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The effect of touch on itch

The influence of affective touch and interpersonal touch on itch relief

Master Thesis Neuropsychology

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Abstract

Introduction: Itch is caused by a variety of conditions, but for some patients effective treatment is still lacking. Itch is processed via unmyelinated C-fibers and is influenced by counter stimuli that rely on similar fibers. Affective touch is a pleasant touch that relies on a subgroup of C-fibers (CT-afferents) and could be effective for itch relief. CT-afferents are shown to respond optimally to typical skin temperature, thus the present study investigates whether interpersonal touch has an additional relieving effect on itch.

Methods: Itch was electrically induced in four touch conditions: 1) impersonal non-affective touch, 2) impersonal affective touch, 3) interpersonal non-affective touch and 4) interpersonal affective touch. A brush was used for impersonal touch and fingers of the experimenter for interpersonal touch, with slow strokes (3cm/s) for affective touch and fast strokes for non-affective touch (18 cm/s). The duration of a condition was 10 minutes, with 5 itch measurements on a VAS-scale.

Results: This study showed that affective and interpersonal touch do not have a greater relieving effect on itch compared to non-affective and impersonal touch. In addition, no relationship between the experienced pleasantness of touch and itch relief was found.

Conclusion: This study could not provide supporting evidence that optimal CT-afferents activation by touch has an additional relieving effect on itch. An attention effect is proposed as alternative explanation. In order to draw firm conclusions, further research with methodological adjustments is needed.

Introduction

Itch is a common somatosensory experience that is defined as a negative sensation that leads to the automatic desire to scratch (Helmchen et al, 2013). Itch is caused by a variety of skin conditions and diseases, as well as systemic, neurological and psychosomatic disorders. Itch can be classified into mechanical and chemical itch, of which chemical itch can be further divided into histamine dependent and histamine independent itch (Chen & Sun, 2020). Anti-histamine medicines are shown to be effective in treating histamine dependent itch. However, the medicines do not relief itch for many chronic itch patients, as they mostly suffer from the histamine independent variant. Therefore, research into histamine independent itch can be helpful (Chuquilin et al., 2016; Ikoma et al., 2003, 2006; LaMotte et al., 2014; Leslie, 2013; Wallengren, 2005).

Itch draws automatic attention, which means it can interfere in daily life activities and has an effect on the quality of life. Moreover, research has shown that chronic itch has similar impact on the quality of life as chronic pain. It is even demonstrated that chronic itch can have mental health problems as result, such as depression and suicidal thoughts (Dalgard et al., 2019; Evers et al., 2019; Leslie, 2013; Van Laarhoven et al., 2018; Wallengren, 2005). This means that there is a strong need for alternative interventions for patients who do not respond to drug treatments.

Itch is immediately relieved by scratching, which suggests that pain stimuli have a reducing effect on itch. Historically it has been thought that itch was a weak variant of pain. However, studies found that increasing pain stimuli reduces itch, but increasing itch stimuli will only lead to more itch without reducing pain. It is therefore suggested that itch and pain are separate sensations and are transmitted along different pathways (Chuquilin et al., 2016; Ikoma et al., 2003; LaMotte et al., 2014; Mochizuki et al., 2014; Sun et al., 2017; Wallengren, 2005). In general, the skin contains different types of nerve fibers with different functions. For instance, large thickly myelinated fibers (Aβ) carry light touch and mechanical information. Moreover, small thinly myelinated fibers (Aδ) or unmyelinated (C) fibers are responsible for sensations such as pain and temperature (Chuquilin et al., 2016). In 1997, Schmelz found evidence that a distinct subgroup of C-fibers is sensitive for itch compounds (Schmelz, 2010). In this case, pruriceptive neurons are considered as a subset of nociceptive fibers, of which itch relies on C-fibers and pain relies on a combination of C- and A-fibers. The selection theory of itch suggests that itch occurs when only pruriceptive neurons are activated, while the sensation of pain dominates when pruriceptive- and nociceptive neurons are activated together (Chuquilin et al., 2016). It explains why pain is able to reduce itch, even though pain and itch are considered as two separate sensations (figure 1).

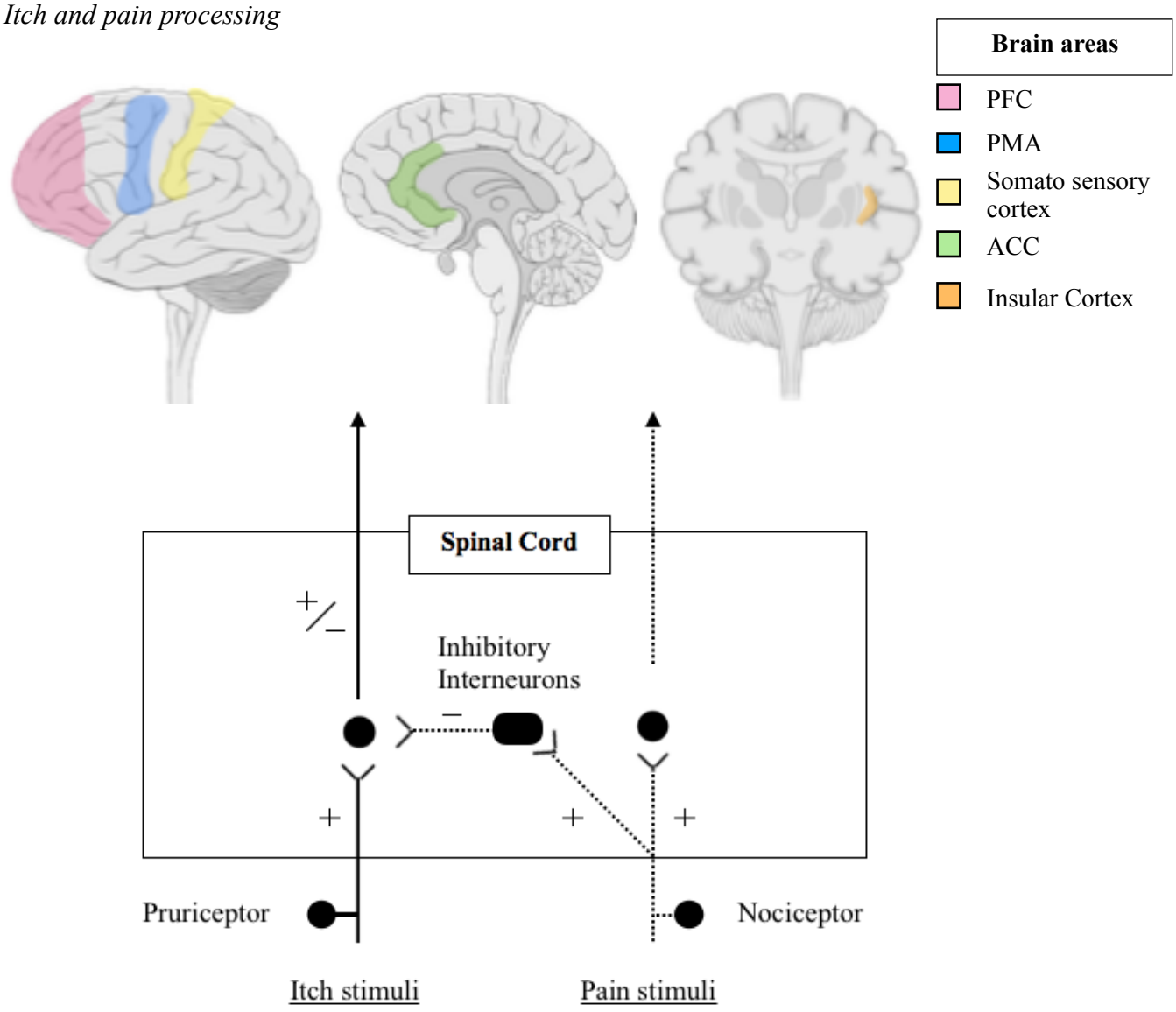
Furthermore, research found that pain and itch influence each other at spinal cord level (Chuquilin et al., 2016; Mochizuki et al., 2014; Schmelz, 2010). The specific mechanisms between pain and itch in the spinal cord are still not understood completely, but studies suggest that counter stimuli (such as scratching) mask the itch sensation by activating interneurons in the spinal cord. The interneurons in turn have an inhibitory effect on the itch afferent stimuli, which is visualized in figure 1 (Chuquilin et al., 2016; LaMotte et al., 2014; Mochizuki et al., 2014).

