I Can Feel Your Pain:

Haptic Roughness Promotes Empathy and Helping Behaviors

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ABSTRACT

Eliciting help has important social impacts. However, we know little about how incidental, contextual cues can encourage helping behaviors. In a series of laboratory and field studies, we show that incidental exposure to haptic sensation of roughness (vs. smoothness) promotes empathy and consequently enhances helping towards unfamiliar targets. In addition, using direct measures of brain activity, we provide important insight to the process by suggesting that haptic roughness increases attention to others' misfortune, and therefore leads to enhanced empathetic responses at later, evaluative (vs. earlier, automatic response) stages. These findings not only underscore the power of subtle contextual cues on shaping important behaviors, but also point to the possibility of developing novel intervention strategies for promoting human prosociality.

From Japan's 9.0 magnitude earthquake and the ferocious tsunami, to the Aids epidemic in Africa, to the suffering patients around the globe looking for cure, to the homeless in every neighborhood, many people are desperately waiting for help. Yet eliciting help has never been easy (U.S. Bureau of Labor Statistics 2010). While extensive research has examined why people help and how to promote helping, much has focused on potential donors' demographic and psychographic characteristics (Harvey 1990; Loewenstein and Small 2007), identity (Aaker and Akutsu 2009), and motivation (Dovidio, Allen, and Schroeder 1990; Dunn, Aknin, and Norton 2008). We know little about how incidental, contextual cues can affect helping behavior (Bendapudi, Singh, and Bendapudi 1996). However, if we can start identifying inherently non-social factors that may influence pro-social behaviors, this may lead to novel approaches for facilitating the massive humanitarian needs of our complex, modern world. Although some early investigations have identified certain environmental factors, such as ambient fragrance (Baron 1997) and music (North, Tarrant, and Hargreaves 2004), we believe the current research is the first work to identify a haptic variable, namely, the haptic sensation of roughness, and investigate its impact on helping behaviors.

The sense of touch (i.e., haptics) provides us with one of the most fundamental means to acquire information and to connect with the external world. Yet historically, despite its importance and ubiquity in our subjective experience, haptic sensations have received little attention in behavioral research (Ackerman, Nocera, and Bargh 2010; Field 2010; Peck and Childers 2008). Existing research in haptics has primarily focused on the issue of the presence versus absence of touch. These factors include object attributes that encourage touch (Grohmann, Spangenberg, and Sprott 2007; Krishna and Morrin 2008; McCabe and Nowlis 2003), individual differences in the need for touch (Citrin et al. 2003; Peck and Childers 2003a, 2003b), situational factors that motivate touch (Peck and Childers 2008; Peck and Shu 2009; Peck and Wiggins 2006), and interpersonal touch (Crusco and Wetzel 1984; Erceau and Guéguen 2007; Fischer et al. 1976; Hertenstein, et al. 2006; Martin 2012; see Gallace and Spence 2010 for a review). Yet, little attention has been directed to examine the haptic attributes (i.e., texture, hardness, weight, and temperature; Klatzky and Lederman 1992, 1993; Lederman and Klatzky 1987), while touch is always present. Within the limited research that examines the haptic attributes, most has focused on the psychophysical aspects, for example, various physical factors contributing to human's tactile roughness perception (Dépeault, et al. 2009; Lawrence et al. 2007), without shedding light on the influence of haptic attributes on people's behaviors. Recently, some exciting work has begun to reveal that haptic experiences can have a significant impact on social evaluative processes (Ackerman, Nocera, and Bargh 2010; Williams and Bargh 2008). For example, holding a resume attached to a heavy clipboard leads people to think the job candidate as more important, touching rough sandpaper makes individuals judge an unrelated social interaction being difficult (Ackerman, Nocera, and Bargh 2010), and holding a cup of hot coffee causes people to perceive another person as having a warm personality (Williams and Bargh 2008). The current research seeks to add to this line of research by proposing that haptic experiences can also affect individuals' helping behavior in an unrelated context.

We propose that exposure to rough haptic surfaces may positively impact helping behaviors. We argue that this should happen because haptic roughness is likely to enhance attention to other's misfortune. Such heightened attention may trigger empathetic responses towards the needy others (Lamm et al. 2007; Singer and Lamm 2009), which leads to greater helping behaviors (Bagozzi and Moore 1994; Baston 1991; Hoffman 1982). By exploring these hypotheses, we not only wish to contribute to the literature on haptics, but also seek to shed light on how non-social factors, such as haptic experience, may influence people's helping behaviors.

