Universiteit Utrecht

Personality-related individual differences in touch appraisal

Name: Anouk Aleva

Student number: 3584690

Master Program: Clinical and Health Psychology, Utrecht University

Supervisor: Prof. dr. R. Geenen

Date: 10-05-2015

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Acknowledgments

I would like to express my great appreciation to prof. dr. Geenen, my research supervisor, for his valuable and constructive suggestions, enthusiastic encouragement and useful critiques of this research work. His willingness to give his time so generously and providing extraordinary support have been very much appreciated. I would also like to thank prof. dr. Dijkerman, for his guidance during the experimental design and belief in the significance of this study. Lastly, my thanks are extended to Mrs. Van Stralen, for her advice during the development of this research work and her assistance in practical arrangements.

Abstract

Touch plays a pivotal role in early development and throughout the lifespan, and is therefore an important research subject. The study of touch may be especially important in certain mental illnesses such as somatoform disorder, where tactile thresholds are indicated to be deviant from normal. The present study examined the influence of extraversion and neuroticism on the pleasantness rating of affective and non-affective touch. Extraversion and neuroticism have been suggested to modulate emotional experience and emotion processing and might therefore also influence affective touch perception. Extraversion is known to correlate with the experience of positive emotions and was therefore hypothesized to have a positive influence on affective touch perception. On the other hand, neuroticism, which is associated with sensitivity to negative emotions, was hypothesized to have a negative influence on non-affective touch. Pleasantness ratings were obtained during low - affective touch - and high - non-affective touch - velocity stroking to the hands and forearms. Sixty-four participants were assessed using the Big Five Inventory. Subsequently, they were affectively and non-affectively stimulated whereupon they scored this experience. Affect appraisals were correlated with extraversion and neuroticism levels. The present data led to rejection of the hypotheses, showing no influence of extraversion and neuroticism on the pleasantness rating of touch. Perhaps affective and non-affective touch are so crucial in normal development that individual differences in personality hardly affect touch perception in healthy participants. Future research should examine the possible influence of extraversion and neuroticism on more positive and more negative touch stimuli, and in psychiatric populations. Keeping in mind that findings cannot be generalized to other experimental situations or other groups, the present study indicates that the appraisal of affective and non-affective touch is not related to personality characteristics.

Introduction

Touch plays a pivotal role in early development and throughout the lifespan (Essick et al., 2010; Gordon et al., 2013), as it is the first and foremost sensory input during life (Field, 2014). Physical contact is readily available in any intimate relationship and represents an important natural activity between human beings (Feldman, 2007). Whether a strong handshake, an encouraging pat on the back, a sensual caress, or a gentle brush on the shoulder, touch can convey a vitality and immediacy at times more powerful than language (Field, 2014; Gallace & Spence, 2010). In certain psychological disorders deviations in touch experience occur. For example in somatoform disorders, where tactile thresholds are indicated to be deviant from normal (Brown, Brunt, Poliakoff & Lloyd, 2010; Katzer, Oberfeld, Hiller, Gerlach & Witthöft, 2012; Lloyd, Mason, Brown & Poliakoff, 2008). Specifically, recent research suggests lower perceptual thresholds for tactile stimulation in these patients (Katzer et al., 2012). To be able to expand the research into tactile perception in somatoform disorders, the present study first examines whether the experience of affective and non-affective touch is linked to personality.

Affective touch refers to the emotional response to touch, with particular emphasis on the pleasantness of such contact (Essick et al., 2010). Affective and non-affective touch form a cornerstone in social behavior in humans and other primates (Björnsdotter, Larsson & Ljungbert, 2000; Essick et al., 2010), and are crucial in physical and cognitive development (Diamond & Maso, 2008; Feldman, Eidelman & Rotenberg, 2004; Feldman, Rosenthal & Eidelman, 2014). The important role of these types of touch is emphasized by research findings showing that less affective touch early in life is associated with social-emotional disorders of infancy, like attachment and mood disorders (Feldman, Keren, Gross-Rozval & Tyano, 2004; Jones & Mize, 2007). In the peripheral nervous system, C-tactile (CT) fibers process affective touch (Gordon et al., 2013; Keysers, Kaas & Gazzola, 2010; Löken, Wessberg, Morrison, McGlone & Olausson, 2009). Stimulation of these low-threshold CT-fibers in the hairy skin, through relatively slow, light brushing, is judged particularly pleasant (Ackerley, Saar, McGlone & Wasling, 2014; Olausson et al., 2008; Wessberg, Olausson & Fernström, 2003). Specifically, stroking applied at a rate of about 3 cm/s appears to be optimal for targeting CT-fibers, and thus affective touch. Moreover, stroking with a velocity of 30 cm/s is suboptimal for provoking affective touch, and is therefore classified as non-affective touch (Löken et al., 2009; Olausson, Wessberg, Morrison, McGlone & Vallbo, 2010; Van Stralen et al., 2014). Regarding cortical processing of affective touch, less explicit results are available. The orbitofrontal cortex (OFC) and insula are implicated as key structures

(McCabe, Rolls, Bilderbeck & McGlone, 2008; Olausson et al., 2010; Royet et al., 2000), and recent research also suggests the involvement of key nodes of the “social brain” in socio-emotional processing while perceiving pleasant touch (Gordon et al., 2013). Specifically, the posterior superior temporal sulcus (pSTS), medial prefrontal cortex (mPFC), dorsal anterior cingulate cortex (dACC), and the connection between the insula and amygdala are active while processing affective touch (Gordon et al., 2013). All of these activated regions are well known for their involvement in social processing (Etkin, Egner & Kalish, 2011; Mar, 2011). The involvement of these central structures suggests that psychological variables may influence the perception of affective touch, as these variables are known to activate these regions as well (Bertolino et al., 2005; Kehoe, Toomey, Balsters & Bokde, 2012).

Although research into the universal neurobiology of affective touch is evolving, current studies do not consider individual differences. This is remarkable, since the ways in which human beings perceive and process their emotional environments tends to differ tremendously across individuals, and the same emotional stimuli may evoke very different responses among subjects (Hamann & Canli, 2004). These differences in how we perceive and respond to the emotional signals around us appear to be partially determined by personality (Brück, Kreifelts, Kaza, Lotze & Wildgruber, 2011). Functional imaging studies have explored how personality-dependent variations in emotional responsiveness are paralleled by differences in the cerebral processing of emotional cues. Evidence for a modulating influence of personality on emotional brain responses has steadily accumulated in the literature (Brühl, Viebke, Baumgartner, Kaffenberger & Herwig, 2011; Hamann & Canli, 2004; Hooker, Versoky, Miyakawa, Knight & D’Esposito, 2008), and indicates the mPFC, OFC and amygdala as being susceptible to personality influences when processing emotional stimuli (Bertolino et al., 2005; Kehoe et al., 2012). These brain regions are also active during the processing of affective touch, as previously described. The observation of activity in corresponding brain regions as a function of personality and affective touch, leads to the presumption that personality factors likely influence the perception of affective touch.