Studies also found that itch and pain share similarities in brain activation, of which the brain areas are demonstrated in figure 1. For instance, the somatosensory cortex is proposed to encode the spatial, temporal and intensity aspects of both itch and pain. Moreover, the activation of the anterior cingulate cortex, insular cortex and prefrontal cortex explains the affective component of both sensations. Although pain and itch share similarities in brain activation, the sensations can be differentiated by their motor response. With regard to itch, activation of the motor cortex leads to scratching behavior, while in pain activation of the motor cortex leads to withdrawal from the stimulus (Berlucchi & Aglioti, 2010; Chen& Sun, 2020; Chuquilin et al., 2016; Gogolla, 2017; Ikoma et al., 2006; Leknes et al, 2007). Research suggests that the frontal areas specifically seem to contribute to the compulsive component of itch and scratching. Itch-associated scratching is able to induce a pleasant feeling, which can be problematic in chronic itch. The hedonic component can lead to an itch-scratch cycle, in which patients may scratch until it no longer provokes a pleasant sensation, rather than until the itch has subside. The scratching behavior in turn leads to skin damages, which could lead to infections (Anderson et al., 2017; Chen & Sun, 2020; Ikoma et al., 2006; Snauwaert et al., 2014; Weisshaar & Dalgard, 2009). Thus, even though pain has a reducing effect on itch, it is not ethically desirable to use pain stimuli as treatment for itch. However, it could be interesting to look into other sensations that rely on the C-fibers group, which might reduce itch sensations without having negative consequences.

Another sensation that relies on a subgroup of C-fibers (CT-afferents) is “affective touch”. In general, there are two categories of touch identified, discriminative touch and affective touch. Discriminative touch carries information of pressure, vibration, slip and texture. It relies on Aβ fibers, which enable fast conduction velocities, support rapid central processing and carry mechanical information (Chuquilin et al., 2016; McGlone et al., 2014). Affective touch on the other hand is a light and slowly conducted touch that is considered to be important in social context for social bonding (Björnsdotter et al., 2014; Ikoma et al., 2006; Goldstein et al., 2016).

Figure 1.

Itch and pain processing



Note. Processing of itch and pain according to the selection theory and the overlapping brain activities between itch and pain.

Affective touch relies on CT-afferents, which are located in the hairy skin and respond optimally to gentle touch with slow conduction velocities. Research has shown that CT-afferents activation is positively correlated to the perceived pleasantness (Björnsdotter et al., 2014; Croy et al., 2016; Löken et al., 2010, 2011; McGlone et al., 2014; Morrison et al., 2011; Olausson et al., 2002, 2010; Pawling et al., 2017). Noteworthy, Von Mohr, and colleagues (2017) argued that affective touch is able to reduce feelings of distress, which gives the impression that itch could be relieved by affective touch. However, the effect of affective touch on itch is not investigated excessively yet, but research did find a reducing effect of affective touch on pain. For instance, Liljencrantz et al.

(2017) demonstrated a difference in pain relief between slow and fast stroking, of which pain ratings were lower when pain was preceded by slow stroking compared to fast stroking. Therefore, the results of the study indicated that activation of CT-afferents by slow stroking modulates pain. The authors proposed that the hedonic aspect of affective touch contributes to the relieving effect on pain, which is also present for other pleasurable stimuli, such as pleasant smells, images, favorite music and foods (Leknes & Tracey, 2008; Konno & Sekiguchi, 2018). Since pain and itch share similarities in sensory processing, it could be possible that CT-afferents activation by affective touch reliefs itch, similar as affective touch reliefs pain.

In the study of Liljencrantz et al. (2017) the CT-afferents were activated by slow conduction velocities using a brush. However, other studies have mentioned that CT-afferents respond optimally to neutral (typical skin) temperature, rather than cooler or warmer stimuli (Ackerley et al., 2014; McGlone, Wessberg & Olausson, 2014). Therefore, Strauss et al. (2019) suggested that C-fibers are more tuned to interpersonal touch than impersonal touch. According to Löken and colleagues (2011), interpersonal touch is frequently used for communication of positive messages and is therefore experienced as more pleasant. Thus, also with respect to interpersonal touch, it is suggested that the hedonic aspect of the touch suppresses negative sensations (Ellingsen et al., 2016; Liljencrantz et al., 2017; Löken et al., 2011).

The purpose of the present study is to investigate the effect of affective touch on itch, by comparing the effects of non-affective touch and affective touch on itch relief. Furthermore, the effects of impersonal touch and interpersonal touch on itch relief is taken into account. Since studies discussed that the hedonic aspect of touch is related to a relieving effect, the relationship between the pleasantness of the touch and itch relief is investigated. In the experiment, an electrode is used as method to induce histamine independent itch (Ikoma et al., 2005; Van Laarhoven et al., 2017a). The touches on the arm will be conducted with a brush (impersonal touch) or fingers of the experimenter (interpersonal touch), with fast conduction velocities (non-affective touch) or slow conduction velocities (affective touch).

First, a difference in itch relief between non-affective touch and affective touch is expected, of which affective touch will have a greater relieving effect on itch than non-affective touch. Second, it is expected that interpersonal touch and impersonal touch will have a different effect on itch, of which interpersonal touch will have a greater relieving effect on itch than impersonal touch. Third, a difference in experienced pleasantness is expected, of which type of touches with a higher pleasantness rating are related to more itch relief.