THEORETICAL BACKGROUND

The Impact of Haptic Sensation on Helping Behaviors

We first posit that haptic sensation of roughness, compared to smoothness, enhances empathy, which is the key antecedent of helping behavior. We suggest that this should happen because haptic roughness, which is known to cause mild discomfort (Lederman 1983), is likely to enhance attention to other's misfortune. Such heightened attention can subsequently result in enhanced empathy towards needy others. This argument finds support in converging evidence from neuroscience and social psychology.

Surface roughness is a very salient attribute for touch. In fact, it is much more salient than other haptic attributes such as form or size (Klatzky, Lederman, and Reed 1987). When touching a coarse surface, the friction between the finger and the surface may cause individuals to experience mild discomfort (Lederman 1983). This minor discomfort is likely to enhance attention to others' discomfort, misfortunes, or challenges. To support this argument, we provide direct evidence in study 2 by measuring participants' brain activity when they were experiencing haptic roughness (vs. smoothness). Further, prior research has suggested that attention to a social target is required for triggering empathetic experience (Lamm et al. 2007; Singer and Lamm 2009). It has also been revealed that empathy responses in the brain can be triggered by perceiving or imagining the emotional states of others (e.g., seeing someone else's pain), in particular, when our attention is directed to the targets (Decety and Lamm 2006; Singer, et al. 2004). For instance, in an fMRI study by Gu and Han (2007), when participants saw pictures of hands in painful situations, they showed activation in the same brain areas that would get activated if they experienced the pain firsthand. However, when participants' attention was distracted away from the inflicted pain, no activation in those brain areas was observed. Similarly, in a follow-up EEG study by Fan and Han (2008), whose paradigm we adopted in study 2, they also demonstrated that attention to the stimuli directly modulates participants' empathetic responses. Taken together, the above literature supports our argument that haptic roughness (vs. smoothness), which may enhance attention to other's misfortune, can promote empathy towards the needy other.

After establishing the link between haptic roughness and empathy, we next reason that the increased empathy elicited by haptic roughness leads to greater helping behavior. Conceptually, empathy has been defined as the attempt to comprehend unjudgmentally the positive and negative experiences of another person (Wispé 1986), by experiencing and understanding another person's affective or psychological state (i.e., put oneself in another person's shoes; Krebs 1970; Eisenberg and Miller 1987; Zahn-Waxler and Radke-Yarrow 1990). Further, the positive association between empathy and prosocial behavior has been well established in the literature (Bagozzi and Moore 1994; Baston 1991; Batson et al. 1997; Coke, Batson, and McDavis 1978; Hoffman 1982).

Summarizing the above theorizing, we propose that haptic sensation of roughness, compared to smoothness, results in greater empathy towards the needy others, thereby leading to increased helping behaviors. Formally, H1: The haptic sensation of roughness versus smoothness leads to people's greater willingness to help.

Interpersonal Familiarity and Empathy

The existing literature on prosocial behaviors consistently shows that interpersonal familiarity between the potential helper and the helping target tends to promote empathy and thus prosocial behaviors (Loewenstein and Small 2007). For instance, Small and Simonsohn (2008) show that a personal connection with a close victim (e.g., a friend or a loved one), or even the close relationship carried over to other victims suffering the same misfortunes as their friends and loved ones, promotes greater empathy and helping behaviors. Along the same lines, people are more likely to help the victims who are similar to themselves (Hornstein 1976; Krebs 1975), or belong to their in-group rather than their out-group (Dovidio et al. 1997; Flippen et al. 1996). According to Batson and his colleagues, reducing social distance and inducing empathy by asking individuals to take the needy person's perspective leads to greater altruistic behaviors (Batson, Early and Salvarani 1997; Batson et al. 2003; Coke, Batson, and McDavis 1978).

Building upon the above findings, we propose an important boundary condition for the aforementioned main effect of the haptic roughness on people's helping behaviors. Specifically, when the potential helper is unfamiliar with the helping target, we should observe the aforementioned main effect, namely, haptic roughness versus smoothness should enhance empathy and thus helping behavior. However, if the potential helper is familiar with the helping target, the helper should experience heightened empathy level and be willing to help regardless of the haptic sensations. Formally stated, H2: The haptic sensation of roughness versus smoothness leads to people's greater willingness to help towards an unfamiliar target; but this effect mitigates towards a familiar helping target.

