

## MASTER

### The bearded ladies in social touch research

Investigating the representativeness of touch interactions used in research on mediated social touch

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Master Thesis

# The bearded ladies in social touch research

**Investigating the representativeness of touch interactions used in  
research on mediated social touch**

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## **0. Draft**

Social touch is an important tool to convey emotion and intention and it helps reduce stress. However, sometimes social touch is not possible (e.g. due to geographical distance). MST is considered to be a substitute. In MST touches are simulated via haptic or tactile feedback. MST research focusses primarily on replicating the effects of human social touch. However, the results of these studies are largely mixed and unconvincing. One possible reason could be that the touch settings used in these studies are rare in the participants ecological environment, therefore implying the results are not applicable to the real world. The aim of this study is to find out what touch settings are used in current (mediated) social touch research and explore how representative these settings are for the ecological environment. First an extensive systematic literature research was executed. Then real-life scenarios were extracted from the touch settings used in research and are compared pairwise by participants based on their perceived commonness and comfortability. Results showed that some of the situations used in literature were even more uncommon in the ecological environment of the participants than was thought. Moreover, a correlation was found between the commonness of the situations and the comfortability of our participants. The rarer a situation is in the ecological environment of the participant, the more uncomfortable one feels.

# 1. Introduction

With social touch, we can convey emotion and intention (Kirsh et al., 2018). Social touch is considered to consist of a mixture of physical, inter-relational and intentional properties and is thought to have only positive effects in appropriate situations. Meaning a touch from a friend is perceived differently than a touch from a stranger. Additionally, a slight tap on the shoulder is perceived differently than when one's hand is being held.

Social touch evokes the release of the hormone oxytocin (Holt-Lunstad, Birmingham, & Light, 2008). An increasing amount of oxytocin has lots of positive effects. It lowers blood pressure, increases the pain threshold, stimulates positive social interactions, promotes growth and healing, is anxiolytic, and it lowers the concentration of the stress hormone cortisol (Uvnas-Moberg & Petersson, 2005). It has also been proven that repeated exposure to social touches lead to longer lasting effects (Di Simplicio, Massey-Chase, Cowen, & Harmer, 2009; Taylor, 2006; Light, Grewen, & Amico, 2005). These positive effects of social touch on the stress levels have been the subject to experiments. In the study by Ditzen et al. (2007) a significant positive effect of social touch on the levels of stress have been found (i.e. the stress levels were lowered with received social touches).

Apart from being able to elicit physical responses, social touch can additionally elicit social responses. In the study of Eaton, Mitchell-Bonair & Friedmann (1986) it was found that the elderly in a nursing home consumed more calories and proteins when touched whilst being encouraged to eat. This increase in consumption helped them to strengthen. Some other examples found in research proved that social touch could elicit helping behavior in others (Guegen & Fisher-Lokou, 2003; Goldman, Kiyohara & Pfannensteil, 1985), can cause higher tips for waitresses (Cusco & Wetzell, 1984) and can make people work harder on shared tasks (Guegen, 2004; Steward & Lupfer, 1987).

However social touch is not always possible. Sometimes people are geographically separated but would still like to engage in social touch. In some cases even, touch could be prohibited (e.g. in hospitals during the COVID-19 pandemic). As alternative for social touch, mediated social touch (MST) is being introduced. MST promises to offer interpersonal physical contact whilst geographically separated. MST uses haptic or tactile feedback which is introduced using devices. An example of a device using MST is the Internet Pajama (Teh, Lee & Cheok, 2006). This pajama is worn by the infant and it provides the possibility for parents to send hugs via the Internet. This is realized by the parents hugging the teddy bear or doll that is embedded by pressure and touch sensing mechanisms. This hug is transmitted via the internet from the doll or teddy bear to the pajama where the hugging sensation is being reproduced.

Another example of a device using MST is the ComTouch (Chang et al., 2002). This device is used to enhance the voice communication channel with the use of the tactile channel as well. This means that the users are able to send vibrotactile signals while being on the phone. The presses of a button are

being mapped to vibrotactile stimuli that are then being send to the other person using the device. This is being realized with an overlay on the mobile phone which has buttons for actuation and motors to reproduce the received vibrotactile stimuli.

Apart from designing devices for MST, a lot of research on MST has been focusing on reproducing similar responses as unmediated or human social touch. This means reproducing the positive effects like stress reduction or even reproducing helping behavior using MST. To name an example; Haans, de Bruijn & IJsselsteijn (2014) found that the Midas touch (i.e. a touch to elicit helping behavior) by a haptic device has the same effect as the Midas touch is an unmediated setting.

While social touch was found to have a positive effect on stress reduction (e.g., Ditzen et al., 2007), this same effect was not found in the studies by Erk, Toet & Van Erp (2015) and by Cabibihan, Zheng & Cher (2012) when trying to replicate these effects in mediated conditions.

To date it is not yet fully understood what could explain these mixed findings. A possible reason could be the lack of realism and/or a lack of context in the used touch settings. Like mentioned before touch is a mixture of inter-personal relations, physical properties, and intention. Thus, touch is dependent on contextual factors. An earlier study by Ipakchian Askari et al. (2020) showed the importance of context upon perceiving the intention and evaluation of MST. In this study the same touch was being administered, but the tone of the textual conversation was different which resulted in other perceived intentions and evaluation of the touch. Moreover, the positive physical effects of social touch are dependent on the individual administering the touch. A touch from a stranger can be perceived as intrusive or even threatening (Thayer, 1986). A touch is also found to be less likely beneficial when it violates the cultural, social, and personal norms. Another study that highlighted the importance of the person administering the touch is the study by Levav & Argo in 2010. They found that the positive effect of interpersonal (or social) touch, the sense of security in this case, was present when participants were touched by a woman but was not present when touched by a man. They also found that the sense of security was higher when they were lightly touched on the shoulder than given a handshake. From this it can be concluded that the relationship between the people engaging in social touch, their genders, and the placement of touch all play major roles in the appraisal of this touch.

When engaging in (mediated) social touch, the contextual factors are part of the ecological environment. Who touches whom, when the touch is administered and in what manner is by and large determined by existing social, personal and cultural norms. If taken a closer look at the study by Cabibihan, Zheng & Cher (2012) it becomes clear that in one of the settings the participant was being touched by a stranger. It is therefore not surprising that this did not result in a decrease of stress response since Thayer (1986) already pointed out that a touch from a stranger could be perceived as threatening.

Egon Brunswik did not agree with the use of systematic design for experiments. He questioned the realism of the created stimuli and the feasibility of disentangling various variables so only one or few of them could be changed systematically in the laboratory whilst the other variables were held constant. According to Brunswik variables were tied (Brunswik, 1943, 1952) and it would therefore be impossible to determine the cause of the observed effect. Moreover, experiments using systematic design tend to have high internal validity (i.e. the observed effect can be replicated in the exact same and controlled environment) at the expense of external validity (i.e. the observed effect can be replicated beyond the controlled environment in which it was studied).