Methods

Participants

In this study 23 Dutch and English speaking adults participated. The participants were females with the mean age of 23.43 years (*SD*= 8.68). The participants where students from Utrecht University or working adults, who were recruited via SONA systems, social media and verbal communication. They were selected by a few exclusion criteria: the participants were not allowed to participate if they had (1*)* a pacemaker, since this could not be safe in combination with the electrode, (2) skin disorders or diseases and (3) medication use, such as anti-histamines/ painkillers, since they might influence the itch experience. Originally 23 participants participated in this study, however one participant was excluded due to malfunctioning of the electrode (*n*=1) and a few of the participants were excluded because they were not able to experience itch, but reported an irritating feeling instead (*n*=9). The participants obtained college credit or 7 euro's as compensation for participation.

Apparatus & Stimulus

The itch was induced electrically, using the Isolated Bipolar Constant Current Simulator DS7 (Van Laarhoven et al., 2017a). The electrode was placed at the radial zone on the wrist of the participant. An electrical current of 200 Volt with a frequency of 50 Hertz was applied to induce itch and to alter the pulse duration, E-Prime® 2.0 was used. A pulse of 20 milliseconds was conducted with 0.2 milliseconds of activation, followed by a 19.8 milliseconds pause. To determine the level of itch, the level of amperage (in milliampere) was adjusted in the experiment to manipulate the itch intensity. The level of milliampere ranged from 2.03 to 5.49 ($M_{amperage}$= 3.45, $SD_{amperage}$= 0.90).

To apply the affective and non-affective touches, a soft brush (HEMA brush 106) was used for the "impersonal touch" condition and fingers of the experimenter were used for the "interpersonal touch" condition. To obtain the same surface as the brush in the impersonal condition, two fingers were used. Moreover, to make sure the temperature of the fingers remained at a neutral temperature of 30 degrees, an infrared thermometer gun was used. If the temperature of the fingers became colder than neutral temperature, the experimenter rubbed the hands to increase the temperature in the fingers.

Questionnaires

The participants (*N*=23) completed an online demographic questionnaire that collected the information about the age, gender and highest level of education. Furthermore, questions about the exclusion criteria were included regarding skin disorders/diseases, current use of medicines such as

painkillers or anti-histamine, and use of a pacemaker for safety purposes(Van Laarhoven et al., 2017a). The participants automatically received feedback whether they were allowed to participate and received general information about the procedure of the experiment in an online version of the informed consent form.

During the experiment, the Visual Analogue Scale (VAS) with a ten point scale was used to rate the pleasantness of the touches and to rate the itch sensation during the experiment (Sailer et al., 2016). In the pleasantness measurements, zero represented “very unpleasant” and ten represented “very pleasant”. In the itch intensity measurements zero represented “no itch at all” and ten represented “worst itch imaginable”.

Procedure & Design

If the participants would like to participate, the instructions about the experiment were sent by mail with a link to the online demographic questionnaire. The participants were asked to complete the questionnaire before the experiment appointment, because it also included an online version of the informed consent.

The experiment itself was conducted in a quiet lab at Utrecht University. Before starting the experiment the participants were verbally instructed about the procedure again and about the next two points: “quitting the experiment is possible at any time and will not have any negative consequences” and “questions can always be asked if something is unclear”. After this, the informed consent form was handed over to be signed by the participant.

First, the electrode was attached on the right or left wrist of the participant. The side of the electrode was randomized across participants. After this, the baseline measurement of the itch sensation was tested. The DS7 was turned on and the amount of milliampere was slowly increased until the participant rated the itch sensations on the VAS with a 7. If a participant did not feel an itch sensation during the baseline measurement, the experiment stopped and the participant received compensation for participation. If a participant did feel an itch sensation at a lower rating then 7, but no itch sensation if the milliampere further increased, their highest ranking was used as baseline. After the baseline rating of itch, the baseline of pleasantness of the different touch conditions was rated on the VAS.

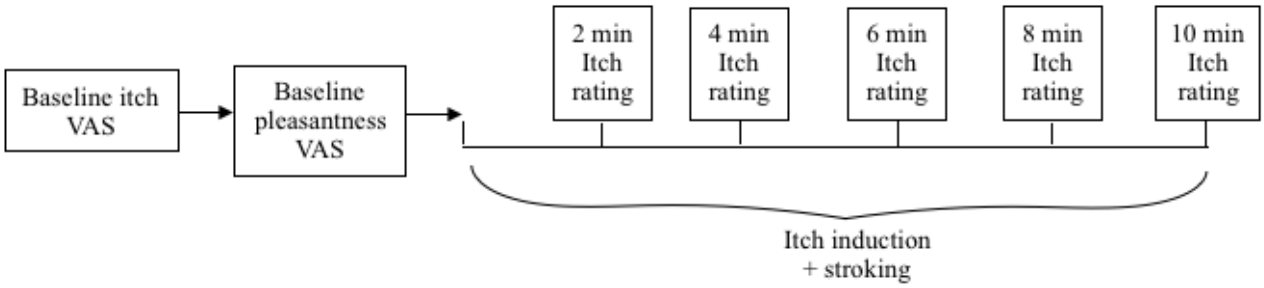
The application of the tactile stimuli was conducted by stroking in between two lines that were drawn on the dorsal forearm with 6 centimeters apart. The strokes on the arm were conducted with a velocity of 1) three strokes per second (18 cm/s) with a brush for “impersonal non-affective touch” 2) one stroke per 2 seconds (3 cm/s) with a brush for “impersonal affective touch” 3) three

strokes per second (18 cm/s) with the fingers for "interpersonal non-affective touch" and 4) one stroke per 2 seconds (3 cm/s) with the fingers for "interpersonal affective touch" (McGlone et al., 2014; Strauss et al., 2019; Sailer et al., 2016). In each experimental touch condition, the participant was instructed to focus on the itch sensation at all times. The duration of each touch condition was 10 minutes, with itch measurements on the VAS scale after every two minutes, resulting in 5 itch measurements per condition.

The design of the study is a repeated measurements within-subject design, since all participants were exposed to the same conditions and were measured multiple times (Field, 2013, chapter 14). The participants provided 5 ratings per condition, thus 20 itch intensity ratings in total. The experiment consisted of four conditions: (1) impersonal non-affective touch, (2) impersonal affective touch, (3) interpersonal non-affective touch and (4) interpersonal affective touch. The order of the conditions were randomized across participants.

Figure 2

Procedure of the experiment.



Note. Baseline measurements of itch and pleasantness were conducted prior to the experiment. A single touch condition of 10 minutes is visualized in the figure. The strokes are conducted during itch induction, with every two minutes an itch intensity rating on the VAS.

Statistical analysis

The data was analyzed using SPSS Statistics (version 26). 10 participants (N=10) were excluded from the analysis, because the electrode malfunctioned for 1 participant and 9 participants did not experience itch during the electrical stimulation.

The Shapiro- Wilk test was used to check for normality and Mauchly's test was used to check the assumption of sphericity.