When studying personality influences on behavior, most studies pin their results onto the Five-factor theory (Gazzangia, Heatherton & Halpern, 2010), which identifies five core personality dimensions, namely openness to experience, conscientiousness, extraversion, agreeableness, and neuroticism (Costa & McCrae, 2003). Within this framework, extraversion - the extent to which people are sociable and outgoing (Gazzangia et al., 2010; Lucas, Diener, Grob, Suh & Shao, 2000) - and neuroticism, - the predisposition to experience negative emotions such as worry and anxiety (Breslau & Schultz, 2013) - are the most extensively studied (Kehoe et al., 2012). Both are known to influence emotional and cognitive processing (Canli, 2004; Gruszka, Matthews & Szymura, 2010), and have shown to modulate brain activity (Deckersbach et al., 2006; Kehoe et al., 2012; O'Gorman et al., 2006). Personality theories have linked extraversion and neuroticism to an individual's susceptibility to experiencing positive or negative affect (Costa & McCrae, 1980; Gray, 1970; Tellegen, 1985). According to Costa and McCrae (1980), extraversion and neuroticism influence the direct outcome of positive and negative stimuli, respectively. They call for independence between these two dispositions, both separately influencing emotional processing. Individuals who exhibit a high degree of extraversion experience more positive emotions in everyday life than introverted individuals. Individuals exhibiting a high degree of neuroticism experience more negative emotions, as opposed to individuals with low levels of this dimension. In line with Costa and McCrea's model, Tellegen (1985) also strongly advocated positive and negative affect to be distinctive dimensions. He demonstrated that positive and negative affect are related to corresponding affective trait dimensions of positive and negative emotionality. According to Tellegen, trait positive affect and negative affect correspond to the dominant personality dimensions of extraversion an neuroticism, respectively (Watson, Clark & Tellegen, 1988).

In accordance with these models, empirical research shows a robust correlation between extraversion and positive emotionality on the one hand, and neuroticism and negative emotionality on the other (Costa & McCrae, 1980; McNiel & Fleeson, 2006; Rusting & Larsen, 1997). Individual susceptibility to experiencing positive and negative affect, and its correlation to individual levels of extraversion and neuroticism, has been shown to interact substantially in different aspects of behavior. Examples of findings include the prediction of mood-related cognitive variables, such as free recall of positive and negative words (Rusting & Larsen, 1998), perception of facial expressions (Knyazec, Bocharov, Slobodskaya & Ryabichenko, 2008) and evaluation of emotional prosody (Brück et al., 2011). Specifically confirming the independence between extraversion and neuroticism, is research focusing on visual perception. A study by Canli and colleagues (2001) showed a positive correlation between extraversion and level of brain activation to positive visual stimuli, and no correlation when viewing negative stimuli. Neuroticism on the other hand was positively correlated with level of brain activation to negative visual stimuli, and showed no correlation to positive stimuli. The same relationship – between extraversion, neuroticism and emotionality - might endure for tactile stimuli.

Touch plays an important role in emotional communication, but has been studied far less than visual and auditory expressions of affect (Yohanan & MacLean, 2009). Research in the area of touch has focused on perceiving touch of others, an action linked to empathic traits (Bufalari & Ionta, 2013; Fitzgibbon, Ward & Enticott, 2014). Apparently, only one study to date concentrated on the differences in personality traits related to the experience of being touched. This research studied cortical activity while being touched, an objective measure examining the effect of personality on touch. They found extraversion to be correlated to activity in the somatosensory cortex, while neuroticism did not show any associations with the brain areas of interest (Schaefer, Heinze & Rotte, 2012). Further research in this area can demonstrate the influence that personality dimensions may have in driving perception. Results are important in the light of subjective well-being, social interactions and psychiatric disorders related to deviations in touch perception, like somatoform disorders (Brown et al., 2010; Katzer et al., 2012; Lloyd et al., 2008).

The present research employed soft stroking to the hands and forearms of healthy participants to investigate the effect of personality on the appraisal of affective and non-affective touch. Specifically, the interaction between the personality dimensions extraversion and neuroticism and their influence on the pleasantness of the touch experience. Since extraversion has been found to correlate with the tendency to experience positive emotions, it was hypothesized that individuals with high scores on extraversion would rate touch in general as more positive than introverted participants. There was a specific hypothesis concerning an interaction between type of touch and extraversion, namely, high extraverted participants rating affective touch more pleasurable than participant scoring low on extraversion. Furthermore, we hypothesized that participants with high neuroticism would rate stimuli more negative as opposed to participants low on neuroticism, since this trait was found to correlate with the experience of negative emotions. An interaction was expected between type of tactile stimulation and neuroticism; participants scoring high on neuroticism were expected to rate non-affective touch more negative than participants low on neuroticism.

All hypotheses were grounded on the previously outlined theoretical models of Costa and McCrae (1980) and Tellegen (1985), the demonstrated influence of extraversion and neuroticism on emotional and cognitive processing, findings from research in other emotional processing domains like vision and hearing (Brück et al., 2011; Canli, 2004; Gruszka et al., 2010; Knyazec et al., 2008), and the modulation of brain activity by these personality traits (Deckersbach et al., 2006; Kehoe et al., 2012; O'Gorman et al., 2006).

Methods

Participants

Sixty-four healthy participants with a mean age of 22.6 years (SD = 2.8, range 18 - 38) participated in the present study, which was conducted at Utrecht University (37 males and 27 females). Subjects received financial compensation (€ 3,00) or course credits (0.5) for participating. Sixty participants were right handed, three participants were left handed and one participant was ambidexter. Participants gave written informed consent to the study, which adhered to the Declaration of Helsinki. All participants had no current neurological or psychiatric disorders, such as DSM-5 pathology.

Materials

Handedness was assessed using a Dutch Hand-preference list, based on the Edinburgh Handedness Inventory (Oldfield, 1971; Van Strien, 1992). Participants were instructed to place their arms on a black cotton cloth, which was placed on the table. The cloth prevented contact with the possible cold surface during stimulation.

Tactile stimuli were delivered with a soft brush (HEMA goat's hair foundation brush, width 2.6 x 2 cm, pressure approximately 11.5 Pa) on the dorsal side of both the right and left hand and posterior forearms. The same light pressure was applied to the skin in all conditions, a black line on the brush indicated the amount of pressure applied. The experimenter manually stroked in a proximal to distal direction, from the perspective of the participant, on the hand and forearm with an unpredictable starting point. Stroking was applied at two different velocities: 3 cm/s optimal for affective touch, and 30 cm/s suboptimal for affective touch. These velocities of the brush strokes were chosen as they were previously found to be optimal and suboptimal for targeting C-fibers, respectively (Löken et al., 2009; Olausson et al., 2010; Van Stralen et al., 2014). Considering the high fatigability of C-fibers (Olausson et al., 2010) stimulation during trials lasted 10 seconds, timed using a stopwatch. The pleasantness of touch was assessed with an adjusted version of the Touch Perception Task (TPT; Guest et al., 2011), listed in Table 1. This version included the positive and negative affect items, as classified by Ackerley and colleagues (2014). A Dutch translation of the original words was used (Martens, 2014). After each stroking trial, the degree by which each of the TPT-items was descriptive of the experience was obtained from the participant using computerized Visual Analog Scales (VAS-scales), ranging from 0, not descriptive at all, to 100, very highly descriptive. A blindfold was worn during stimulation and removed thereafter so that the participant could completely focus on the experience of stimulation.