Further, because both haptic roughness and interpersonal familiarity produce empathy, we posit that smooth versus rough haptic sensations as well as familiar versus unfamiliar relationship harbor differential abilities to garner empathy that influence helping behaviors. In other words, the interactive effect of haptic sensation and interpersonal familiarity leads to different levels of empathy, which, in turn, affects people's willingness to help. Formally,

H3: The interactive effect of haptic sensation and interpersonal familiarity on willingness to help is mediated by empathy.

In what follows, we report a series of six studies to test our theory. Study 1 establishes the basic main effect that the haptic sensation of roughness versus smoothness is more likely to promote helping behaviors (hypothesis 1). Study 2 uses direct measures of brain activity to provide insights into the underlying mechanism that exposure to haptic roughness may enhance attention to others' misfortunes. Study 3 demonstrates the moderating role of familiarity in the relationship between haptic sensations and helping behavior (hypothesis 2). Study 4 further probes the underlying process and finds support that the interactive effect between haptic sensation and interpersonal familiarity is mediated by empathy (hypothesis 3). Study 5 provides additional support for the mediating role of empathy by showing that the interaction between haptic sensation and interpersonal familiarity only occurs for low empathizers. Finally, study 6 provides external validity for our laboratory results with field data from a street fundraising event.

STUDY 1: HAPTIC ROUGHNESS LEADS TO GREATER DONATION

In study 1, we directly tested the hypothesis 1 that haptic roughness enhances helping behaviors. We manipulated the haptic sensations by two different kinds of hand washes under the cover story of a product evaluation task. The key dependent measure was the participants' willingness to donate in a subsequent task. We predicted that haptic sensation of roughness versus smoothness would lead to greater donate intention.

Method

Sixty-seven undergraduate students participated in the experiment for course credit. We employed a one factor 3 (haptic sensation: smooth vs. rough vs. control) between-subject design.

The study was run in small groups of no more than four people per session. Upon arrival, participants were randomly assigned to one of the three haptic conditions, and were led to individual workstations. The workstations were separated from each other by dividers, such that participants could not see each other during the study. On each workstation for the rough and smooth conditions, there were a basin of water, a bottle of hand wash, a clean and dry towel, and a computer. Only a computer was present for the control condition.

Participants in the rough and smooth conditions first performed the haptic manipulation under the disguise of a product evaluation task. They were asked to experience and evaluate one of the two hand washes that varied only in texture (smooth vs. rough), but were identical in terms of color and scent. Specifically, in the smooth condition, the hand wash was a moisturizing hand wash containing vitamin E and aloe, whereas in the rough condition, the hand wash was a scrub hand wash containing exfoliating microbeads. Participants were instructed to wet their hands first with water, squeeze two drops of the hand wash on their hands, and then feel the hand wash very carefully by rubbing it between their fingers for 20 seconds. Then they cleaned their hands and answered two filler questions on the computer regarding their attitudes towards the hand wash. Participants in the control condition did not perform this task.

Next, all participants were asked to do an allegedly unrelated willingness-to-donate task on the computer, which measured our key dependent variable. They were presented with information about two fictitious non-profit organizations, "Leadership Camp" and "U Fit", one on each screen, and were asked to indicate their willingness to donate to each charity. We used fictitious charities to avoid prior knowledge and preference towards any existing ones.

Finally, participants completed a manipulation check and a mood measure. The manipulation check assessed the effectiveness of the haptic experience manipulation by asking participants to rate on two questions (i.e., "Recall the hand wash you used at the beginning of the study. To what extent did it make your hands feel smooth and soft?" and "To what extent did the hand wash make your hands feel rough and coarse?"). The mood measure included six randomly ordered adjectives, three representing positive mood (i.e., happy, excited, and cheerful) and the other three representing negative mood (i.e., sad, upset, and depressed). All items were on 7-point scales (1 = not at all; 7 = very much). The study ended with a suspicion probe by asking participants the true purpose of the study.

Results and Discussion

To check the manipulation, an index for roughness was created by averaging the rating of roughness and the reversed rating of smoothness of the hand wash ($\alpha = .91$). The result of a one-way ANOVA confirmed that the scrub hand wash indeed felt rougher ($M = 5.04$) than the moisturizing hand wash ($M = 2.68$, $F(1,43) = 18.13$, $p < .0001$).