Secondly, Brunswik stressed the importance of the consideration of the real world in setting up experiments. Psychological processes are adapted to the environment in which they operate (Brunswik, 1943, 1952). Therefore, Brunswik invented a new design to conduct experiments, representative design (Brunswik 1955c). This design is different from systematic design because it takes stimuli from the ecological environment, and the different variables within these stimuli are not disentangled and varied. Taking a stimulus from the ecological environment entails taking a stimulus that can occur naturally in the life of the participants and not creating a stimulus or situation which can never happen in the lives of the participants. This would imply that experimental research on the effects of (mediated) social touch should strive to mimic the ecological environment, and thus to incorporate touch settings that are common for the ecological environment of one's participant. If not, then research findings will not generalize to the real world.

In current literature more often experiments are conducted still using systematic design instead of the well-argued representative design by Egon Brunswik. This might be one of the main reasons why there are mixed findings in the area of MST research. Because there is not one paradigm that experimenters stick to, not only external validity is low, but also internal validity is inadequate.

The aim of this study is to uncover whether the touch settings which are currently used in MST research are representative for the ecological environment according to Brunswik (1955c) and to see if this might be one of the reasons why there are largely mixed findings when it comes to reproducing the positive effects of social touch with MST. Therefore, the following research questions will be addressed:

- RQ1:** What settings are used to test the physiological and/or psychological responses to a natural or mediated social touch before, during, or after a stressful situation?
- RQ2:** How representative are these settings with respect to their frequency of occurrence in our participants ecological environment?

**RQ3:** Are settings that are rare in the ecological environment of our participants also more stressful/arousing?

Here, we expect a negative correlation between representativeness of the setting and anticipated arousal in such setting. Already it is clear that it matters a great deal by whom the participants are touched. A touch from a stranger could be perceived as threatening (Thayer, 1986) and thus could be more stressful. Thereby a setting in which a participant is touched by a stranger could be stressful in itself and not reduce stress in the participant but actually amplify stress.

## 2. Systematic Literature Research

### *Selection of articles*

To be able to research the situations that were used in literature, a systematic literature research is required. Firstly, databases needed to be selected. Because articles specifically about stress and social (mediated) touch were sought after, the databases which contained this work were combined. This resulted in the selection of the databases *PsychInfo*, *Inspec*, and *Scopus*. Additionally, the reviews by Ditzen & Heinrichs (2014), Field (2019) and Jakubiak & Feeney (2017) were used because they seemed relevant, and they were quite recent.

Secondly the keywords needed to be chosen carefully. The situations in literature must contain a social touch and a stressful condition. Therefore, the main keywords should be *stress* and (social) *touch*.

Keywords as *physiological effect* and *physical contact* were added to broaden the search area. The complete list of keywords that were used to search the databases can be found below in table 1. During the database search a AND operator was used to make sure articles contained both a social touch and a stressful condition. The OR operator was used as well between the words that resembled (social) touch and between the words that resembled stress.

*Table 1 List of keywords used to search the databases*

Touch	Stress
Physical contact	Physiological effect/response
Tele(-)touch	Recovery
Mediated touch	Stress response
Robot touch	Distress
Social touch	
Human touch	

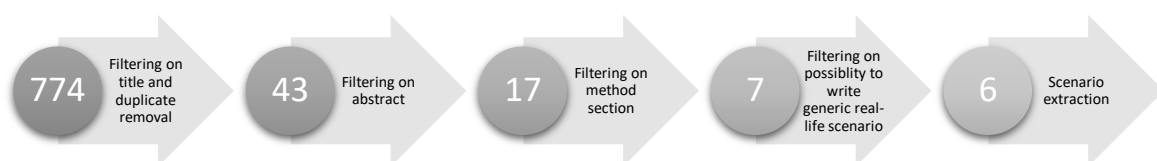
The search for articles in the databases and in the literature used in the review papers was an iterative process. In this process, exclusion criteria were made. Studies with children were excluded, as were studies with animals. Studies that examined the effect of touches on the pain levels, however



interesting, were also excluded because the focus lies with stress. Lastly touches that were meant to be healing or therapeutic were also excluded because the focus lies with social touch.

Because the MST settings are often compared to naturalistic (unmediated) touch settings within the same study, studies covering only naturalistic social touches are also included.

The final search resulted in 774 articles. These 774 articles were filtered in 4 rounds. In the first round of filtering the titles of the articles were examined based on relevance and the exclusion criteria, and the duplicates were removed. Many articles were removed in this step because there were many articles that did not contain touches or were in a complete other area. E.g.: there were articles about survival of sex abuse, about cognitive recovery after a stroke and even about the histories of hurricanes. When it was not clear whether to remove an article, it was kept. This resulted in a resting total of 43 articles. The second round of filtering focused on the abstracts of the articles. Again, relevant articles that contained a stressful condition and a social touch remained, so articles that were about providing social support by social touch and did not involve induces stress were removed. Of the 43 articles in the beginning of this round, 17 were left. These 17 articles were then further filtered by reading the method section. Another 10 articles were filtered out because they did not include induced stress or a social touch. The situations in the last remaining 7 articles were mapped. Of only 6 of the 7 articles, it was possible to write a real-life scenario that was testable among all participants. The article by Hiraoka, Miyasaka & Nomura (2019) was filtered out in this last round because it contained a crying baby as a stressor for an insecure mother. In this article they tested whether the presence or the touch of a partner influenced the stress reaction. This would be a highly specific stressor and would require a very specific group of participants. This is not within the scope of the present study, so this article was removed as well. A short summary of the filtering process is listed below in figure 1.



*Figure 1 Flow chart of the filtering process*

The six remaining articles after all four rounds of filtering are:

- Edens, Larkin & Abel (1992)
- Cabibihan, Zheng & Cher (2012)

- Cabibihan, & Chauhan (2017)
- Erk, Toet & Van Erp (2015)
- Ditzen et al. (2007)
- Willemse & Van Erp (2019)

Table 2 (starting on the next page) gives an overview of the study aim, measures, stress elicitations, conditions and the administered touches used in the remaining six articles. These areas of the touch are highlighted because of the importance of the context of the touch and because the touch settings used in these articles will be translated into real-life scenarios which resemble a similar context.

The used settings are rewritten into real-life scenarios because of the generalizability and the type of experiment that will be conducted in this study. The participants will be asked to compare scenarios with each other and that is hard when the type of agent is not the same in all cases. Most people have never received a touch from a haptic or tactile device, not to mention a touch from a robot. Therefore, these setting will be rewritten into scenarios with people and no devices and robots.