Table 1.

Used TPT-items, their Dutch translation and aggregation in two General Descriptors

English	Dutch	General Descriptors
Comfortable	Comfortabel	
Enjoyable	Aangenaam	
Soothing	Geruststellend	
Relaxing	Ontspannend	*Positive Affect*
Calming	Kalmerend	
Pleasurable	Plezierig	
Desirable	Begeerlijk	
Irritating	Irritant	*Negative Affect*
Discomfort	Oncomfortabel	

Note: TPT = Touch Perception Task

Personality was measured using a computerized version of the Dutch translation of the Big Five Inventory (BFI; Denissen, Geenen, Van Aken, Gosling & Potter, 2008). The BFI measures Openness, Conscientiousness, Extraversion, Agreeableness, and Neuroticism. The computerized version has shown satisfactory reliability (Lang, John, Lüdtke, Schupp & Wagner, 2011). Items are scored on a 5-point Likert-scale, ranging from 1 (disagree) to 5 (agree). Relevant subscales for the present study were Extraversion and Neuroticism, both scales containing eight items with scale reliabilities of $\alpha = .84$ and $\alpha = .86$, respectively (Denissen et al., 2008). The congruent validity of both scales is satisfying, being .94 for extraversion and .90 for neuroticism (John & Srivastava, 1999). Demographics were assessed through a questionnaire regarding participant's age, gender, level of education and current relational status.

SPSS 20.0 (IBM Crop., 2011) was used to statistically analyze the data.

Procedure

When signing up for participation, subjects received an information letter describing the protocol of the study. A test-appointment was made in consultation with the researcher.

On arrival, the participant was seated comfortably on a desk chair, which could be adjusted to the body size of the participant so that a standardized body posture could be adopted, depicted in Figure 1. The experimental protocol was fully described to the participant, and informed consent was obtained. Handedness was checked using a Dutch

Hand-preference list. Participants filled out the demographic questionnaire and computerized BFI, respectively. Next, participants were asked to roll up their sleeves and place their hands in the standardized position on the cloth, being forearms on the table in a 90-degrees position to their body with the dorsal side of their hands facing upwards.

Figure 1

Body posture during experiment (Arbo Unie, 2007)

Before data acquisition, participants were instructed to remain still and focus on the touch they experienced. They were showed the soft brush and were able to feel the hardness. There was a practice trial, wherein participants could practice filling out the computer task. If the participant had no further questions, he or she was asked to put on the blindfold, where-after the first trial started. During trials participants were stroked according to a standardized procedure. Prior to stimulation, the participant was told whether stimulation would occur on the left or right side. This was done to prevent a surprise effect. Trials lasted 10 seconds, wherein 3 strokes were applied in the 3 cm/s condition, and 7 strokes in the 30 cm/s condition. The length of the strokes was 15 cm, with a regular interval of one second. In total, the duration of material-skin contact was 7 seconds for the low velocity stroking and 3 seconds for the high velocity stroking. After each stroking trial, the participant was asked to take of the blindfold and fill out the computer task. The task asked the participant to rate the TPT-items on level of descriptiveness regarding the touch experience, using computerized VAS-scales, ranging from 0 to 100.

One trial lasted around one minute, a total of 16 trials was administered. Overall, the whole experiment lasted around 20 minutes. All data were collected by one female experimenter (A. Aleva), a master student at Utrecht University, who was trained at applying different stroking velocities.

Design

The design of the present study was a mixed quasi-experimental – experimental design. The influence of level of the personality dimensions extraversion and neuroticism on an experimental procedure, different types of touch, was evaluated. Variables were assessed both within and between subjects. The main hypotheses, concerning extraversion and neuroticism in interaction with affective/non-affective touch, were assessed within participants. Gender and handedness were assessed between participants.

Between trials, variation occurred in velocity of stroking, 3 cm/s or 30 cm/s, and side of stimulation, right or left. These two categorical variables resulted in a total of four possible conditions, depicted in Table 2. Each condition was repeated four times to increase reliability, which meant subjects participated in a total of 16 experimental trials (2 velocities x 2 sides x 4 replications). The order of trials was randomized using a Latin Square Design, wherein the orders were not allowed to begin with the same condition. An online Latin Square Design program was used to calculate four random orders of trials, depicted in Figure 2. The orders were assigned to participants on the basis of their time of entering the study.

Table 2.

Experimental conditions, all conditions were conducted four times per participant

Stroking velocity cm/s	Side of stimulation right/left	Code
3	Left	L3
3	Right	R3
30	Left	L30
30	Right	R30

1	R30	L3	R3	L30	R3	R30	L30	L3	L30	R3	L3	R30	L3	L30	R30	R3
2	L3	R3	R30	L30	R30	L30	L3	R3	R3	L3	L30	R30	L30	R30	R3	L3
3	L30	R30	L3	R3	L3	R3	R30	L30	R30	L30	R3	L3	R3	L3	L30	R30
4	R3	L30	R30	L3	L3	R30	L30	R3	R30	R3	L3	L30	L30	L3	R3	R30

Figure 2.

Orders of experimental conditions, assembled by Latin Square Design

Note: R3 = right hand, velocity 3 cm/s, R30 = right hand, velocity 30 cm/s, L3 = left hand, velocity 3 cm/s, L30 = right hand, velocity 30 cm/s

Statistical Analyses

The dependent variables in the present study were Positive and Negative Affect aggregations of the TPT-items defined in Table 2. An exploratory factor analysis was conducted to analyze whether the chosen classification of TPT-items, based on research by Ackerley et al. (2014), could be replicated in the present dataset. Since the sample size was relatively small and TPT-items were assumed to correlate, an oblique rotation (direct oblimin) was applied. No participants were excluded from the analyses since there were no outliers detected.

All conditions, broken down into Positive and Negative Affect, were analyzed for cases of notable skewness in the data. These analyses revealed extreme skewness for Negative Affect in two conditions, R3 and L3, statistics are depicted in Table 5 and Figure 3 in the Appendix. This finding leads to the following preliminary remark; although Negative Affect is reported in the results, it is done so with emphatic caution, since examination of the distribution of scores in this variable leads to doubts about validity. Because the psychometric properties of the negative affect scores were low, analyses were conducted separately for both factors, being the dependent variables in separate analyses.

The main independent variables were participant's Extraversion and Neuroticism scores on the BFI. These variables were assessed on continuous scale. Subgroups based on Extraversion and Neuroticism were made by splitting, using tertiles of the score distribution. This way participants were assigned to either the low, medium or high group of Extraversion and Neuroticism, whereupon levels of these traits could be compared.