To analyze the difference in itch relief between the type of touches, a 2 × 2 × 5 repeated measures ANOVA was conducted. The within factors were defined as "touch" (affective vs. non-

affective), "personal" (impersonal vs. interpersonal) and "time" (2 minutes, 4 minutes, 6 minutes, 8 minutes & 10 minutes). The baseline measurement was subtracted from the experimental itch measurements, to create difference scores of itch as dependent variable.

To investigate whether there is a difference in experienced pleasantness between the type of touches, a 2 × 2 repeated measures ANOVA was conducted with the within factors "touch" (non-affective vs. affective) and "personal" (impersonal vs. interpersonal).

A correlation test was conducted in order to analyze the relationship between the pleasantness of the type of touch and itch relief. There was an outlier present and the assumption of linearity was not met, so a non parametric Spearman Rho analysis was conducted for "touch" and "personal". To calculate the difference scores of itch for "touch", the five measurements of itch per 2 minutes were averaged for affective and non affective touch. The mean itch scores of non-affective touch were subtracted from affective touch. To calculate the difference score of itch for "personal", the five itch measurements per 2 minutes were averaged and the mean itch scores of impersonal touch were subtracted from interpersonal touch.

Results

Relieving effect of touch on itch

In order to analyze the difference in effect on itch between the type touches over time, a 2 (touch: affective vs. non-affective) × 2 (personal: impersonal vs. interpersonal) × 5 (time: 2 min, 4min, 6min, 8min, 10min) repeated measures ANOVA was conducted.

There were no outliers present in the data. The results of Shapiro Wilk test indicated non normality for 4 of 20 standardized residuals. The skewness of the data was checked, since Marshall (n.d.) reported that the repeated measures ANOVA can still be conducted provided that the residuals are not 'very' skewed. By checking the skewness z-scores, the scores were within the range of -1.96 and 1.96, indicating an approximately normal skewness (Field, 2013, p.179). The assumption of sphericity was analyzed with Mauchly's test, indicating that the assumption was mildly violated for "time" and "touch × time". For these effects the Greenhouse- Geisser correction was used. The results of the repeated measures ANOVA showed no significant main and no significant interaction effects. Further details of the results are reported in table 1 and visualized in figure 3.

Table 1

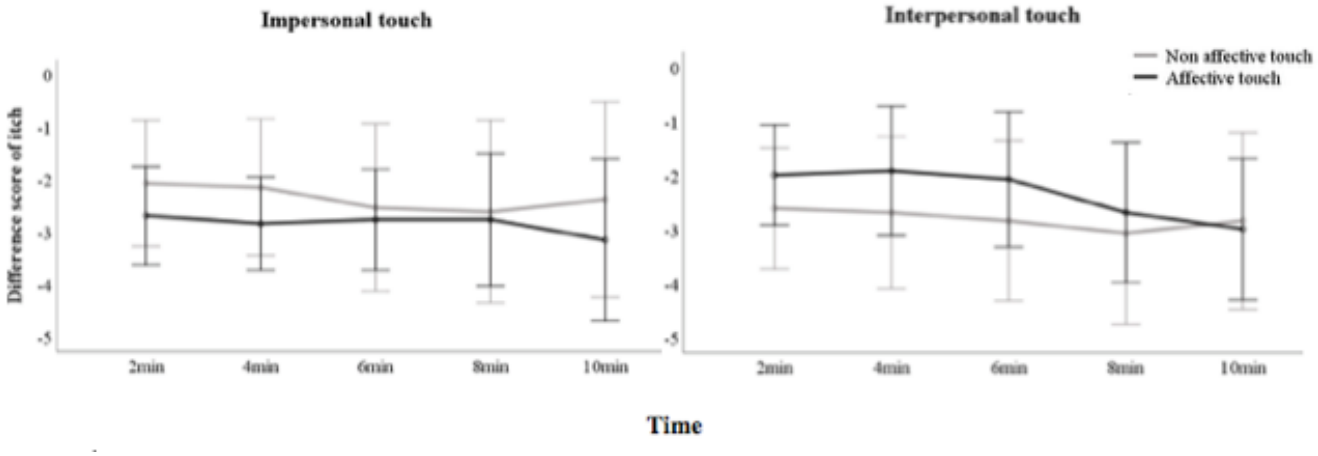
Results of the 2 × 2 × 5 repeated measures ANOVA.

Effect	*Df*	*Df error*	*F*	*P*	*Partial* η^2
Main effects					
Touch	1	12	.00	.990	.000
Personal	1	12	.01	.925	.001
Time	1.28	15.37	1.08	.334	.082
Interaction effects					
Touch x Personal	1	12	3.26	.096	.214
Touch x Time	1.86	22.35	1.77	.195	.128
Personal x Time	4	48	.72	.585	.056
Touch x Personal x Time	4	48	.91	.468	.070

Note. The main and interaction effects of touch, personal and time are reported, derived from the 2 × 2 × 5 repeated measures ANOVA.

Figure 3

The mean difference scores of itch per type of touch over time.



Note. The graphs represent the difference between impersonal touch (left) and interpersonal touch (right). The lines represent the difference between non-affective touch (grey line) and affective touch (black line), with error bars that represent SE, (*N*=13).

Pleasantness of the type of touch

The Shapiro-Wilk test was conducted and indicated a normal distribution. To analyze the difference in pleasantness rating on the VAS scale between non-affective touch vs. affective touch and impersonal touch vs. interpersonal touch a 2 (personal: impersonal vs. interpersonal) × 2 (affective: non-affective vs. affective) repeated measures ANOVA was conducted.

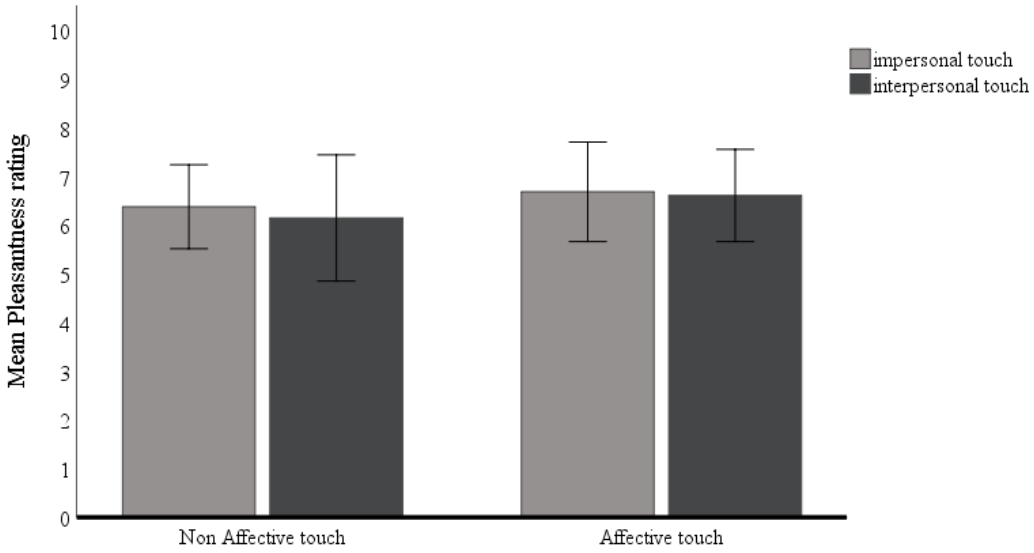
The main effect of "touch" showed no significant difference in VAS pleasantness rating between non-affective touch and affective touch ($F(1,12)= .576$, $p= .463$, Partial $\eta^2 = . 046$), which indicated that the mean pleasantness rating for affective touch (*mean*= 6.65, *SD*= 1.46) was equal to non-affective touch (*mean*= 6.27, *SD*=1.84).