Table 2 Summary of tested conditions in the remaining articles

Article	Study aim	Measures	Stress elicitation	Study design: conditions	Time and place of touch(es)	Who is being touched	Who touched
Edens, Larkin & Abel (1992)	Examine the effects of social support on cardiovascular reactions to behavioral stress	Diastolic and systolic blood pressure (DBP & SBP) and Heartrate (HR)	Mental arithmetic and mirror-tracing task	<ol style="list-style-type: none"> <li>1. Alone</li> <li>2. Presence of best friend</li> <li>3. Presence of a stranger</li> <li>4. Touch of best friend</li> <li>5. Touch of stranger</li> </ol>	Hand is placed across the wrist of the non-dominant hand, during the stress eliciting tasks	Female participants	the confederate (stranger) and the best friend were female
Cabibihan, Zheng & Cher (2012)	Examine the effects of affective touches on the Heart Rate after a sad event	HR	Sadness-eliciting video clip	<ol style="list-style-type: none"> <li>1. No touch (NT)</li> <li>2. Human touch (HT)</li> <li>3. Tele-touch (mediated touch) (TT)</li> </ol>	Hand/cuff is placed across the forearm, during three minutes of recovery after the movie	Both male and female participants	the gender of the person administrating the touch (HT) is unknown
Cabibihan & Chaucan (2017)	Evaluate the effects of the tele-touch device and compare it to two control conditions: with and without touch	HR and Galvanic skin response (GSR)	Sadness-eliciting video clip	<ol style="list-style-type: none"> <li>1. NT</li> <li>2. HT (partner)</li> <li>3. TT</li> </ol>	Hand/cuff is placed across the forearm, during the most intense part of the movie clip	Male participants	HT was performed by their female partner

Erk, Toet & Van Erp (2015)	Examine whether mediated hand pressure can 1) enhance sadness recovery, 2) enhance affective quality of experience, and 3) increase trust in fellow participant	HR, GSR, number and duration of presses and self-reports	Sadness-eliciting movie clip	<ol style="list-style-type: none"> <li>1. Frebble (haptic input, haptic feedback) (mediated touch)</li> <li>2. Joystick (haptic input, visual feedback)</li> </ol>	Haptic feedback via handheld device during the recovery (funny) movie clip	Both male and female participants	ostensible fellow participant (gender not announced)
Ditzen et al. (2007)	Determine whether different kinds of couple interaction reduce the hypothalamic pituitary adrenal and autonomic responses to stress in women	Salivary free cortisol, oxytocin plasma levels, HR and self-reports	Trier Social Stress Test (TSST): Public speaking task and mental arithmetic	<ol style="list-style-type: none"> <li>1. Alone</li> <li>2. Verbal support by partner</li> <li>3. Neck- and shoulder massage by partner</li> </ol>	Neck- and Shoulder massage, both in the 2 <sup>nd</sup> and 3 <sup>rd</sup> condition, the interaction took place before the actual stress-eliciting tasks	Female participants	massage was executed by their male partner
Willemse & Van Erp (2019)	Examine whether robot-initiated touches could elicit beneficial responses that are comparable	HR, HR Variability (HRV), GSR, Respiratory Rate, self-	Scary movie	<ol style="list-style-type: none"> <li>1. Robot Touch (RT) with prior bonding</li> <li>2. RT without prior bonding</li> <li>3. No touch, with prior</li> </ol>	8 touch interactions on the right shoulder during the 2 movie clips (one neutral movie	Both male and female participants	Gender of the robot is unknown/ not announced

	to responses to human touch, and examine whether having a pre-existing positive social bond with the robot modulates these responses.	reports about the robot (robot's appearance likeability, relation with robot, bonding, etc.)		bonding 4. No touch, without prior bonding	and one scary movie)		
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### *Scenario extraction*

In Edens et al. (1992) two distinct settings are used which involve touch. Both settings involve female participants. In both settings the stressor is a social event. In both settings the physical aspects of the received touch are the same (i.e. same timing and same location). The difference between the two settings is the person who executes the touch. In the first setting, the participants are touched by their best female friend. In the second setting, the participants are being touched by a female confederate. Therefore, two distinct real-life scenarios are written to resemble these settings. In both scenarios a female character is touched on the wrist during a very stressful (social) event by either a close female friend (1<sup>st</sup> scenario), or an unfamiliar woman (2<sup>nd</sup> scenario).

Similarly, this is done for the remaining five articles. This means that Cabibihan et al. (2012) gives four different scenarios. The only difference in the settings used is the gender of both the receiver of the touch and the administer of the touch. Therefore, all four combinations are included when writing the real-life scenarios.

Cabibihan & Chaucaan (2017) results in three more real-life scenarios. In all settings involving touch in the article the participant is male. The difference in these settings lies in the administer of the touch. It is either an unfamiliar woman, an unfamiliar man, or their partner (female).

The article by Erk et al. (2015) holds four more settings which involve touch. The participants are both male and female. Moreover, the person administering the touch is either an unfamiliar man or an unfamiliar woman. This means that this article results in four additional real-life scenarios.

Of the article by Ditzen et al. (2007) one real-life scenario is extracted. The article contained one setting involving touch. The setting contains a female character being touched by their male partner.

In the last article, the one by Willemse and Van Erp (2019), the stressor and the physical aspects of the received touch are the same in every setting, but the gender of the receiver and administer of the touch differs. Moreover, there are two types of “strangers” administering the touches. On the one hand there is a robot which whom the participants had the chance to bond before the administering of the touches (e.g. they played a game together with the robot), in the other settings, the participant are touched by robots they have never met, bond with or seen before. This would mean that another eight real-life scenarios would be added.

When the mention of the gender of the person administering or receiving the touch(es) was omitted, both options were included when writing real-life scenarios, since the gender of the person administering the touch makes a great difference (Levav & Argo, 2010). The touch by a haptic device or robot is in this case regarded similarly as a touch from an unfamiliar person.

These real-life scenarios, like the settings they are based upon in the literature, all differ on the type of touch, the place of touch, the timing of the touch and the gender of the person administering and

receiving the touch. In all scenarios the receiver of the touch is central, and this person is either male (named John) or female (named Jane). The scenarios are written with fictional characters because it would be easier for participants to judge scenarios if they must empathize with the characters rather than them being the one receiving the touch. To be able to better compare the different scenarios, the context of these scenarios has been set to either watch a emotional movie in the theater (which is applicable for all scenarios extracted from the articles by Erk et al.(2015), Cabibihan et al.(2012), Cabibihan & Chauhan (2017) and Willemse & Van Erp (2019)) or having a job interview (which is applicable to the scenarios extracted from Ditzen et al. (2007) and Edens et al. (1992) since this is originally part of the TSST; Kirschbaum, Pirke & Hellhammer, 1993).