As main analyses, repeated-measures analyses of covariance (ANCOVA) were conducted. Order was included as a covariate. Gender, handedness and side of stimulation were control variables in the analyses conducted, perhaps moderating the hypothesized effects. First off, main effect of stimulus velocity was assessed, separately for Positive and Negative Affect. Next, the influence of Extraversion- and Neuroticism-group membership on Positive and Negative Affect rating was assessed. After determining the main effect, a possible interaction between stimulus velocity and group membership was assessed. Finally, control variables – side of stimulation, repetition, gender, handedness and order - were assessed on possible influence on ratings of Positive and Negative Affect using repeated-measures analyses of variance.

Results

Factor Analysis

The factor analysis yielded two factors, as depicted in Table 3. Both the Positive Affect and Negative Affect factor had high reliabilities, α = .97 and α = .95 respectively. Further analysis were conducted based on factor scores per participant, determined by calculating the average of the included TPT-items per factor.

Table 3.

TPT-items factor analysis, eigenvalues, percentages of explained variance, and internal consistency coefficients (Cronbach's α)

	Factor Loadings	
Descriptors	**Factor 1: Positive Affect**	**Factor 2: Negative affect**
Calming	**.93**	-.02
Soothing	**.93**	-.02
Relaxing	**.88**	-.17
Comfortable	**.85**	-.18
Enjoyable	**.83**	-.22
Desirable	**.81**	.26
Pleasurable	**.78**	-.24
Irritating	-.05	**.95**
Uncomfortable	-.14	**.90**
Statistics		
Eigenvalues	6.59	1.18
% of Explained Variance	73.2	13.1
Cronbach's α	.97	.95

Note: Descriptor in bold were included in the factor, TPT = Touch Perception Task

Preliminary Analyses

When designing the experiment, a Latin Square Design was used to randomly compose four different orders wherein each condition was replicated four times. To check whether this design still yielded consistent individual differences across the four replications of the stroking velocity applied to the left or right side, reliability analyses were conducted. All α's were larger than .70, which is satisfactory (Field, 2009), statistics are depicted in Table 4. Separate replications did not influence the reliability in such a way that, when deleted, the reliability became unsatisfactory ($\alpha < .70$).

Main Analyses

As described previously, main analyses were repeated-measure analyses of covariance. Within subject variables included the independent variable stimulus velocity, control variables side of stimulation and repetition, and dependent variable being either Positive or Negative Affect. Between subject variables included dependent variable level of neuroticism and extraversion, and control variables gender, handedness, and order. Results of these analyses will be discussed sequentially, adhering the order of hypotheses in the *Introduction*.

Table 4.

Cronbach's Alpha representing internal consistency of conditions composing Positive and Negative Affect

Condition	Cronbach's α
Positive Affect	
R30	.89
R3	.85
L30	.91
L3	.83
Negative Affect	
R30	.89
R3	.81
L30	.90
L3	.82

Note: R3 = right hand, velocity 3 cm/s, R30 = right hand, velocity 30 cm/s, L3 = left hand, velocity 3 cm/s, L30 = right hand, velocity 30 cm/s

Stimulus Velocity

Low velocity stroking, 3 cm/s, was evaluated significantly more positive (M = 73.57, SE = 3.09) than high velocity stroking, 30 cm/s (M = 30.03, SE = 4.09): $F(1, 53) = 38.76$, $p < .001$, $\eta^2 = .42$. This difference is depicted in Figure 4. The effect size was large (Field, 2009).

The statistics for Negative Affect revealed a significantly more negative evaluation for high velocity stroking, 30 cm/s (M = 40.31, SE = 5.24), than for the low velocity stroking, 3 cm/s (M = 12.01, SE = 2.99): $F(1, 53) = 9.53$, $p < .05$, $\eta^2 = .15$. This difference is depicted in Figure 5. The effect size was medium (Field, 2009).

Extraversion

The rating of Positive Affect was not significantly different between participants with relatively low (M = 49.31, SE = 4.08), medium (M = 53.89, SE = 4.77) and high (M = 52.44, SE = 4.90) extraversion scores: $F(2, 53) = .28$, $p = .76$, $\eta^2 = .01$. With regard to Negative Affect, the ratings also did not significantly differ between participants with relatively low (M = 20.15, SE = 5.99), medium (M = 31.04, SE = 5.95) and high (M = 27.01, SE = 6.11) extraversion scores: $F(2, 53) = 1.06$, $p = .35$, $\eta^2 = .04$.

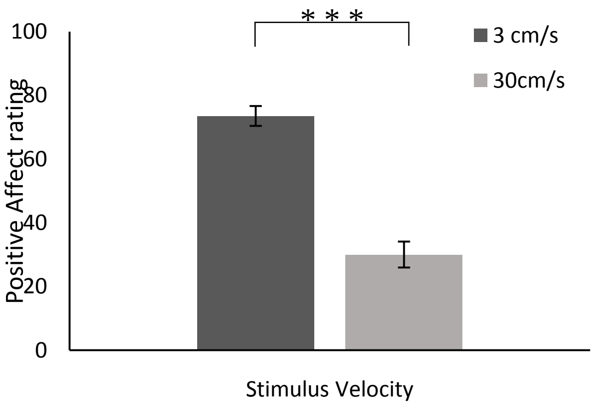

Figure 4.

Positive Affect rating for 3 cm/s and 30 cm/s stimulus velocity stroking. Asterisks represent significant difference ($p < .001$). Error bars represent standard error of the mean.

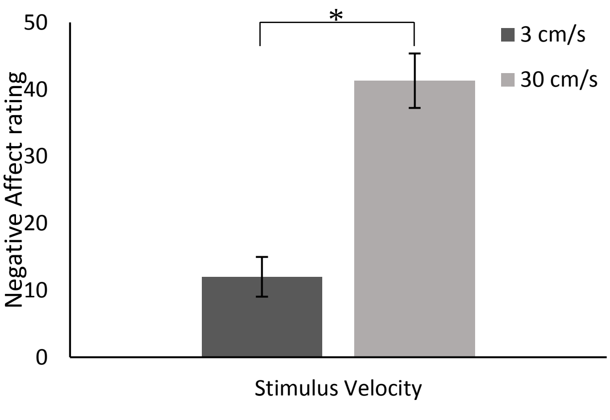

Figure 5.

Negative Affect rating for 3 cm/s and 30 cm/s stimulus velocity stroking. Asterisks represent significant difference ($p < .05$). Error bars represent standard error of the mean.

Statistics associated with the interaction effects described below are listed in Table 6. The rating of Positive Affect between stimulus velocities, was not affected by whether a participant had a low, high or medium score on extraversion: $F(2, 53) = .22$, $p = .80$, $\eta^2 = .01$. The rating of Negative Affect between stimulus velocities, was also not affected by whether a participant had a low, high or medium score on extraversion: $F(2, 53) = .1.18$, $p = .31$, $\eta^2 = .04$.

