neither for the subjective nor for the physiological reaction. However, confirming regarding the effect of a suppression effect by gender (Hypothesis 3), the investigation of gender differences first revealed that, contrary to our hypothesis, the effect of the romantic partner touch differed across gender, such that it buffered women's subjective stress response but not men's. This gender difference differs from most previous studies, which found no effects (e.g., Debrot et al., 2014; Holt-Lunstad et al., 2008; Jakubiak & Feeney, 2016; Kreuder et al., 2017). The current design might explain this. Indeed, participants received (false) failure feedback and men have been found to generally have less support interactions after experiencing a failure (Altermatt, 2007). As such, they might expect less from the presence of their partner. Ditzen et al. (2019) also found that women (but not men) had a lower cortisol response after a stressor when their partner had previously touched them. Therefore, a potential explanation for this gender difference could be women's higher tendency to turn to others when experiencing distress (Taylor, 2006). Hence, in future research, it would be interesting to test the support expectations of male and female partners in a stress-induction task.

An unexpected and interesting discrepancy also emerged regarding opposite-gender stranger touch: women reported more lowered subjective stress than men but showed an *increased* physiological stress reaction to stranger touch. The fact that only women experienced a significant buffering effect regarding their subjective stress after receiving touch from a stranger is not in line with previous research showing that men perceive this touch more positively than women (Heslin et al., 1983; Kirsch et al., 2018; Struckman-Johnson & Struckman-Johnson, 1993; Trotter et al., 2018). However, recent research by Schirmer et al. (2022) found that women reported more comfort than men when confronted with unfamiliar or unknown people's touch, though they felt particularly comfortable with other women as opposed to men. The stress-buffering of stranger touch found only for women might also be an indication of the tendency of lower-power individuals (such as women in most domains of our societies; Carli, 1999) to please other people (such as being nice to the toucher; Keltner et al., 2003).

In parallel, women showed increased physiological responses to touch from a stranger. To our knowledge, this is the first study directly testing this gender difference in the physiological response to opposite-gender stranger touch. A possible explanation for the discrepancy between decreased subjective and increased physiological stress among women touched by opposite-gender strangers is that women are generally more exposed to opposite-gender sexual harassment (O'Leary-Kelly et al., 2009; Rotundo et al., 2001; Uggen & Blackstone, 2004). They might thus be conditioned to be more vigilant and more reactive to opposite-gender touch. As a result, their physiological changes may reveal their discomfort with stranger touch. A disjoint between subjective and physiological responses is not entirely unexpected and has been documented before during stressful situations (e.g., Schwerdtfeger & Kohlmann, 2004). In our case, we saw physiological responses consistent with a more stressed response among women receiving touch from a male stranger, but this was not reflected in self-reported measures. This differs from other gender differences previously documented in stress-reactivity (e.g., Kelly et al., 2008; Santl et al., 2019). One reason may lie in the strong interpersonal nature of the touch condition. Perhaps women felt they *should* be less stressed after receiving touch (i.e., to please others; Keltner et al., 2003) and so their self-reports reflect this, even though their physiological responses did not.

Supporting this speculative explanation, previous research has shown that women tend to comply with feminine emotional display rules, which require the suppression of negative emotions and the simulation of positive ones (Simpson & Stroh, 2004). The stronger suppression of negative affect in females compared to males is even found at a very young age (six to nine years; Davis, 1995), indicating that this mechanism of emotional display could be highly automated in women. Caution should be taken, however, with this interpretation as we did not assess women's display of positive emotions but rather their written report of them. Further research is needed to confirm this speculation. In previous research, women have shown similar discrepancies as the one found in the present study; Kirschbaum et al. (1995) found, for example, that women showed a less beneficial cortisol response than men to the social support provided by their partner, but that they subjectively rated this support more favorably than men. This result would be consistent with the possible difference between a genuine evaluation of the benefits of supportive behavior and what is acceptable to disclose openly.