However, as will be discussed later, some other scenarios will be added as anchoring points. With a total of 22 real-life scenarios and additional anchoring points, it will be a total of at least 24 scenarios which should be compared pairwise by our participants. This would mean that the participants would have to make at least  $\frac{24*23}{2} = 276$  comparisons (comparing each of the 24 scenarios with the 23 remaining scenarios, division by two to prevent double comparisons). It is thought that 276 comparisons would take about 60 minutes for our participants. 60 minutes of making pairwise comparisons is regarded to be very monotonous and repetitive. It is therefore decided to reduce the amount of scenarios. The easiest way to do this was to exclude the article by Willemse & Van Erp (2019) because it yielded eight scenarios. Another reason why this article was chosen to be removed was because the stressor did not completely fit the set context of the scenarios with watching the emotional movie in the theater. This context fits the other scenarios perfectly, but in the article by Willemse & Van Erp, the stressor was actually a scary movie and not an emotional movie. Lastly, the touch of the robot was placed on the right shoulder of the participant. This means that in the setting used in the article the robot was placed on the armrest of the chair to be able to reach the shoulder. This would be hard to rewrite into a real-life scenario because it would not be entirely the same as a stranger sitting next to you.

The remaining 14 extracted scenarios can be found below in table 3.

*Table 3 Real-life scenarios used for the questionnaires*

	<b>Scenario in questionnaire</b>	<b>Based on situation used in</b>
1	Jane is having a job interview with an unfamiliar woman sitting next to her. For the duration of the interview this woman has her hand placed on Jane's wrist to comfort her.	Edens, Larkin & Abel (1992)

2	Jane is having a job interview with her best friend Anna sitting next to her. For the duration of the interview Anna has her hand placed on Jane's wrist to comfort her.	Edens, Larkin & Abel (1992)
3	John has been watching an emotional movie in the theatre sitting next to an unfamiliar man. After the movie ended, the unfamiliar man gently places his hand on John's forearm to comfort him.	Cabibihan, Zheng & Cher (2012)
4	Jane has been watching an emotional movie in the theatre sitting next to an unfamiliar man. After the movie ended, the unfamiliar man gently places his hand on Jane's forearm to comfort her.	Cabibihan, Zheng & Cher (2012)
5	John has been watching an emotional movie in the theatre sitting next to an unfamiliar woman. After the movie ended, the unfamiliar woman gently places her hand on John's forearm to comfort him.	Cabibihan, Zheng & Cher (2012)
6	Jane has been watching an emotional movie in the theatre sitting next to an unfamiliar woman. After the movie ended, the unfamiliar woman gently places her hand on Jane's forearm to comfort her.	Cabibihan, Zheng & Cher (2012)
7	John is watching an emotional movie in the theatre sitting next to an unfamiliar woman. During the intense sad parts of the movie the woman strokes his forearm to comfort John.	Cabibihan, & Chauhan (2017)
8	John is watching an emotional movie in the theatre sitting next to an unfamiliar man. During the intense sad parts of the movie the man strokes his forearm to comfort John.	Cabibihan, & Chauhan (2017)
9	John is watching an emotional movie in the theatre sitting next to his partner Anna. During the intense sad parts of the movie Anna strokes his forearm to comfort John.	Cabibihan, & Chauhan (2017)
10	John is watching a movie in the theatre sitting next to an	Erk, Toet & Van Erp



	unfamiliar man. During the movie this man holds John's hand and squeezes it regularly to comfort John during the movie.	(2015)
11	John is watching a movie in the theatre sitting next to an unfamiliar woman. During the movie this woman holds John's hand and squeezes it regularly to comfort John during the movie.	Erk, Toet & Van Erp (2015)
12	Jane is watching a movie in the theatre sitting next to an unfamiliar man. During the movie this man holds Jane's hand and squeezes it regularly to comfort Jane during the movie.	Erk, Toet & Van Erp (2015)
13	Jane is watching a movie in the theatre sitting next to an unfamiliar woman. During the movie this woman holds Jane's hand and squeezes it regularly to comfort Jane during the movie.	Erk, Toet & Van Erp (2015)
14	Jane and her partner Peter head towards Jane's job interview. Before having this interview Peter gives Jane a shoulder- and neck massage to comfort her.	Ditzen et al. (2007)

### 3. Method

#### *Participants*

The participants in this study were recruited in two ways. The recruitment was started by inviting participants of the JFS database. Because the recruitment of participants via the database was not sufficient, additional participants were recruited personally via e-mail and text messages. Other than a good comprehension of the English language no limitations were set.

After a power analysis using the Rasch model, it was thought that there had to be 171 comparisons per scenario to be able to detect a well-enough difference (of 0.3 logits) between the scenarios. This comes down to a total of  $\frac{171}{15} = 11.4$  participants for the first questionnaire (because one participant compares one scenario to 15 others; will be explained later). For the second questionnaire  $\frac{171}{16} = 10.9$  participants should be enough.

There were 45 entries for the first questionnaire. 11 of these entries were used for data analysis (4 male, 7 female ( $M_{\text{age}} = 32$ ,  $SD = 12$ , range 22-76)). 34 entries were excluded because participants made none or too little (one or two) comparisons.

For the second questionnaire, there were 20 entries. 9 of these entries were used for data analysis (1 male, 8 female ( $M_{\text{age}} = 36$ ,  $SD = 14$ , range 25-59)). 11 of the entries were excluded because of too little usable answers (again: none or only one or two).

Of the total 20 participants, 18 originate from the Netherlands, 1 originates from Germany and 1 originates from India.

#### *Design and Instruments*

The study was conducted using two distinct online questionnaires. Participants would complete one of the two questionnaires. These questionnaires were constructed using an open-source online survey tool called LimeSurvey (Schmitz, 2012). The objective of the first questionnaire was to get a sense of the perceived commonness of the scenario. To achieve this, the real-life scenarios from table 3 would be compared pairwise by the participants. Participants were asked to repeatedly indicate the scenario which they would find less abnormal to observe. The objective of the second questionnaire was to get a sense of the perceived comfortability of the scenarios. In the second questionnaire participants were repeatedly asked to indicate in which of the two scenarios they would feel least comfortable being the one touched. This again was done using pairwise comparisons. Pairwise comparisons were chosen because it made it easier for the participants to assess the scenarios based on their commonness and comfortability, and to correct for possible range bias.

Both the order of the comparisons and the order in which the scenarios were shown were random, as depicted in figure 3.

The downside of using pairwise comparisons is that data from these questionnaires would only result in relative relations between the scenarios. Anchor points have been added because a quantifiable commonness and the comfortability was sought after, and absolute inferences are difficult.

These anchor points should ideally both cover a very uncommon situation and a very common situation, so that a part of the 14 scenarios falls between these anchor points. The anchor points that were chosen are added to the first questionnaire as scenarios 15 and 16 (as can be seen in figure 2 below).

Figure 2 Depiction of the creation of the two distinct questionnaires using the same scenarios and (mostly) the same anchoring points.