To test our main hypothesis, we first created a composite score for the willingness to donate, by averaging the ratings for two charities ($\alpha = .75$). As anticipated, one-way ANOVA revealed a significant main effect of haptic experience ($F(2,64) = 6.14$, $p < 0.01$), such that those in the rough condition ($M = 4.30$) indicated greater willingness to donate than both those in the smooth condition ($M = 2.86$, $t(64) = 3.16$, $p < .01$), and those in the control condition ($M = 3.00$, $t(64) = 2.86$, $p < .01$). The contrast between the latter two conditions was not significant ($t(64) = .30$, $p > .70$). These results thus supported our hypothesis that rough haptic sensation can facilitate helping behaviors.

To examine whether the haptic manipulation altered individuals' mood states, we created two indices by averaging the three positive mood items ($\alpha = .76$), and the three negative mood items ($\alpha = .78$). One-way ANOVA revealed that the haptic manipulation did not affect positive ($M_{\text{smooth}} = 4.70$, $M_{\text{rough}} = 4.57$, $M_{\text{control}} = 4.59$; $F(2,64) = .17$, $p > .84$), or negative mood ($M_{\text{smooth}} = 1.70$, $M_{\text{rough}} = 1.64$, $M_{\text{control}} = 1.80$; $F(2,64) = .33$, $p > .72$). We also measured mood in studies 3, 4, and 5, and in none of the studies did we observe a significant mood effect. Thus, we do not report this mood measure in later studies. Finally, no one showed suspicion about the connection between the ostensible product evaluation task and the donation task.

The results of this study supported hypothesis 1 that the haptic sensation of roughness enhances helping behaviors. In the next study, we explored the underlying process. In particular, we used direct measures of brain activity to demonstrate that haptic roughness may enhance attention to other's misfortune in the stimuli.

STUDY 2: BRAIN ACTIVITY WHEN EXPERIENCING HAPTIC ROUGHNESS

The purpose of study 2 was to test our hypothesis that exposure to haptic roughness may promote empathy and helping behavior by triggering individual's enhanced attention to other's misfortune. Recent research in neuroscience has found that attention to a social target is required for triggering an empathetic experience (Lamm et al. 2007; Singer and Lamm 2009). Further, the empathetic responses to other's misfortune have been temporally dissociated into two distinct processes – an initial automatic response of mirroring the physical discomfort itself, followed in time by a more deliberate appraisal of the painful context (Decety and Lamm 2006; Fan and Han 2008; Goubert, et al. 2005). If haptic roughness can indeed enhance attention to socially-relevant stimuli and promote empathy, we predicted that it should affect these later, evaluative aspects of empathy, owing to the known modulatory effects attention has on them (Fan and Han 2008). To test this, we used direct measures of brain activity by replicating Fan and Han's (2008) paradigm, in which they recorded event-related brain potentials (ERPs) to investigate the temporal mechanism of neural activities underlying empathetic responses towards seeing other's pain.

Method

A total of 16 healthy students (8 males, 8 females) served as paid participants in the study. All had no neurological or psychiatric history, were right-handed, had normal or corrected-to-normal vision, and were not color blind.

The task required participants to briefly view digital color images of hands in various action sequences (e.g., cutting vegetables, shutting doors), and to make a forced, two-choice response for each image—did it appear painful or non-painful. Their brain's electrical responses were recorded via ERPs as they were observing the images. The images were the "cartoon" image set used originally by Fan and Han (2008), and depicted the hands from a first-person perspective. Twenty images showed hands in "painful" positions (e.g., a hand trapped in a door), and twenty showed hands in "neutral" positions similar to the "painful" condition, but not implying pain (e.g., a hand next to a door). The images themselves were presented on the center of a black computer screen. There were 40 trails (20 pain pictures and 20 neutral pictures) in each trial block, and participants were run in 16 blocks in total. On each trial, the stimulus was displayed for 500 ms and then followed by a fixation cross with a duration varying randomly between 2400 and 2600 ms. The order of images was randomized between blocks and participants. Responses were made via a response device held with both hands; half of the participants signaled "painful" and "non-painful" via responses with the left and right thumbs, respectively, and the other half performed the task with the reverse thumb-response mapping.

To manipulate haptic roughness versus smoothness, the hand-held response device was placed in a small, shallow box made out of 60-grit sandpaper (rough condition) or vinyl paper (smooth condition). The response device and box were held with both hands, such that the thumbs were on top of the response device and positioned to hit the respective response buttons, and the fingers were all holding the bottom of the box and making direct contact with the box surface. Participants alternated the box for each trial; the order (rough vs. smooth box first) was counterbalanced between participants.