The main effect of "personal" also showed no significant difference in VAS pleasantness rating between impersonal touch and interpersonal touch ($F(1,12)= .163$, $p= .694$, Partial $\eta^2 = .013$), which indicated that the mean pleasantness rating for interpersonal touch (*mean*= 6.39, *SD*= 1.58) was equal to impersonal touch (*mean*= 6.54, *SD*= 1.52).

The interaction effect between "touch" × "personal" indicated no significant interaction ($F(1,12)= . 062$, $p=.808$, Partial $\eta^2= .005$). The details of the interaction effect are visualized in figure 4.

Figure 4

The mean pleasantness ratings of the type of touches



Note. The bars represent the mean pleasantness ratings for the interaction effect between touch and personal derived from a 2x2 repeated measures ANOVA, with error bars that represent SE, (*N*=13).

Relationship pleasantness and itch relief

In order to analyze the correlation between the pleasantness and itch relief a Spearman Rho correlation was conducted. The results for "touch" indicated no significant correlation, r_s = -.33, p= .269, two tailed, N=13. The results for "personal" also indicated no significant correlation, r_s = -.11, p= .717, two tailed, N=13.

Discussion

The aim of the current study was to investigate the effect of affective touch on itch and whether interpersonal touch had an additional effect in relieving itch. In addition, the relationship between itch relief and the experienced pleasantness of the touches was analyzed.

First, it was hypothesized that affective touch would have a greater relieving effect on itch than non-affective touch. The expectation was based on the study of Liljencrantz et al. (2017), in which the authors demonstrated that pain was relieved more by affective touch than non-affective touch. The results of the current study were in contrast with the expectations, since no difference in itch relief was found between non-affective and affective touch. Noteworthy, the results also showed no difference in experienced pleasantness between non-affective touch and affective touch, which indicates that the CT-afferents were not optimally activated in the affective touch condition. Studies argue that activation of CT-afferents is a very complex system that does not only rely on bottom up information, but is influenced by top down information as well (Cascio et al., 2019; Ellingsen et al., 2014, 2016; Liljencrantz et al., 2017; McCabe et al. 2008; Pawling et al., 2017). For instance, Cascio and colleagues (2019) mentioned that the relationship with the toucher influences the subjective experience of affective touch. Research shows that affective touch between partners is experienced as pleasant and has a powerful effect on relieving distress, but affective touch from a stranger is able to elicit a more negative emotional valence (Ellingsen et al., 2016). Especially for women the meaning of the touch is primarily influenced by how close the relationship to the toucher is (Heslin et al., 1986). Besides the relationship with the toucher, Cascio et al. (2019) also discussed that multisensory information, such as visual information of the facial expression, can influence the brain's response to affective touch. For example, a neutral expression is related to decreased arousal to affective touch (Harjunen et al., 2017). In the current study it could be possible that the gender of the participants, superficial relationship with the experimenter and neutral facial expression of the toucher interfered with the effect of affective touch on itch relief. Further research is needed to investigate this matter.

Second, it was hypothesized that interpersonal touch would have a greater relieving effect on itch than impersonal touch. The expectation was based on the responding preference of CT-afferents to typical skin temperature (Ackerley et al., 2014; McGlone et al., 2014). The results of the current study showed no differences in itch relief between impersonal touch and interpersonal touch, which was in contrast with the expectations. There is a possibility that the temperature differences in stimuli has its own effect on the perception of itch and interfered with the effect of interpersonal touch on itch. Studies have mentioned that subtle changes in temperature of the skin, environment and experimental tools are able to influence itch perception. For example, warmth is shown to increase itch intensity in Atopic Dermatitis (AD) (Fruhstorfer, Hermanns & Latzke, 1986; Sanders et al., 2018; Murota & Katamaya, 2016; Pfab et al., 2010). However, the mechanisms behind temperature changes and itch perception are still not understood completely. According to Sanders and colleagues (2018), differences between histamine dependent and histamine independent itch are shown. The authors state that even within the histamine independent itch category differences are found in the effect of temperature on itch. It could be possible that a warmer experimental tool increases itch, such as the fingers compared to the brush. As far as known, the effect of temperature changes on electrically induced itch is not investigated yet, so further research should clarify this matter. With respect to the perceived pleasantness of impersonal touch and interpersonal touch also no differences were found. This could be explained by influences of top down information, similar as affective touch. Research showed that in interpersonal touch the relationship with the toucher (Gallace & Spence, 2008; Goldstein et al., 2016), the facial expression (Ravaja et al., 2017), but also cultural-social norms influence the subjective experience of the touch. For instance, Gallace and Spence (2008) discussed that when interpersonal touch is less frequent in a culture, it will be experienced as less pleasant. Besides that, the authors mentioned that gender and age influence the perceived pleasantness as well, of which touches between same gender pairs are less common for college students and when age increases interpersonal touch becomes more reserved for intimate relationships (Gallace & Spence, 2008; Miller, 2015). The participants of the current study were college students and the same gender as the experimenter, which indicates that the pleasantness ratings of interpersonal touch could have been influenced by top down information, and possibly interfered with its effect on itch relief.