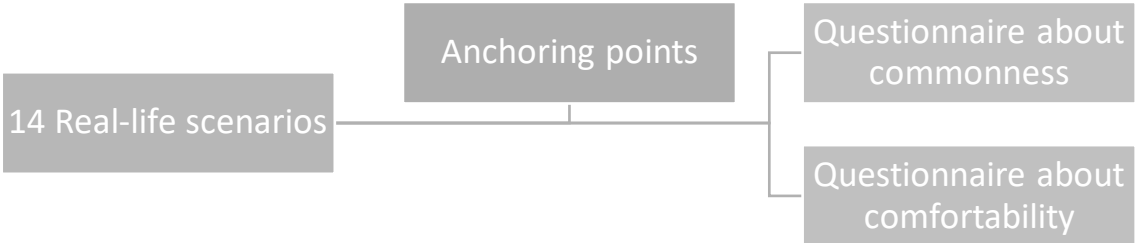
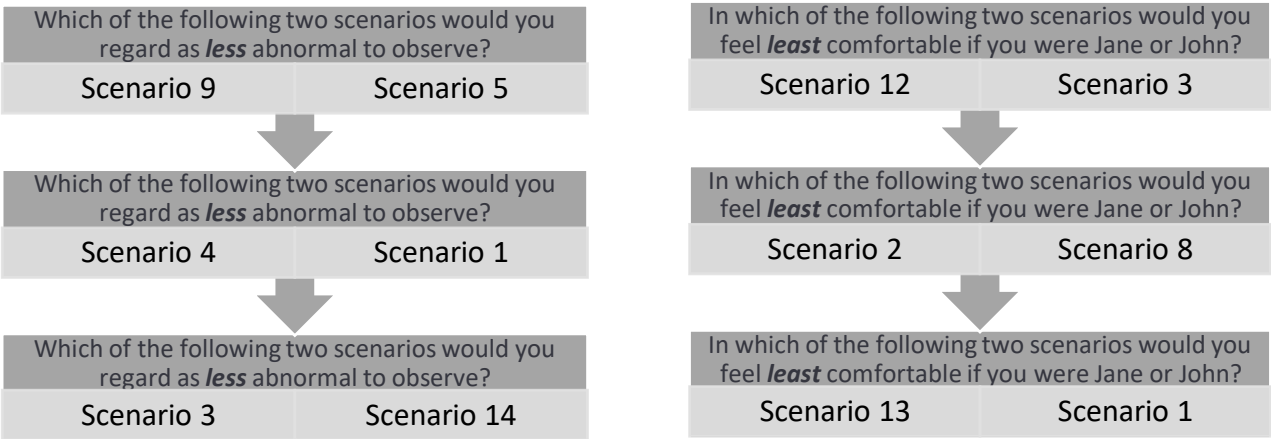


Figure 2 Exemplary order for the questionnaires, and the questions for the different objective of the questionnaires



Scenario 15 was thought to be slightly uncommon as it describes a woman being asked to take part in an interview while she was shopping. Scenario 16 was thought to be common and depicts a man who walks towards a crossing when the pedestrian light turns red.

Consequently, the first questionnaire consisted of 120 pairwise comparisons of the 16 scenarios (every of the 16 scenarios is being compared to the other 15 scenarios, thus this results in  $\frac{16*15}{2} = 120$  comparisons).

After a quick look at the preliminary results of the first questionnaire it was found that scenario 15, or anchor point 1, was not quite uncommon enough. Therefore, an additional uncommon anchor point was added along with the first two in the second questionnaire. In this anchor point two people take a walk together and then one sees the other vanishing into thin air.

Thus, the second questionnaire consisted of 136 pairwise comparisons of 17 scenarios ( $\frac{17*16}{2}$ ).

The additional 3 scenarios for the surveys are shown below in table 4.

*Table 4 Added anchor points as scenarios in the questionnaires*

	Scenario in questionnaire	Number of anchor point
15	As Jane is browsing through the shopping district, a journalist of the local newspaper comes up to her and asks her to take part in an interview.	1
16	As John walks towards the street to cross it, the traffic light for pedestrians turns red.	2
17	As John and Anna take a walk together, John sees Anna vanishing into thin air.	3 (only in questionnaire 2)

### *Procedure*

The procedure for both questionnaires are similar. The participants were invited via e-mail or text to participate in the questionnaire. Please note that the participants were only invited to either the first or the second questionnaire and did not participate in both questionnaires. Upon clicking the link, the participants had to read and accept the digital informed consent and explicitly click that they read the consent, that they agreed and that they would proceed with the questionnaire. In this informed consent was stated that the questionnaire was expected to last for 30 minutes, that they could withdraw participation at any time and that they had a 20% chance of winning 25€. Next, the participants were asked to indicate their age, their (identified) gender and their country of origin.

After these introductory questions, the actual questionnaire began. This is where the questionnaires started to differ. In the first questionnaire the participants got 120 pairwise comparisons consecutively in which they were asked to compare the two given scenarios. They had to indicate which of the two scenarios shown on screen was less likely to occur in their daily lives. The question remained the same throughout the questionnaire (“Which of the following two scenarios would you regard as *less* abnormal to observe?”), only the options to choose from, and thus the scenarios changed. This would give a sense of commonality of the scenarios.

The other questionnaire was similar to the first. Participants were asked to consecutively choose one of the two displayed scenarios. However, the objective for this questionnaire was different. Participants were asked to indicate in which of the two scenarios they would feel least comfortable if they were the main character (being John or Jane; “In which of the following two scenarios would you feel *least* comfortable if you were Jane or John?”). The number of comparisons they had to make increased slightly because another anchor point was added after launching the first questionnaire. This means that the participants had to make 136 choices in the pairwise comparisons. The results of these pairwise comparisons would give a sense of the perceived comfortability of the scenarios.

### *Data Analysis*

The Facets software (Linacre, 2020) was used to analyze the responses on the questionnaire with the many-facets Rasch model (Bond, 2007). An estimation for commonness and comfortability was made based on the joint maximum likelihood procedure. The units of the estimations are log odds units, or logits. Both estimates were then correlated.

## 4. Results

Analysis on the MS statistics of the participants (shown below in table 5) results in the elimination of two participants in the first questionnaire. In the first iteration participant 11 has detrimental MS values (i.e.  $MS > 2$ ; Wright & Linacre, 1994) and should therefore be removed from the data. However, in the second iteration, participant 2 was removed additionally because of detrimental high MS values. In the third iteration, no detrimental MS statistics were found. There were two participants (participants 3 and 8) with higher MS outfit values ( $1.5 < MS < 2$ ; Wright & Linacre, 1994) but since these are not detrimental for measurement, the data was left in. This results in a participant agreement of 81.8% (or 9 out of 11).