Neuroticism

The rating of Positive Affect was not significantly different between participants with relatively low ($M = 51.75$, $SE = 4.76$), medium ($M = 53.66$, $SE = 4.69$) and high ($M = 53.35$, $SE = 4.12$) neuroticism scores: $F(2, 54) = .08$, $p = .92$, $\eta^2 = .00$. With regard to Negative Affect, ratings were also not significantly different between participants with relatively low ($M = 23.38$, $SE = 6.37$), medium ($M = 31.60$, $SE = 6.28$) and high ($M = 24.55$, $SE = 5.51$) neuroticism scores: $F(2, 54) = .68$, $p = .51$, $\eta^2 = .03$.

Statistics associated with the interaction effects described below are listed in Table 7. The rating of Positive Affect between stimulus velocities, was not affected by whether a participant had a low, high or medium score on neuroticism: $F(2, 54) = .83$, $p = .44$, $\eta^2 = .03$. The rating of Negative Affect between stimulus velocities, was not affected by whether a participant had a low, medium or high score on neuroticism: $F(2, 54) = .31$, $p = .74$, $\eta^2 = .01$.

Table 6.

Means and Standard Errors, between brackets, for the different Extraversion-groups, broken down into Positive and Negative Affect, and stimulus velocity

		Extraversion-group		
	Stimulus Velocity	**Low**	**Medium**	**High**
Positive Affect	3 cm/s	71.14 (5.25)	72.60 (5.21)	76.11 (5.35)
	30 cm/s	27.48 (6.95)	35.18 (6.90)	28.76 (7.09)
Negative Affect	3 cm/s	10.78 (5.07)	13.98 (5.04)	11.45 (5.18)
	30 cm/s	29.53 (8.91)	48.10 (8.84)	42.56 (9.09)

Table 7.

Means and Standard Errors, between brackets, for the Neuroticism-groups, broken down into Positive and Negative Affect, and stimulus velocity

		Neuroticism-group		
	Stimulus Velocity	**Low**	**Medium**	**High**
Positive Affect	3 cm/s	73.34 (5.17)	70.82 (5.10)	77.38 (4.47)
	30 cm/s	30.17 (6.97)	36.50 (6.88)	29.32 (6.03)
Negative Affect	3 cm/s	9.92 (5.12)	14.87 (5.05)	10.32 (4.43)
	30 cm/s	36.83 (9.45)	48.34 (9.33)	38.79 (8.17)

Control Variables

Statistics of the main effects of the control variables described below are depicted in Table 8.

Right and left side stimulation did not differ in terms of rating of Positive Affect (F(1, 59) = .41, p = .53, η^2 = .01) or Negative Affect (F(1, 59) = .48, p = .49, η^2 = .01).

Repetition did not influence the rating of Positive Affect (F(2.24, 132.23) = .13, p = .90, η^2 = .00) or Negative Affect (F(2.51, 147.92) = .58, p = .63, η^2 = .01). When examining the main effect of repetition, Mauchly's test indicated that the assumption of sphericity had been violated, $\chi^2(5)$ = 18.80, $p < .05$. Therefore degrees of freedom reported are corrected using Greenhouse-Geisser estimates of sphericity.

Assigned order of the participant did not influence the rating of Positive Affect, F(3, 52) = 1.12, p = .35, η^2 = .06. However, Negative Affect indicated a significant difference between orders, F(3, 52) = 2.84, p = .047, η^2 = .14. This effect will be examined in further detail in the section *Miscellaneous*.

Men and women did not differ in their rating of Positive and Negative Affect. The main effect of gender was non-significant on both Positive Affect (F(1, 59) = .07, p = .80, η^2 = .00) and Negative Affect F(1, 59) = .03, p = .87, η^2 = .00).

Stimulation was rated no different by right handed participants and participants with other hand preferences. The main effect of handedness was not significant on both Positive Affect (F(1, 59) = .07, p = .79, η^2 = .00) and Negative Affect (F(1, 59) = .01, p = .92, η^2 = .00). However, handedness did affect the rating of the different stimulus velocities, which is depicted in Figure 6. Right handed participants scored the high velocity stroking more positive (M = 35.77, SE = 2.39) than participants with other handedness (M = 20.83, SE = 10.60). The opposite was true for the low velocity stroking, where right handed participants showed a lower Positive Affect rating (M = 69.27, SE = 1.81) than other handed participants

(M = 80.28, SE = 10.60). This interaction effect between handedness and stimulus velocity was significant for Positive Affect (F (1, 59) = 4.94, p = .04, η^2 = .07), but not for Negative Affect (F (1, 59) = 1.14, p = .29, η^2 = .02). As will be discussed in the *Discussion*, the other Handedness group only contained four subjects.

The final two-way interaction which showed significance was between stimulus velocity and repetition on Positive Affect. This interaction indicated that the difference of Positive Affect rating between stimulus velocities was influenced by number of repetition: F (2.59, 147,38) = 3.29, p = .02, η^2 = .05. This effect will be examined in further detail in the section *Miscellaneous*. The interaction between stimulus velocity and repetition was non-significant for Negative Affect, F (2.51, 147,92) = 1.21, p = .31, η^2 = .02. Mauchly's test indicated that the assumption of sphericity had been violated or both Positive ($\chi^2(5)$ = 32.65, p < .001) and Negative Affect ($\chi^2(5)$ = 16.71, p < .05). Therefore degrees of freedom reported are corrected using Greenhouse-Geisser estimates of sphericity.

Other two- and three-way interactions were non-significant.

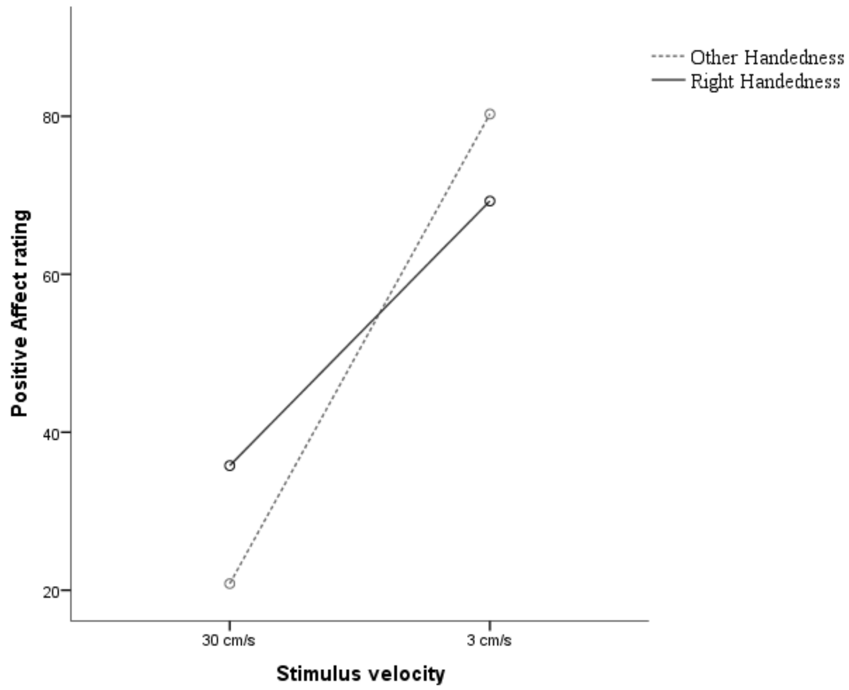

Figure 6.