Third, Pawling and colleagues (2017) mentioned that CT-afferents activation is positively correlated to perceived pleasantness, thus a relationship between itch relief and experienced pleasantness of the touch was hypothesized. However, the results of the current study did not find supporting evidence that pleasantness of the touch is related to more itch relief. This indicates that

the reduced itch intensity of the experimental conditions compared to the baseline measurement (figure 3) is related to an alternative factor than CT-afferents activation. It could be possible that attention played a role. With respect to pain, previous research has shown that distraction plays an important role in pain relief and therefore some therapies for chronic pain include forms of distraction (Leibovici, et al., 2009). Pain and itch share similarities in somatosensory processing, thus an attention effect could also occur in itch. Studies have demonstrated that attentional processes are also relevant in itch perception. For instance, itch sensations draw automatic attention and therefore interferes in daily life activities (Evers et al., 2019; Van Laarhoven, 2018). Besides that, studies demonstrated an attention bias towards itch related stimuli and found that more attention towards bodily sensations increased itch intensity (Van Laarhoven et al., 2017b, 2018). Although the effect of distraction on itch is not investigated extensively yet, pruritus patients did report decreased itch intensity during distraction and increased itch intensity during rest (Ständer et al., 2015). This could be explained by the competition between two or more somatosensory stimuli for further attentional processing. In this case, selective attention towards one stimulus weakens the processing of other stimuli (Kessels et al., 2012; Porcu, Keitel & Müller, 2014). Although the participants were specifically instructed to focus on the itch sensation at all times, research has shown that an attention shift occurs when touch is conducted as counter stimuli. This attention shift is even able to occur when the touch is unattended (Johansen-Berg & Lloyd, 2000). In addition, Strauss and colleagues (2019) investigated similar touch conditions and found that all touch conditions were associated with strong deactivation of the default mode network (DMN). Activation of DMN is generally related to situations such as mind wandering, thus studies suggest that deactivation of DMN is related to attentional processes towards the external stimuli (Broyd et al. 2009; Poerio et al., 2017; Smallwood et al., 2013; Strauss et al., 2019). This indicates an attention grasping effect of touch in general, and could also be an explanation for the non significant differences between type of touches. In order to investigate whether an attention effect is related to itch relief, further research is needed.

The present study was not without methodological limitations. The first and most important limitation was the small sample size due to the COVID-19 situation. The design of the experiment included touch conditions, which means that social distance could not be guaranteed in the experiment. Therefore, continuing with data collection was not responsible. Unfortunately, a small sample size has larger risk for type II errors and smaller chances of finding significant differences (Columb & Atkinson, 2016). Therefore the conclusions of the current study should be interpreted with caution, since the small sample size undermines the reliability of results (Button et al., 2013).

It could be possible that the results would have been significant with more data, thus a larger sample size is recommended for future research.

The second methodological limitation was the inadequate baseline measurement of itch, since the baseline measurement was only conducted prior to the experiment. The reason for the baseline measurement of itch was to control for itch intensity. However, the baseline measurement was not conducted prior to each touch condition, thus an habituation effect of itch cannot be excluded. Habituation occurs when a stimulus is repeatedly present and appears to be a general, non specific process, observed in all sensory modalities (Vossen, 2018). Habituation is even more likely to occur if the presence of a threatening stimuli is unlikely to be associated with bodily damage, such as in an experimental setting (De Paepe et al., 2019; Vossen, 2018). Besides that, habituation is able to occur within seconds if the stimuli is presented on a fixed location, such as the electrode in the current study (Greffrath et al., 2007). A baseline itch measurements prior to each condition is recommended in order to control for habituation of itch.

The third limitation of the study could be the method itch was induced, since 9 participants were excluded due to the inability to experience itch by the electrode. The participants reported an irritating feeling instead of itch, which indicates different interpretations for the electrically induced itch. This makes it challenging to ensure that the participants who continued with the experiment really experienced itch. Also, electrically induced itch is difficult to generalize to chemical itch, since mechanical and chemical itch are processed by independent neural circuits in the spinal cord (Chen & Sun, 2020). To deal with this matter, an alternative method for itch induction could be considered. For instance, “Mucuna pruriens” (cowhage) is routinely used in human research to induce itch (Chuquilin et al**.,** 2016; Jeffry et al., 2011; Kosteletzky et al., 2009; LaMotte et al., 2014; Papoiu et al., 2011; Reddy et al., 2018). Cowhage can produce an intense itch sensation lasting several minutes, which begins shortly after insertion into the skin (Davidson et al., 2007). Cowhage is a chemical histamine-independent method, thus could be an effective alternative for electrically induced itch.

In conclusion, the current study could not provide supporting evidence that affective touch is able to relief itch more than non-affective touch. With regard to the effect of interpersonal touch itch, the current study did not find a greater relieving effect on itch than impersonal touch. There were also no differences found in perceived pleasantness between type of touches, which is could be explained by interaction with of top down information. Also, no relationship was found between pleasantness and itch relief. This indicates that an alternative factor was related to the reduced itch intensity for all type of touches during the experiment, of which attentional processes are proposed

as alternative. At last, it is important to mention that the results of the present study were possibly influenced by methodological limitations, of which the small sample size is the most important limitation. In order to draw firm conclusions, further research with methodological adjustments is needed.

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Appendix A

Informed Consent (Dutch)

Utrecht University

Beste deelnemer,

U gaat zo direct mee doen aan een experiment voor een onderzoek over jeuk. Hierbij krijgt u doormiddel van een elektrode en het aaien van een kwast en vingers verschillende tactiele sensaties. Daarnaast wordt u gevraagd verschillende vragen te beantwoorden. Hierbij is het belangrijk om niet te lang stil te staan bij uw antwoorden en af te gaan op uw eerste ingeving.

Het onderzoek duurt ongeveer 60 minuten. Met deelname aan het onderzoek kunt u 1 PPU of 7 euro verdienen. U kunt zich ten alle tijden terugtrekken uit het onderzoek. U hoeft hier geen reden voor te geven.

Uw gegevens worden anoniem verwerkt en uw deelnamen aan dit onderzoek zal vertrouwelijk blijven.

Door de informed consent te ondertekenen stemt u in met de voorwaarden van het onderzoek.

Met vriendelijke groet,

Babette Rahangmetan
Supervisors: Chris Dijkerman & Larissa Meijer

Ingevuld door de participant:

Ik verklaar hierbij dat ik de informatie over het onderzoek gelezen en begrepen heb. Mij is zowel verbaal als schriftelijk uitgelegd wat het nut is van deze studie, hoe lang het gaat duren en welke methoden gebruikt worden. Ik heb de mogelijkheid gehad om vragen te stellen en ik ben tevreden over de hoe de vragen beantwoord zijn.

Ik begrijp dat dit experiment gebruikt maakt van een niet pijnlijke elektrische stimulatie om jeuk op te wekken. Ik begrijp dat er geen negatieve consequenties zullen zijn door deelname aan deze studie of bij verlaten van deze studie. Ik begrijp dat ik op elk moment de studie kan verlaten zonder opgaaf van reden of consequenties.

Ik geef toestemming voor het gebruik van mijn geatomiseerde testresultaten en demografische informatie in wetenschappelijke analyse en presentaties.

Datum: ____-____-_____ Naam:_____

Handtekening deelnemer:

_____

Ingevuld door de onderzoeker:

Hierbij verklaar ik dat ik de participant voldoende op de hoogte heb gesteld van de studie en dat ik alle vragen beantwoord heb.

Naam onderzoeker: _____ Studie:
_____ Positie:
_____ Datum: ____-____-_____

Handtekening onderzoeker _____

Appendix B

Informed Consent (English)

Utrecht University

Dear participant,

You will participate in an experiment for a study about itch. You will get different tactile sensations by a non painful electrode, and by stroking with a brush and fingers. You will also be asked to answer various questions. Hereby it is important to not overthink your answers, but rely on your first intuition.