Table 5 Questionnaire 1: Participant MS statistics

Participant	1 <sup>st</sup> iteration		2 <sup>nd</sup> iteration		3 <sup>rd</sup> iteration	
	MS infit	MS outfit	MS infit	MS outfit	MS infit	MS outfit
1	0.74	0.62	0.95	1.19	0.96	1.07
2	0.97	0.99	1.40	2.38	-	-
3	0.86	0.77	1.23	1.49	1.32	1.82
4	0.64	0.50	0.74	0.44	0.74	0.42
5	0.79	0.69	1.04	1.07	1.06	1.11
6	0.67	0.54	0.90	0.64	0.98	0.71
7	0.61	0.47	0.67	0.39	0.73	0.41
8	0.77	0.68	0.97	1.10	1.00	1.54
9	0.63	0.51	0.75	0.50	0.77	0.51
10	0.79	0.64	1.13	0.91	1.27	1.03
11	3.18	6.08	-	-	-	-

Analysis on the MS statistics of the participants of the second questionnaire (shown below in table 6) also results in the elimination of more than one participant. In the first iteration, participant 6 has detrimental MS values and is removed for this reason. Participant 7 has a MS outfit that is too high, but not detrimental for measurement (i.e.  $1.5 < MS < 2$ ; Wright & Linacre, 1994), their MS infit is within the set boundaries. However, when running the dataset again without the data of participant 6, the MS values for participant 7 are detrimental and therefore removed. When running the data for a third time, another detrimental value was found, this time for participant 2. Participant 2 was thus removed. The fourth iteration did not have any detrimental MS statistic values, but there was a high MS outfit for participant 5. This outfit was high, but not detrimental ( $1.5 < MS < 2$ ; Wright & Linacre, 1994) and was thus not removed. The agreement among these participants is 66,7% (or 6 out of 9).

Table 6 Questionnaire 2: Participant MS statistics

Participant	1 <sup>st</sup> iteration		2 <sup>nd</sup> iteration		3 <sup>rd</sup> iteration		4 <sup>th</sup> iteration	
	MS infit	MS outfit	MS infit	MS outfit	MS infit	MS outfit	MS infit	MS outfit
1	0.75	0.53	0.82	0.51	0.89	0.52	0.89	0.50
2	0.78	0.87	0.89	1.25	1.00	2.21	-	-
3	0.63	0.44	0.65	0.42	0.67	0.44	0.70	0.47
4	0.98	0.75	1.16	0.90	1.32	1.12	1.45	1.35
5	1.03	1.19	1.16	1.74	1.17	1.79	1.17	1.70
6	1.71	2.93	-	-	-	-	-	-
7	1.28	1.64	1.45	2.81	-	-	-	-
8	0.76	0.56	0.84	0.56	0.90	0.59	0.89	0.58
9	0.86	0.69	0.88	0.63	0.92	0.71	0.84	0.62

After eliminating data of participants that were detrimental for measurement, the data for both questionnaires was run again in the Facets software separately (Linacre, 2020). The found logit measures for commonness per scenario are depicted in table 7 below. Further analysis on the measures with individual T-tests (DF set to 95) indicates that the measures of scenarios 10 and 16 are significantly different than all other measures, indicated by a star (\*). Scenario 1 was found to be significantly different from all other measures except those of scenario 3 and 11, indicated by these number in superscript (<sup>3, 11</sup>). All significant effects can be found in table 7 below. From this table is can be concluded that scenario 16 is thought to be the most common. This was expected because this was the scenario in which John walks up to a red turning traffic light. Scenario 10 is thought to be the least common. In this scenario John's hand is being squeezed by an unfamiliar man during the emotional movie.

Table 7 Commonness measures per scenario in odds logits. The numbers in superscript are referrals to the scenarios with which the current scenario were not significantly different, an asterisk means that the scenario was different from alle other scenarios.

Scenario	Logit measure	S.E.
1	-1.56 <sup>3, 11</sup>	0.23
2	-0.05 <sup>5, 6</sup>	0.23
3	-1.22 <sup>1, 4, 7, 13</sup>	0.23
4	-0.67 <sup>3, 7, 13</sup>	0.23
5	0.30 <sup>2, 6</sup>	0.24
6	0.78 <sup>5</sup>	0.26
7	-0.67 <sup>4, 13</sup>	0.23
8	-2.46 <sup>11, 12</sup>	0.26
9	2.63 <sup>14, 15</sup>	0.33
10	-3.78 *	0.38
11	-1.96 <sup>1, 8, 12</sup>	0.24
12	-2.28 <sup>8, 11</sup>	0.26
13	-0.81 <sup>3, 4, 7</sup>	0.23
14	1.92 <sup>9, 15</sup>	0.29

15	2.38 <sup>9, 14</sup>	0.31
16	4.07 *	0.48

The found logit measures for comfortability per scenario are depicted in table 8 below. Further analysis on the measures with individual T-tests (DF set to 95) indicate that the measures of scenarios 10 and 16 are significantly different than all other measures, indicated by a star (\*). Scenario 1 was found to be significantly different from all other measures except those of scenario 8, 11, 12 and 17, indicated by these number in superscript (<sup>8, 11, 12, 17</sup>). All other significant differences are stated in table 8. Please note that in this case there are 17 scenarios because the second questionnaire had one extra anchoring point. As can be seen from the data in the table, scenario 10 (John's hand being squeezed by an unfamiliar man during the movie) yielded the least perceived comfortability whereas scenario 9 yielded the highest perceived comfortability (John's arm is being stroked by his partner during the movie). If a closer look is taken, a cluster of 4 scenarios (all not significantly different from each other) is found at the highest perceived comfortability, these are scenarios 9, 14, 15 and 16.

*Table 8 Comfortability measures per scenario in odds logits. The numbers in superscript are referrals to the scenarios with which the current scenario were not significantly different, an asterisk means that the scenario was different from alle other scenarios.*

Scenario	Logit measure	S.E.
1	-1.71 <sup>8, 11, 12, 17</sup>	0.27
2	0.03 <sup>4, 5, 7</sup>	0.28
3	-0.94 <sup>7, 13</sup>	0.26
4	-0.10 <sup>2, 7</sup>	0.28
5	0.62 <sup>2, 6</sup>	0.30
6	0.94 <sup>5</sup>	0.31
7	-0.43 <sup>2, 3, 4</sup>	0.27
8	-1.85 <sup>1, 11, 12, 17</sup>	0.28
9	3.54 <sup>14, 15, 16</sup>	0.42
10	-2.92 *	0.35
11	-1.58 <sup>1, 8, 12, 13, 17</sup>	0.27
12	-1.85 <sup>1, 8, 11, 17</sup>	0.28
13	-1.13 <sup>1, 3, 11, 17</sup>	0.26
14	2.76 <sup>9, 15, 16</sup>	0.38
15	3.01 <sup>9, 14, 16</sup>	0.39
16	3.26 <sup>9, 14, 15</sup>	0.40
17	-1.65 <sup>1, 8, 11, 12, 13</sup>	0.27

The measures of both commonness and comfortability of each scenario are combined and depicted in table 9 below.