Positive Affect as a function of stimulus velocity and handedness

Table 8.

Means and Standard Errors, between brackets, broken down into Positive and Negative Affect, for side of stimulation, repetition, order, gender and handedness

		Positive Affect	Negative Affect
Side of stimulation	**Right**	52.15 (3.58)	24.74 (4.83)
	Left	50.93 (4.02)	26.56 (5.26)
Repetition	**1**	51.39 (4.45)	27.12 (4.78)
	2	51.83 (4.00)	24.81 (4.85)
	3	51.34 (4.14)	25.39 (5.71)
	4	51.59 (4.01)	25.28 (5.98)
Order	**1**	48.81 (4.74)	33.10 (6.00)
	2	45.93 (4.97)	22.58 (6.30)
	3	55.96 (3.16)	19.28 (4.00)
	4	55.81 (4.72)	29.74 (5.98)
Gender	**Male**	50.58 (3.81)	26.45 (5.09)
	Female	52.49 (6.38)	24.85 (8.52)
Handedness	**Right**	52.52 (1.64)	25.14 (2.19)
	Other	50.56 (7.27)	26.17 (9.71)

Miscellaneous

The previously described significant main effect of order on Negative Affect, and the interaction between stimulus velocity and repetition for Positive Affect, were encouragements to examine the effect of repetition and order in more detail. A significant four-way interaction between side of stimulation, stimulus velocity, repetitions and order for Negative Affect (Linear Trend; $F(1, 59) = 6.17$, $p = .02$, $\eta^2 = .10$), further strengthened this motivation.

First, one-way repeated measures analyses of variance (ANOVA) were used to assess the influence of repetition on each condition. Statistics are depicted in Table 9 in the Appendix. These analyses revealed an upward trend for positive rating with the progressing of repetitions. The Linear Test of Within-Subjects Contrasts revealed a significant trend only for condition R3 Positive Affect, $F(1, 63) = 18.56$, $p < .001$. Since Mauchly's test indicated a violation of sphericity, the degrees of freedom reported are corrected using Greenhouse-Geisser.

Subsequently, separate multivariate analyses of variance (MANOVA) were conducted to examine whether assigned order of the participant influenced the ratings of conditions. Statistics are depicted in Table 10 in the Appendix. Four conditions exhibited significantly different ratings between orders. These were examined in further detail using Contrast Statistics. Figure 7 in the Appendix shows which stimuli turned out significantly deviating.

When combining the specified significant deviations in repetition and order, a systematic error could not be detected. This indicates the likelihood of both being coincidental errors. Considerations regarding this conclusion will be discussed in more detail in the *Discussion.*

Discussion

The present study examined the influence of individual levels of extraversion and neuroticism on the appraisal of affective and non-affective touch. Accomplishment of the intended experimental manipulation, namely generating affective and non-affective touch, was verified by the present data revealing low velocity stroking being evaluated more positive than high velocity stroking (Ackerley et al., 2014; Löken et al., 2009; Olausson et al., 2010; Wessberg et al., 2003; Van Stralen et al., 2014). In addition, consistent individual differences in affect ratings were observed. Although the intended manipulation was accomplished and individual differences were consistent, personality variables were not associated with the affectivity ratings of touch.

The present study revealed no influence of extraversion level on touch appraisal. The hypothesized positive influence of extraversion on touch perception, based on findings showing a positive influence of extraversion on the ease with which positive emotions are experienced (Costa & McCrea, 1980; McNiel & Fleeson, 2006; Rusting & Larsen, 1997; Tellegen, 1985), was not confirmed. This might suggest that the previously reported influence of extraversion level on auditory and visual perception does not apply to touch perception. This suggested insusceptibility of touch perception is to a certain extent understandable. Touch, especially affective and non-affective, plays a crucial role in physical and cognitive development (Diamond & Maso, 2008; Feldman et al., 2004; Feldman et al., 2014). An observed influence of individual levels of extraversion on affective touch would imply that an aspect of personality is able to influence an essential developmental process. Therefore, affective and non-affective touch might be insensitive to individual differences and follow a universal course across individuals. This interpretation is supported by the universal neurobiology and role of affective touch in healthy individuals described in the *Introduction* (Field, 2014; McGlone, Wessberg & Olausson, 2014).

The present study did al so not provide evidence for the hypothesis that higher neuroticism levels lead to more negative touch appraisal. Although neuroticism has been shown to exert an influence on visual and auditory perception (Brück et al, 2011; Canli et al., 2001; Knyzec et al., 2008), present findings suggest that this influence does not apply to touch. A specific hypothesis considered neuroticism to influence non-affective touch, as a link between neuroticism and susceptibility to negative emotions has been previously demonstrated (Costa & McCrae, 1980; McNiel & Fleeson, 2006; Rusting & Larsen, 1997). However, this hypothesis was also not supported by the data. The assumption previously proposed for extraversion is likewise applicable to neuroticism, namely touch possibly being insusceptible to individual personality characteristics because of its important role in developmental processes (Diamond & Maso, 2008; Feldman et al., 2004; Feldman et al., 2014). This assumption might be particularly applicable to the negative touch that warns us of physical harm and triggers the appropriate reflex – withdrawal – to minimize exposure to noxious stimuli, which is crucial for survival (Ross, 2011). Personality characteristics influencing this process and leading to individual diversity seems unlikely from an evolutionary perspective.

As mentioned in the *Introduction*, hypotheses were partly based on the observed activity in corresponding brain regions as a function of personality and affective touch. The regions proposed as being influenced by personality when processing touch stimuli - the mPFC, OFC and amygdala - are part of the limbic system and its pathways (Morgane & Mokler, 2006). Rejection of the hypotheses in the present study suggests that functioning in the limbic system is not similar when processing touch and personality influences. Supporting these doubts is recent research stating the concept of a single limbic system to be outmoded, rather suggesting distinct networks within the limbic system (Barbas, 2015; Catani, Dell'Acqua & De Schotten, 2013; Rolls, 2015). These networks are proposed to be partially overlapping, sharing cortical nodes, but functioning separately. Although research regarding these networks is still in its infancy, it is conceivable that touch and personality are not processed by the same limbic network or not in a similar way. Perhaps touch and personality are both processed by distinct pathways in the limbic system, each projecting to distinct secondary brain regions. This would be the same organization as proposed by the Specificity Theory of Pain (Moayedi & Davis, 2012), wherein modalities are encoded in separate dedicated pathways and by specialized organs. The fundamental tenet of the Specificity Theory is that each modality has a specific receptor and associated sensory fiber. This theory of organization might also be applicable to touch and personality; both activating the limbic system but not influencing each other, as is supported the present results.