The experiment takes approximately 60 minutes. With participation in this study you will earn 1 PPU or 7 euros. You can withdraw yourself from this study without any negative consequences or giving reasons at any time you want.

Your information will be processed anonymously and the participation in this experiment will remain confidential.

By signing this informed consent you will accept the terms of the experiment. Best Regards,
Babette Rahangmetan
Supervisors: Chris Dijkerman & Larissa Meijer.

Signed by the participant:

I hereby declare that I have read and understood the information about the experiment. I have been explained both verbally and written about what the use of this study is, how long it will take and which methodes will be used. I have had the opportunity to ask questions and I am satisfied with how the questions have been answered.

I understand that this experiment uses a non-painfull electrical stimulation to induce itching. I understand that there will be no negative consequences by participating in this study or by leaving this study. I understand that I can leave the study at any time without giving reasons or without consequences.

I authorize the use of my atomized test results and demographic information in scientific analysis and presentations.

Date: ____-____-_____ Name:_____

Signature participant:

_____

Signed by the researcher:

I hereby declare that I have sufficiently informed the participant of the study and that I have answered all questions.

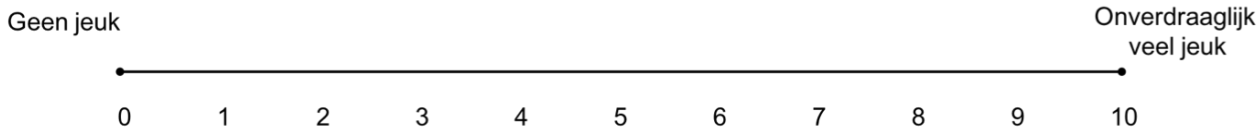
Name researcher: _____ Study:
_____ Position:
_____ Date: ____-____-_____