Table 9 Measures of Commonness and Comfortability per scenario

Scenario	Commonness Measure (logits)	S.E.	Comfortability Measure (logits)	S.E.
1	-1.56	0.23	-1.71	0.27
2	-0.05	0.23	0.03	0.28
3	-1.22	0.23	-0.94	0.26
4	-0.67	0.23	-0.10	0.28
5	0.30	0.24	0.62	0.30
6	0.78	0.26	0.94	0.31
7	-0.67	0.23	-0.43	0.27
8	-2.46	0.26	-1.85	0.28
9	2.63	0.33	3.54	0.42
10	-3.78	0.38	-2.92	0.35
11	-1.96	0.24	-1.58	0.27
12	-2.28	0.26	-1.85	0.28
13	-0.81	0.23	-1.13	0.26
14	1.92	0.29	2.76	0.38
15	2.38	0.31	3.01	0.39
16	4.07	0.48	3.26	0.40
17			-1.65	0.27

Discussion the measures of both commonness and comfortability as depicted in table 9

The second anchor point (scenario 16) has the lowest measure in commonness and is therefore found to be the most common, which was expected. However, the first anchor point, which was believed to be uncommon, was found to be more common than 13 out of 14 scenarios. Only the 9<sup>th</sup> scenario, in which John was stroked on his forearm by his partner Anna during the intense part of the movie, was found to be more common than the first anchor point. This means all other scenarios are found to be less common than being asked to participate in an interview while shopping.

The three most uncommon scenarios were scenario 10, scenario 8, and scenario 12. In these scenarios, respectively, John is watching a movie and is squeezed in his hand by an unfamiliar man, John is watching a movie and is stroked by an unfamiliar man on his forearm during the most intense part of the movie, and Jane is watching a movie and squeezed in her hand by an unfamiliar man. So the three most uncommon scenarios have in common that the touch is being administered by an unfamiliar man.

The three most common scenarios (excluding the anchor points) were scenario 9, scenario 14 and scenario 6. In these scenarios John is watching a movie and his partner Anna strokes his forearm during the most intense parts of the movie, Jane receives a shoulder- and neck massage from her partner Peter before having an interview, and Jane has been watching a movie in the theater and after the movie ended an unfamiliar woman places her hand across Jane's wrist.

The measures of comfortability showed a similar ranking. However, in these data anchor point 3 is added. Anchor point 3 was found to be much less comfortable than the other anchor points, but not as uncomfortable as all scenarios. The three scenarios that were most uncomfortable are scenario 10, scenario 12, and scenario 8. Scenarios 10 and 12 were also found to be most uncommon and were thus already describe above. In the 8<sup>th</sup> scenario John is watching a movie and is stroked on his arm by an unfamiliar man. Interestingly, these three scenarios also contain a touch by an unfamiliar man.

The three least uncomfortable, or most comfortable, scenarios were scenario 6, scenario 14, and scenario 9. Again, scenarios 14 and 9 were found to be also the most common scenarios and are thus describe above. In scenario 6 an unfamiliar woman places her hand across Jane's wrist after the movie ended.

Looking at scenarios 3-6, a clear pattern emerges. When a division is made based on the gender of the administer of the touch, the difference in both commonness ( $p < 0.05$  for both Jane and John) and comfortability ( $p < 0.01$  for both Jane and John) is significant (for both the scenarios with Jane (4 & 6) as for the scenarios with John (3 & 5)). When a division is made based on the gender of the receiver of the touch, the differences are not that outspoken. There is a significant difference in comfortability between scenario 3 and scenario 4 ( $p < 0.05$ ) meaning it would be more uncomfortable for Jane to be touched by an unfamiliar man as it is for John), but no such difference in commonness. There was no significant difference found between scenario 5 and scenario 6 meaning that there would be no difference in commonness or comfortability if Jane were touched by an unfamiliar woman or if John would be touched by an unfamiliar woman.

This same pattern emerges when looking at scenarios 10-13. Scenario 12 and scenario 13 differ significantly on both commonness ( $p < 0.05$ ) and comfortability ( $p < 0.01$ ). This means that it would be more common and more comfortable for Jane to be touched by an unfamiliar woman than an unfamiliar man. This also holds true for the scenarios with John (scenario 10 and scenario 11, commonness,  $p < 0.001$ ; comfortability,  $p < 0.01$ ). However, with these scenarios there is a significant difference between the receivers of the touch. For a touch by an unfamiliar man, it would be more common ( $p < 0.001$ ) and comfortable ( $p < 0.01$ ) for John than for Jane (scenario 10 and scenario 12). The difference for a touch by an unfamiliar woman is only significant for the commonness ( $p < 0.01$ ; scenario 11 and scenario 13).

The measures of commonness and comfortability are correlated ( $R = 0.9763$ ). This means that when a scenario is more common, the perceived comfortability is higher. Even so, when a scenario is thought to be uncommon, the perceived comfortability is significantly lower. A further regression has been executed. The coefficient of commonness on comfortability has been found to be 0.9501 with a SD of

0.0563 (all measures are in logits). The following equation 1 describes the regression of these measures.

$$\text{Comfortability} = 0.3038 + 0.9501 * \text{Commonness} \tag{Equation 1}$$

In figure 2, the measures of comfortability and commonness are plotted for each scenario. In this graph the correlation can be seen clearly as calculated above following equation 1.

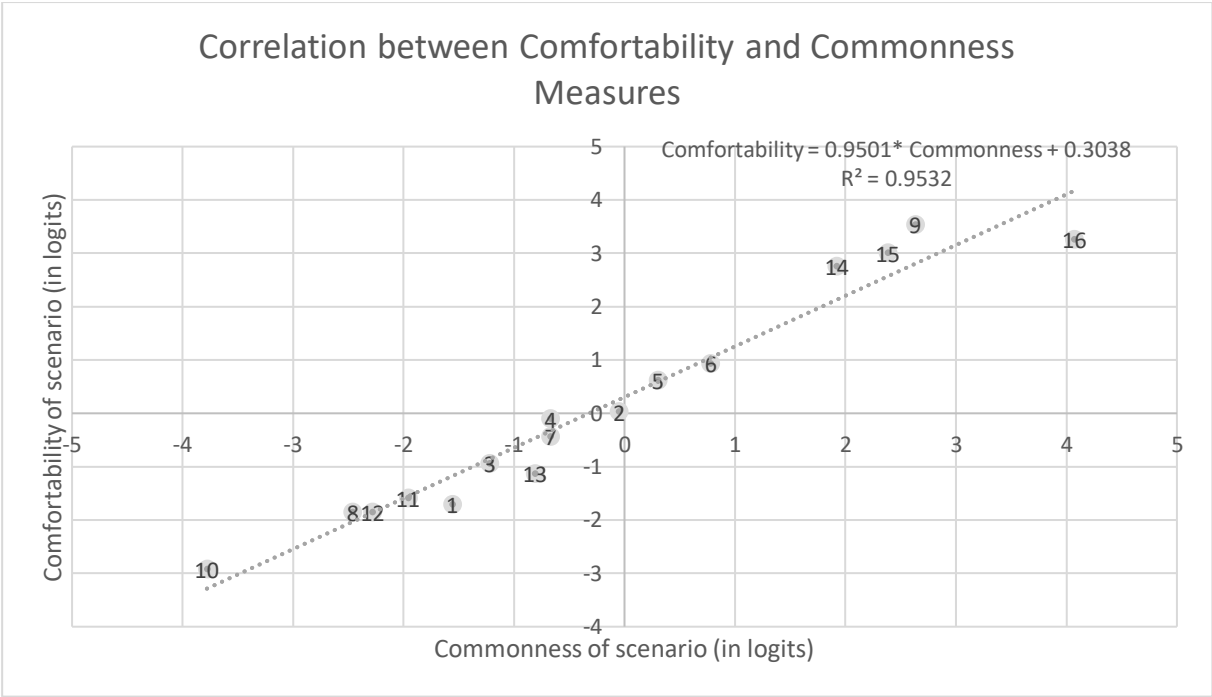


Figure 2 Graph of plotted measures of comfortability and commonness

The estimated commonness of the third anchor point, based on the comfortability measure (-1.65) and the equation found in regression, is -2.06. This means this anchor point would be roughly as common as scenario 11. In other words, a man being squeezed in his hand by an unfamiliar woman during the movie is roughly as common as taking a walk with a friend and witness them vanishing into thin air.