Electroencephalograms (EEGs) were recorded from 32 active electrodes (Bio-Semi Active2 system) distributed evenly over the head at locations based on a modified version of the International 10-20 System, relative to two scalp electrodes located over medial-parietal cortex (CMS/DRL), using a second order high-pass filter of 0.05 Hz, with a gain of 0.5 and digitized on-line at a sampling rate of 256 samples-per-second. Additional electrodes were also recorded from the left and right mastoids, for later re-referencing of scalp signals. To ensure proper eye fixation and allow for the correction and/or removal of events contaminated by eye movement artifacts, vertical and horizontal electro-oculograms (EOGs) were recorded for all participants. The vertical EOG was recorded from an electrode inferior to the right eye, and the horizontal EOG from an electrode on the right outer canthus.

Results and Discussion

Electrophysiological results. Off-line, computerized artifact rejection was used to eliminate trials during which detectable eye movements, blinks, and muscle potentials occurred. Off-line artifact rejection was based on exceeded min-max difference thresholds within a -200 to 800 ms time window around each event (for eye and muscle artifacts), with each participant’s threshold scaled via data visualization to the ambient level of that participant's EEG noise. Prior to signal averaging of the EEG, each subject’s ERP waveforms were algebraically re-referenced to the average of the left and right mastoid signals and low-pass Gaussian filtered (25.6 Hz half-amplitude cut-off) to eliminate high-frequency artifacts in the waveforms. The resulting singlesubject ERPs were used to derive group-averaged waveforms for display and analysis. Statistical quantification of ERP data were based on mean amplitude measures relative to a -200 to 0 pre-stimulus baseline.

ERP data analysis focused a priori on frontal/central electrode sites CZ and FCZ, the scalp region previously showing modulations in the empathetic responses to painful vs. neutral images (Li and Han 2010). Statistical interrogation of the ERP waveforms were based on repeated-measure ANOVAs on mean amplitude measures taken across three time windows of analysis tailored to the morphology of the CZ/FCZ waveforms: a 250-500 post-stimulus window capturing an N2 component, a 500-650 ms window capturing a P3-like component, and a 650-800 ms window capturing an LPP-like component. The ANOVAs within each time window included factors of image type (painful vs. neutral), haptic sensation (rough vs. smooth) and electrode location (CZ vs. FCZ). For brevity and because we had no a priori predictions about electrode location differences in the effects of image type and haptic sensation, we do not report any main effects of electrode or interactions with the other factors. The results confirmed our predictions (Figure 1). Consistent with Fan and Han (2008), the painful images elicited a significantly greater mean amplitude compared to the neutral images across all three time windows (250-500 ms: $F(1,14) = 12.33$, $p < .005$; 500-650 ms: $F(1,14) = 6.78$, $p < .05$; 650-800 ms: $F(1,14) = 4.61$, $p < .05$). More importantly, however, this heightened response to painful (vs. neutral) images was amplified in the rough condition in the later time windows, as indicated by the significant image type X haptic sensation interaction (500-650 ms: $F(1,14) = 4.71$, $p < .05$; 650-800 ms: $F(1,14) = 4.78$, $p < .05$). Specifically, in these later time windows, the sensitivity to painful images was only evident in the rough condition (500-650 ms: $t(14) = 9.65$, $p < .01$; 650-800 ms: $t(14) = 14.90$, $p < .01$), but not in the smooth condition (both *t*s < 2.8, both *p*s > .11).

Insert figure 1 about here

Behavioral results. We extracted and analyzed two measures of behavioral performance in study 2. First, we wanted to examine the breakdown of "painful" versus "non-painful" responses in each of the four stimulus conditions. Specifically, we calculated the proportion of total responses in each condition that were "painful", and reported values in Table 1 (top). As expected, there was a significant main effect of image type ($F(1,15) = 1409.25$, $p < .001$), indicating the obvious tendency to respond "painful" more often to the painful (vs. neutral) images. However, there was no main effect of haptic sensation ($F(1,15) = .54$, $p = .82$), nor a haptic sensation X image type interaction ($F(1,15) = .009$, $p = .93$), indicating that haptic experience had no impact on whether people reported the images to be painful or non-painful.

Second, we also wanted to examine the reaction times (RTs) to images as a function of image type (painful vs. neutral) and haptic sensation (rough vs. smooth), as reported in Table 1 (bottom). In this analysis, RTs for each image were collapsed across "painful" and "non-painful" responses. Although responses appeared to be slightly faster in the smooth vs. rough condition, the effect was non-significant ($F(1,15) = 1.51$, $p = .24$). Again, there was no main effect of image type ($F(1,15) = .28$, $p = .60$), or interaction between haptic sensation and image type ($F(1,15) = 1.54$, $p = .24$). This indicated that haptic sensation had no impact on the speed of participants' categorical responses.