The present study aimed to neutralize the experimental situation, among other things by eliminating expectations about the stimulus by providing an introduction to each participant before data acquisition stating that the stimulus is not negative. Perhaps manipulation of expectations about the touch experience would have led to different results, since contextual factors - i.e. top-down mechanisms - have shown to influence the pleasantness of touch (Ellingsen et al., 2013; Ellingsen, 2014; Elsenbruch, 2012). Research has shown modulatory circuits to up- and downregulate early sensory processing, depending on whether the generated expectation is improvement of positive or negative hedonic feelings

(Ellingsen et al., 2013; Ellingsen, 2014; Elsenbruch, 2012). Perhaps extraversion and neuroticism influence the hedonic content of expectations, subsequently manipulating the related modulatory circuits and sensory processing. In line with previous research findings (Costa & McCrea, 1980; McNiel & Fleeson, 2006; Rusting & Larsen, 1997; Tellegen, 1985), extraversion would be suggested to promote positive expectations regarding touch perception. Previous research, showing extraverts to have diminished pain sensitivity compared to introverts (Ferracuti & De Carolis, 2005; Lee, Watson & Frey Law, 2010; Ramirez-Maestre, Lopez Martinez, & Zarazaga, 2004; Vassend, Roysamb & Nielsen, 2013), could support this assumption. In these studies, it is thinkable that extraverted participant downregulated early sensory processing by formulating positive expectations, allowing them to tolerate more pain than introverts. Neuroticism on the other hand would be suggested to promote negative expectations. Research in the area of brain functioning during appraisal provides support for this presumption. Dysregulated anticipatory brain responses (Drabant et al., 2010), and brain regions responsible for emotional and cognitive appraisal showing hyperactivity during anticipation (Coen et al., 2011), are both associated with neuroticism level and show deviating anticipatory processes. Since the present study aimed at neutralizing the experimental situation, nothing can be said about the possible influence of expectations based on the present data. Therefore, present findings should not be generalized to experimental or real-life situations involving anticipation of positive or negative touch. Future research might address the hypothesized influence of extraversion and neuroticism on touch perception through expectations.

Although the present data do not suggest an influence of extraversion and neuroticism on touch perception in healthy individuals, results may turn out differently in psychiatric populations. For example, somatoform patients show lower extraversion and higher neuroticism levels than non-somatoform patients (Carlier et al., 2014; Noyes et al., 2001), and have lower tactile thresholds than healthy individuals (Brown et al., 2010; Katzer et al., 2012; Lloyd et al., 2008). Perhaps these two deviations are correlated, since differences perception are known to be partially determined by extraversion and neuroticism levels (Brück et al., 2011). Studies identifying extraversion and neuroticism as resilience or vulnerability factors for certain kinds of psychopathologies support the suggested importance of these personality dimensions in somatoform disorders (Canli et al., 2004). Therefore, examining a psychiatric population, such as patients with somatoform disorders, may yield different results than the present study which focused on healthy individuals.

A possible methodological explanation for the rejection of the present hypotheses is the intensity of stimulation. Certain levels of stimulation are required to observe the preferences of extraverts and neurotics concerning intensity of stimulation (Eysenck, 2009; 1967, Gomez et al., 2002). A hallmark study by Geen (1984) demonstrates this threshold stimulation phenomenon. Extraverts and introverts were shown to be equally aroused at very high and very low levels of intensity of noise stimulation. However, when allowed to individually choose the level of stimulation, extraverts choose more intense noise levels than introverts for optimal arousal. Perhaps, stimulation in the present study did not fall into the appropriate stimulation range, thereby not eliciting an influence of extraversion and neuroticism on touch perception. The skewness observed in the present negative rating suggest that the negative condition to be ‘not positive’ rather than truly negative. It is possible that, had more positive and negative touch stimulation been used, extraverts and people high on neuroticism might have shown appraisal differences in relation to their lower counterparts.

Unexpectedly, handedness did affect the pleasantness rating of affective and non-affective touch. Since the other handedness group included only four participants, interpretations regarding this finding can only be made tentatively. Affective touch was rated more pleasant by all participants, however, right handed participants rated affective touch even more positive than participants with other hand preferences. Interestingly, the opposite was true for the non-affective touch, on which right handed participants showed lower pleasantness ratings than other handed participants. Perhaps the predominant activation in the left hemisphere of right handed participants, because of crosslateral processing of motor signals, provides a basis for an explanation of the found interaction. The literature associates left-frontal activation with positive stimuli or mood, and right-frontal activation with negative stimuli or mood (Davidson, Ekman, Saron, Senulis & Friesen, 1990; Miller, Crocker, Spielberg, Infantolino & Heller, 2013). A long stretch explanation might suggest that right handed participants show more developed left hemispheres, supported by research showing cerebral and cognitive asymmetry related to handedness (Beaton, 1997; Halpern, Haviland & Killian, 1998; Snyder, Bilder, Wu, Bogerts & Lieberman, 1995), which could make them react more intensely when experiencing positive emotions. This would explain the more positive appraisal when perceiving affective, pleasant touch. Hemispheric dominance for the processing of emotional stimuli is also influenced by other factors, such as gender (Bourne & Maxwell, 2010; Bourne & Watling, 2014), which further complicates the interpretation. Additional research is necessary to determine if any real effects of handedness on touch perception can be established.

As for task-delineating effects, both repetition and order showed significant results. One may speculate that being assigned to a specific order or repeating conditions has a particular influence on touch appraisal. However, the experiment was designed to avoid effects of order of conditions and invalid findings. For this purpose, different orders were used; moreover, conditions were repeated to enhance the reliability of measurements. After detailed examination of the effects of repetition and order, a systematic error could not be detected. This, in combination with the deliberate experimental design, indicates the likelihood of both effects being coincidental scores.

Psychometric strengths of this study should be noted. Firstly, the sample size seems sufficient for the conducted analyses. Secondly, the experimental manipulation had the intended effect and the replications of conditions increased the reliability of findings, making the experimental design valid and reliable. Lastly, the administration by one practiced researcher following a set protocol reduced confounding influences by increasing standardization. A limitation of this study should be noted as well, namely the non-affective stimulus seeming to be rather ‘not positive’, as opposed to truly negative. However, due to ethical constraints, it was not possible to use a genuinely negative stimulus. Future research should examine the possible influence of extraversion and neuroticism on more positive and more negative touch stimuli. Another recommendation for future research is the examination of touch perception in psychiatric populations and possibly the exploration of the influence of handedness on touch perception. Perhaps this research will yield results that shed more light on the role of personality in touch perception.

In conclusion, the present study indicates that extraversion and neuroticism have no influence on the perception of affective and non-affective touch.

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Appendix

Table 5.