## 5. Discussion & Conclusion

The results of this study show that scenarios in which the touch was administered by a stranger were all regarded most uncommon and most uncomfortable. Especially the touch of unfamiliar men tends to make scenarios uncommon and uncomfortable. Most touches by the partners were regarded as most common and most comfortable by the participants. Moreover, this study showed that there was a high correlation between commonness and comfortability in such situations.

So to answer the first research question: There is no clear paradigm for touch settings used in literature. This means that a lot of different touch settings are used. These settings do have one thing in common, for example the way of stress elicitation can be regarded similar for some of these settings. However, the timing and placing of the touch as well as the environment in which the touch takes place, the physical properties of the touch and also the person administering the touch differs throughout all these settings.

Moving on to the second research question: Most of the settings used in current literature are not at all representative with respect to the frequency of occurrence in the ecological environment of the participants. This implicates that the findings of these studies might have a high internal validation but have low external validation and thus are not applicable to real-life (Brunswik, 1955c). This also supports the comment that was made in the 2017 paper by Cabibihan & Chauca, in which they state that the results of an earlier study showed ambiguous results due to the evoked discomfort in participants that were touched by a stranger (Cabibihan, Zheng & Cher, 2012).

The hypothesis for the last research question can be confirmed. Settings that are rare in the ecological environment of our participants are also more stressful/arousing. This study showed that there is an undeniable correlation between the commonness and the comfortability of a touch setting. Hereby stressing once again the importance of context for a touch setting. This means that the touches used in MST research that are regarded as uncommon, would be stressful in itself. Measuring the effect of the (mediated) social touch on stress leads to ambiguous results as the touch does not reduce stress because the setting is stressful.

The importance of context has also been found in other studies, for example the study by Askari et al. (2020). In this study two mediated social touches were administered to the same participant. Both touches had the same physical properties, the only difference was the tone of the textual conversation at hand. Participants evaluated both touches quite different, while they were actually the same apart from the different context.

Erk et al. (2015) found no difference in their two conditions with visual or haptic feedback. This could be due to the used settings in their study. All scenarios extracted from their settings were regarded highly uncommon and highly uncomfortable by participants. If the participants receiving the haptic

feedback were uncomfortable during the executing of their experiment, it would not be strange if their stress levels were not lowered considerably more than in the condition with visual feedback.

The results of the study by Cabibihan & Chauca (2017) were also inclusive. This could also be due to their choice of settings. One of the scenarios extracted from their settings used in this study was regarded highly common and comfortable (being touched by a partner), but the other scenarios were not considered common or comfortable (touched by an unfamiliar man or woman).

The study by Edens et al. (1992) found that touch did not attenuate stress reaction. Again, this could be due to the choice of settings used. Participants regarded one of the scenarios as uncommon and uncomfortable (being touched by an unfamiliar woman), whereas the other was regarded as neither.

Lastly, the study by Ditzen et al. (2007) showed a clear difference in stress responsiveness. Their setting was regarded as common and comfortable, so their results would be applicable to real-life settings.

### *Limitations*

The foremost limitation of this study was the COVID-19 pandemic and all the restrictions it came with. The initial idea for this exploratory study was to measure the stress levels in one or two touch settings from the literature to see if the setting itself might be stress inducing. Sadly, due to the restriction of this pandemic, laboratory studies were put on hold. This is the reason another setup for this study was chosen. The only possible way to include actual data in this study was to include self-reports and thus the choice for questionnaires was made. The biggest setback is that in this case no actual stress could be measured. Also, the touch settings could not be set-up in the laboratory, so the idea of real-life scenarios occurred. So next to the fact that only perceived measures can be taken, the participants would also have to imagine being in a specific scenario. Especially the difference in gender between the participant and the main character of the scenario might be a potential pitfall and could lead to a man versus woman bias.

In a potential follow-up study it would be good to test some of the scenarios out in the laboratory and thus setting the actual context of the touch setting and measuring the stress levels of the participants instead of dealing with only perceived comfortability.

Although the questionnaires had no detrimental effects for the participants, the questionnaires were considered too long, as many participants stopped after a few questions. Therefore, it was hard to get the desired number of participants and thus the desired comparisons per scenario. Friends, colleagues, and family members were therefore asked to participate. This however means that the sampling of the participants is no longer random and most participants share the same cultural values and social norms.

One of the main challenges was to find the right number of scenarios. Ideally, all scenarios in current literature are added. However, this brings a huge load to the participants. As more scenarios are added, the chances of participants stopping halfway through increase. The main source of the large number of scenarios was the unknown gender of the person administering the touch. Therefore, the scenario was added twice, once with an unfamiliar woman and once with an unfamiliar man. These different scenarios showed significant difference in both commonness and comfortability as was to be expected following Levav & Argo (2010). For future references it might be interesting to see if there is a difference between the effects of the touches of an unfamiliar man and woman, and the effect of the touch of an unknown person. So what effect would a (mediated) social touch have when the person receiving the touch does not know from who the touch is.

Another possible way of making sure the participants finish the questionnaire could be by making the comparisons more interesting, like using pictures instead of the textual scenarios or adding one or more senses (e.g. sound or vision). It could even be done using virtual reality, making it more immersive. However, making it immersive by the use of virtual reality would require participants to come to the laboratory as well and was in this case not possible. It could be done in the future to test touch settings in a similar way.

Both the real-life scenarios as well as the anchoring points were constructed during this study. They would have to be precise, and descriptive of the context but concise to make the questionnaire most efficient. The participants would have to read both scenarios before making a comparison. Making small adjustments would possibly lead to other results since the importance of the context of the touch cannot be stressed enough.

All in all, this study has its limitations. However, based on the results of this study it can still be concluded that some of the touch settings used in literature can be regarded as uncommon and as uncomfortable. This indicates that some of these settings are stressful in itself and thereby it is not strange that no conclusive results have been found in literature. This study again stresses the importance of context of (mediated) social touches and thereby the importance of taking stimuli from the ecological environment of one's participant on the outcome of the experiments.

Therefore, MST research should stick to naturalistic stimuli from the participant's ecological environment. However, this statement applies not only to MST research, it can be applied to every other area of research.

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