Limitations and Future Directions

To our knowledge, this is the first study using a randomized design to investigate touch from counterparts with different degrees of familiarity (romantic partner or an opposite-gender stranger) while examining gender differences and assessing both subjective and physiological stress responses. Despite these strengths, there are some limitations worth mentioning. First, our task may not have been sufficiently stressful. Although the task reduced perceptions of efficacy in emotion recognition and increased subjective stress with medium to large effect sizes, absolute levels of stress were relatively low. Future research should replicate this study with another stress induction that generates higher absolute levels of stress, such as the Trier Social Stress Test (A. P. Allen et al., 2017; Kirschbaum et al., 1993). Relatedly, it is possible that the stress related to the task was confounded with the stress potentially induced by touch, in particular stranger touch. Unfortunately, we did not assess how this touch was perceived (e.g., in terms of pleasantness).[4] Hence, a similar experiment with a control condition without any stressor (e.g., with a filler task) would allow to disentangle the source of stress. Additionally, one of the present study's strengths was to account for the partners' interdependence. However, dyads were not stressed simultaneously. A stress-induction whereby both partners could be stressed at the same time would allow to examine the dyadic interplay between the studied processes by analyzing partner effects.

Second, the present study had sufficient power to detect medium effect sizes. However, small effects might have been missed. Hence, future research should replicate this study with a larger sample and caution should be taken in interpreting null effects. Third, the chosen touch manipulation (a hand on the shoulder) was minimal, to allow it to be acceptable when provided by strangers. However, the touch that appears to be most affectively beneficial is a stroking stimulation that activates the so-called C-tactile fibers (CTs), a particular class of unmyelinated, low threshold and slowly conducting mechanoreceptors (Löken et al., 2009). CT-optimal touch (corresponding to a typical caress) is evaluated as

[4] Anecdotal accounts of participants support a variability in the experience of stranger touch during the experiment. For example, some participants mentioned that it was unpleasant or up to very annoying in the stranger condition. However, others said that they were so involved in the task, that they totally forgot about the touch.

the most pleasant one and appears to have the most beneficial effects on HRV (Triscoli et al., 2017a, 2017b). Hence, results might be different with a CT-optimal touch or other kinds of more intense touch behaviors.

Fourth, the present design does not allow to disentangle whether gender differences were due to the gender of the touch giver or that of the touch receiver, or their combination, as we had no same-gender touch pairs. Future research should investigate all possible gender combinations, both with strangers and partners (Meuwly & Randall, 2019).

Finally, the sample had high homogeneity regarding cultural background, gender, and sexual orientation. Therefore, caution should be taken when trying to generalize to other cultures and to LGBTIQ + communities. Future studies should test similar hypotheses in other cultures (indeed, a recent cross-sectional study failed to find a link between touch and individual well-being in a Brazilian sample; Teixeira e Silva et al., 2022) and among LGBTIQ + communities.

Conclusion and Clinical Implications

An increasing number of scholars are investigating interpersonal touch and most research typically find benefits (see Jakubiak & Feeney, 2017; Schirmer & McGlone, 2022). The present study's design allowed to differentiate the stress-buffering effects of touch as a function of the familiarity with the toucher and the gender of the target. Results indicate that, when investigating the effects of touch as a stress-buffer, it is important to consider gender, since women and men did not react in a similar way to our conditions. This contributes to nuance what is known about the effects of touch.

Additionally, our work has important clinical implications. First, our lack of consistent benefits of partner touch highlights the differing benefits that this behavior can have. This work should encourage practitioners (e.g., couple therapists but also massage therapists) to pay attention to the experience of their patients and to be particularly rigorous in asking for consent. Moreover, our results indicate that women in particular might have difficulties not only in disclosing, but also in perceiving their stress related to the physical proximity of an opposite-gender stranger. Hence, programs aiming at promoting consent could benefit from integrating modules aiming at better listening to oneself, in particular one's body signals.

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Author contributions AD and PLK designed the study, AD collected and analyzed the data, JES and EDG provided guidance and references for the collection and analysis of the physiological data, AD prepared the tables and figures, AD wrote the manuscript. All authors revised critically the manuscript.

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Declarations

Competing interests The authors declare no competing interests.

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