Mean, Standard Deviation (SD), Skewness and Minimum and Maximum score for Negative Affect

	Mean	SD	Skewness	Minimum	Maximum
R30	36.63	24.08	.38	0	88.67
R3	13.57	13.10	1.89	0	71.27
L30	36.57	24.97	.31	0	85.83
L3	14.68	15.23	1.85	0	68.42

Note: R3 = right hand, velocity 3 cm/s, R30 = right hand, velocity 30 cm/s, L3 = left hand, velocity 3 cm/s, L30 = right hand, velocity 30 cm/s

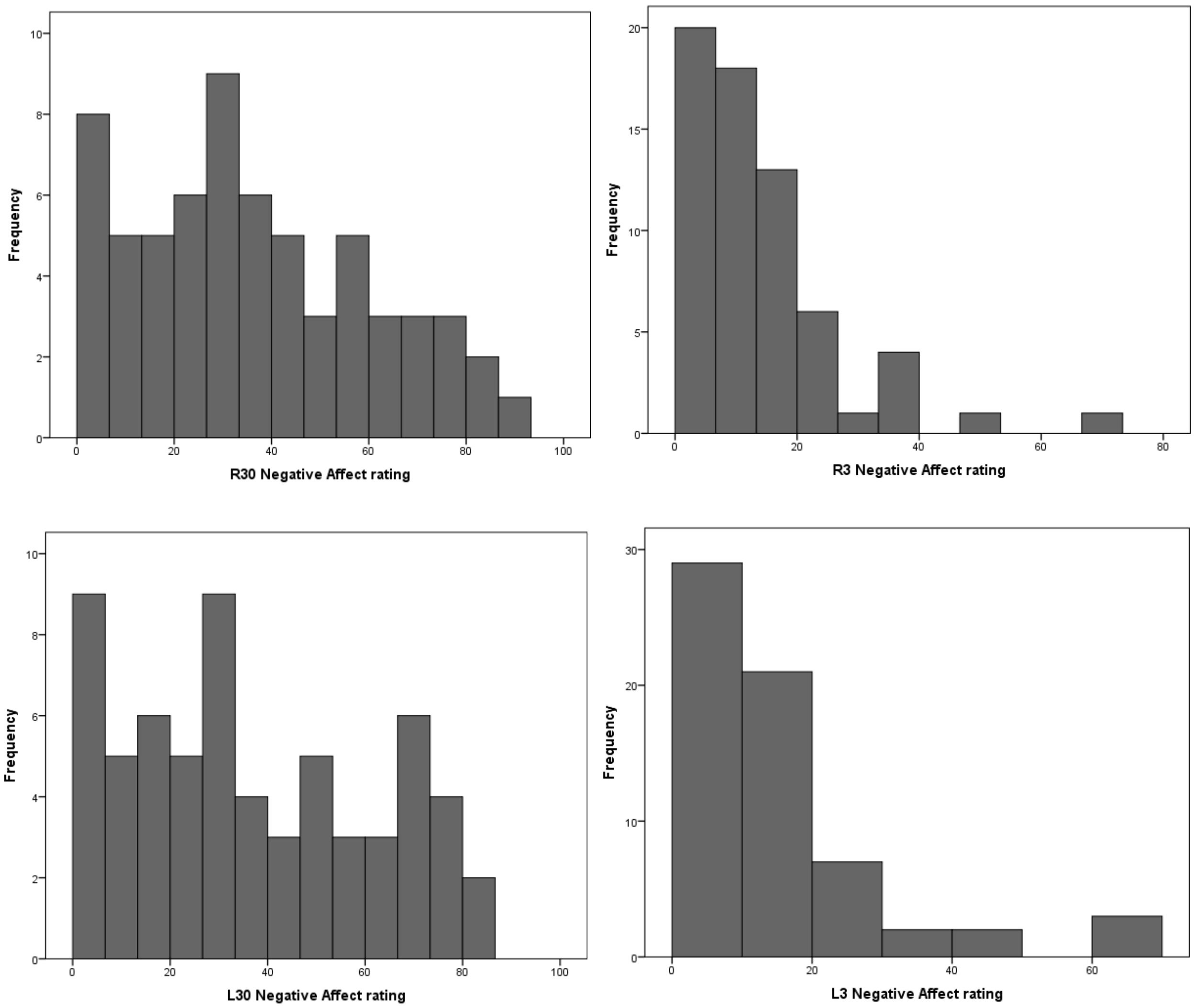

Figure 3.

Histograms of the skewness of the Negative Affect ratings on the four conditions

Note: R3 = right hand, velocity 3 cm/s, R30 = right hand, velocity 30 cm/s, L3 = left hand, velocity 3 cm/s, L30 = right hand, velocity 30 cm/s

Table 9.

P-values, Means and Standard Errors for the separate repetitions per condition

		Number of Repetition			
	p	**1**	**2**	**3**	**4**
Positive Affect					
R30	.11	38.84 (2.86)	34.64 (2.74)	35.56 (2.57)	33.92 (2.67)
R3	.00*	66.07 (2.27)	72.13 (2.07)	69.74 (2.22)	75.44 (1.78)
L30	.35	36.38 (3.00)	36.15 (2.67)	36.69 (2.83)	33.61 (2.57)
L3	.88	69.40 (2.22)	69.69 (2.03)	68.56 (2.47)	70.14 (2.43)
Negative Affect					
R30	.68	36.93 (3.29)	37.85 (3.55)	35.42 (3.38)	36.34 (3.73)
R3	.24	15.04 (2.30)	12.96 (1.84)	14.20 (2.17)	12.06 (1.85)
L30	.55	39.47 (3.58)	34.73 (3.32)	34.67 (3.67)	37.40 (3.67)
L3	.71	16.46 (2.43)	13.28 (1.88)	13.66 (2.53)	15.31 (2.58)

Note: Asterisks represent significant differences, $p < .05$

R3 = right hand, velocity 3 cm/s, R30 = right hand, velocity 30 cm/s, L3 = left hand, velocity 3 cm/s, L30 = right hand, velocity 30 cm/s

Table 10.

F-ratio and p-value of multivariate analyses of variance, to determine effect of order per condition

	F	***p***
Positive Affect		
R30	2.25	.01*
R3	2.37	.01*
L30	2.88	.00*
L3	.63	.81
Negative Affect		
R30	.83	.50
R3	.70	.75
L30	1.90	.04*
L3	.70	.75

Note: Asterisks represent significant differences, $p < .05$

R3 = right hand, velocity 3 cm/s, R30 = right hand, velocity 30 cm/s, L3 = left hand, velocity 3 cm/s, L30 = right hand, velocity 30 cm/s

1	R30	L3	R3	L30	R3	R30	L30	L3	**L30**	R3	L3	R30	L3	L30	R30	R3
2	L3	R3	R30	L30	R30	L30	L3	R3	R3	L3	L30	R30	L30	R30	R3	L3
3	**L30**	**R30**	L3	R3	L3	R3	R30	L30	R30	L30	R3	L3	R3	L3	L30	R30
4	R3	L30	R30	L3	L3	R30	L30	R3	R30	R3	L3	L30	L30	L3	R3	R30

Figure 7.

Orders of experimental conditions, conditions depicted in red scored significantly different between orders

Note: R3 = right hand, velocity 3 cm/s, R30 = right hand, velocity 30 cm/s, L3 = left hand, velocity 3 cm/s, L30 = right hand, velocity 30 cm/s