Signature researcher: _____

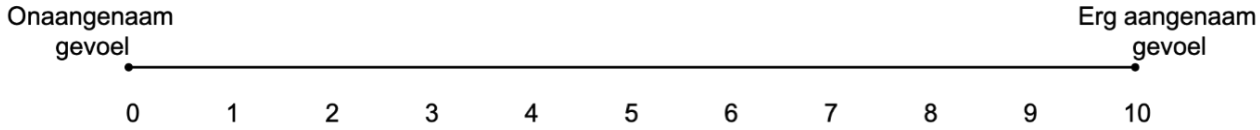
Apendix C

VAS Scales

Basis Jeuk

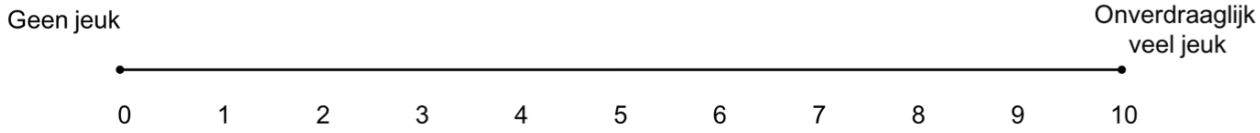


Basis Aangenaamheid

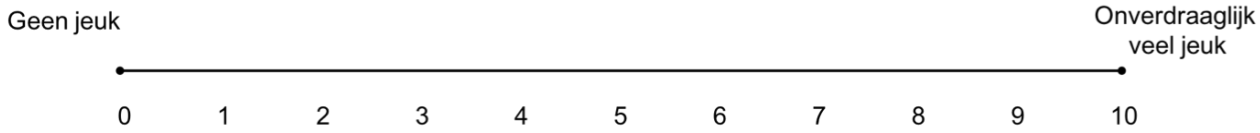


Conditie: non affective touch- kwast

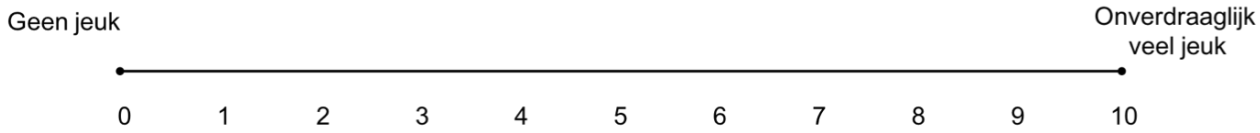
2 min. itch rating



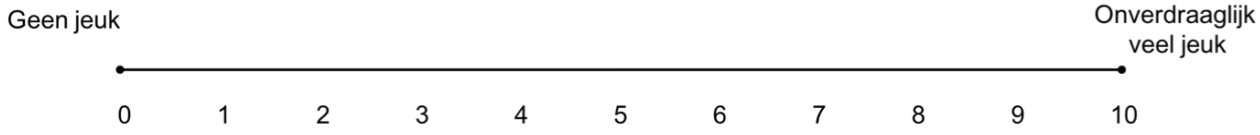
4 min. itch rating



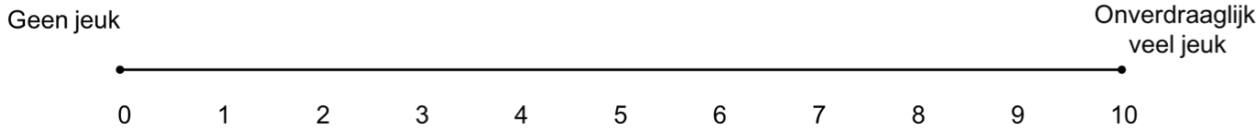
6 min. itch rating



8 min. itch rating

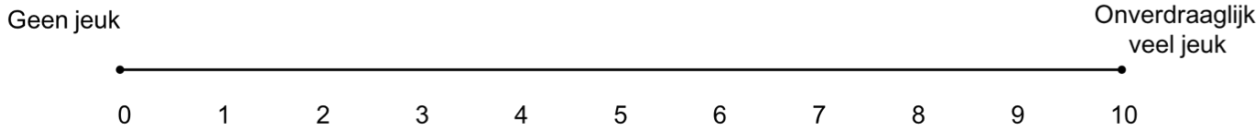


10 min. itch rating

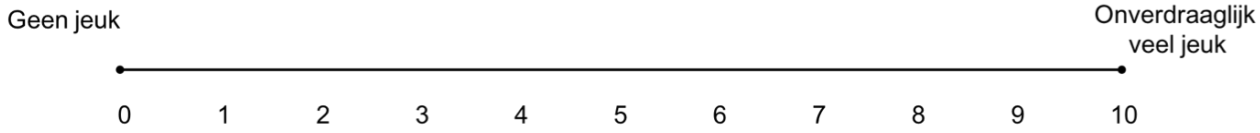


Conditie: affective touch- kwast

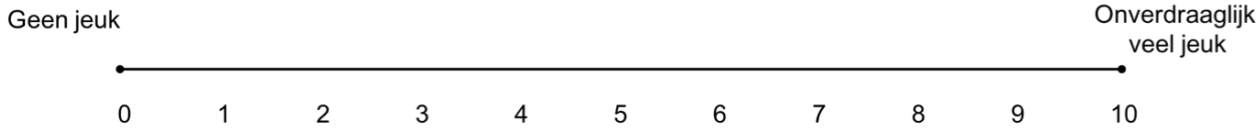
2 min. itch rating



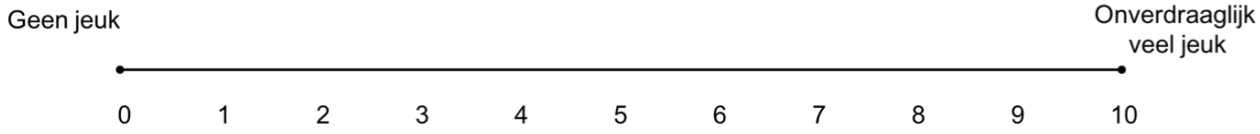
4 min. itch rating



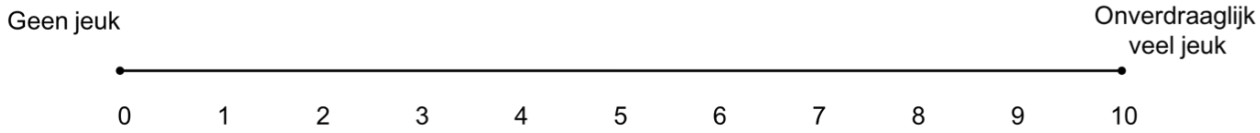
6 min. itch rating



8 min. itch rating

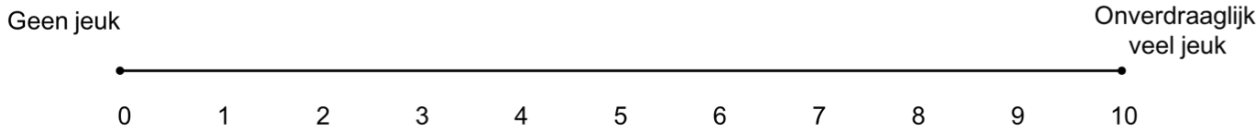


10 min. itch rating

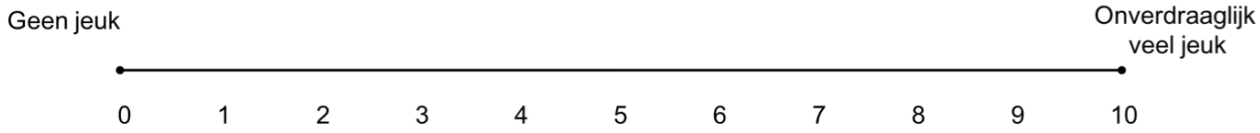


Conditie: non affective touch- vingers

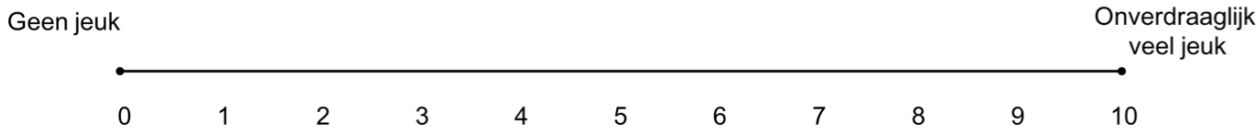
2 min. itch rating



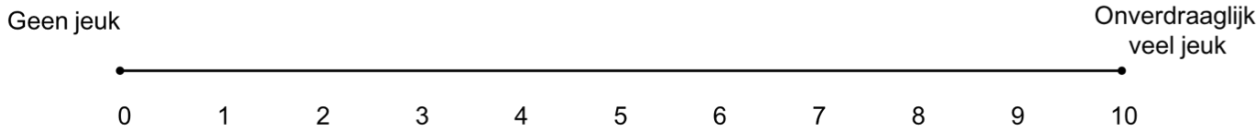
4 min. itch rating



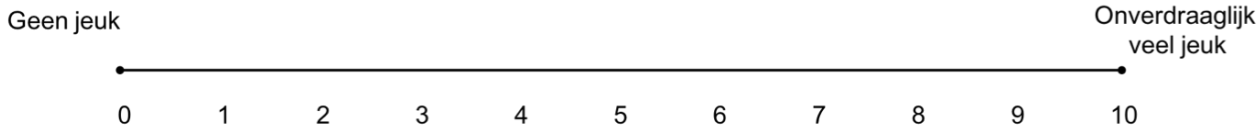
6 min. itch rating



8 min. itch rating

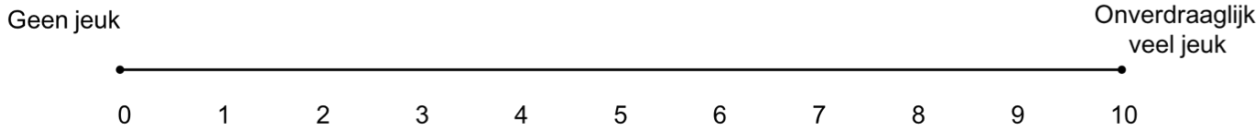


10 min. itch rating

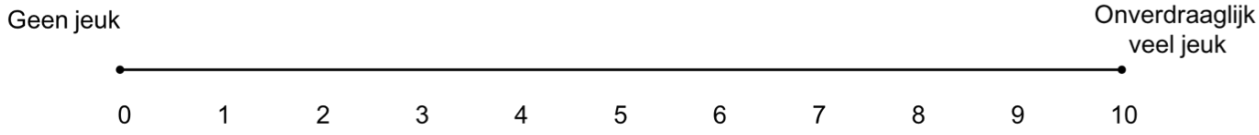


Conditie: affective touch- vingers

2 min. itch rating



4 min. itch rating



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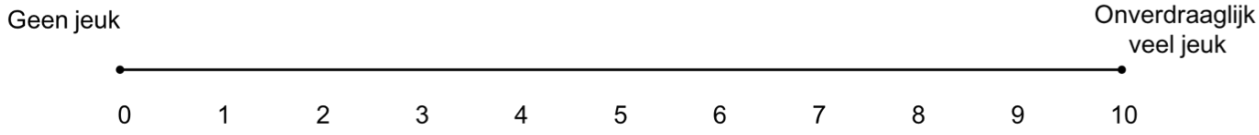
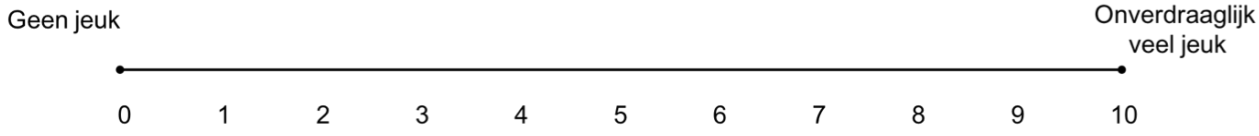


8 min. itch rating



10 min. itch rating