Insert table 1 about here

Discussion. In short, we noted that the effects of pain sensitivity and haptic sensation in our ERP waveforms had no corresponding correlate in either of our primary behavioral measures reported above (% "painful" responses and RTs). Importantly, Fan and Han (2008) found a similar data pattern – effects of painful vs. neutral images in ERP waveforms but not in RTs between image types. This suggested that differential levels of implicit sensitivity to the painful images (as captured in the ERP waveforms) did not appear to affect the category an image was actually ascribed to (as captured by the % "painful" responses), nor the speed of image categorization itself (as captured via RTs). Rather, given that we found a consistent positive effect of haptic roughness on participants' willingness to help others, the dissociation in measures in the current paradigm suggested a similar quantitative effect of haptic sensation on empathy-related responding. That is, texture may not be affecting what looked painful vs. non-painful, but instead, how painful or intense a painful image appeared to be.

Taken together, results from this study thus provided crucial evidence that haptic roughness (vs. smoothness) may enhance empathy-related responses such as attention to the pain or misfortune of others, and this effect appeared to be at later, evaluative stages of cognitive analysis. Hence, by using disparate methods and measures, the first two studies directly confirmed that non-social contextual factors can indeed affect our propensity for empathy and willingness to engage in helping behaviors. However, does haptic roughness always lead to greater helping intention? Given that helping behaviors are also subject to known social influences, we suggested that the effects of haptic roughness may be modulated by social factors. As such, study 3 introduced an important moderator to the main effect, namely, familiarity towards the target.

STUDY 3: DONATE TO FAMILIAR VERSUS UNFAMILIAR CHARITIES

Study 3 aimed to test hypothesis 2 by investigating the moderating role of target familiarity on the effect of haptic roughness on people's helping behavior. Prior research suggests that people experience enhanced empathy towards a familiar target (e.g., a friend, an identifiable victim) and are more likely to help (Loewenstein and Small 2007; Small and Simonsohn 2008). Thus, we reasoned that when individuals are familiar with the target, the already heightened empathy would override any haptic effect, leading to comparably high levels of helping behavior. But for unfamiliar target, we expected to replicate the main effect observed in study 1.

Method

Forty undergraduate students participated in the study for course credits. The design was a 2 (haptic sensation: rough vs. smooth) X 2 (target: familiar vs. unfamiliar) mixed design.

The procedure was similar to that of study 1, except a) we dropped the control condition, and b) included both familiar (e.g., Aids.org) and unfamiliar charities (e.g., Sjögren's Syndrome Foundation). Participants were asked to first perform a hand wash evaluation task to complete the haptic manipulation. Next, all participants completed a willingness-to-donate task on the computer. They were presented with four organizations, one at a time. Two organizations (i.e., National Breast Cancer Foundation and Aids.org) were selected as familiar charities, whereas the other two organizations (i.e., Sjögren's Syndrome Foundation and Schizophrenia Foundation) were chosen as unfamiliar ones. We included a short description for each charity, and the presentation order of the charities was randomized. For each charity, participants indicated their willingness to donate at that moment on 7-point scales (1= not at all, 7 = very much).

Upon finishing the willingness-to-donate task, participants completed the manipulation checks by indicating the roughness of the hand wash as per the questions in study 1, and by rating the familiarity to each of the four charities. All items were measured on 7-point scales.

A pretest with 18 participants from the same population confirmed that the selected two well-known charities were indeed more familiar to our participants than the two unknown ones. Participants were presented with the same list of the charities and were asked to indicate their familiarity towards each charity on 7-point scales. Two indices were created, one for the familiar (α = .78) and the other one for the unfamiliar (α = .85) charities. Results indicated greater familiarity with the two well-known (M = 5.92) than with the two unknown charities (M = 2.06, $t(17) = 14.43$, $p < .001$).

Results and Discussion

The manipulation checks confirmed the effectiveness of our manipulations. As to the haptic manipulation, the scrub hand wash felt rougher than the moisturizing hand wash (*Ms* = 4.78 vs. 2.80, $F(1,38) = 11.03$, $p < .005$). As to the familiarity manipulation, we created two indices that summarized the average ratings for the well-known charities (α = .80) and the lesser-known charities (α = .83). The results confirmed greater familiarity with the well-known charities (M = 4.30) than with the lesser-known ones (M = 1.74, $t(39) = 9.20$, $p < .001$).

To analyze the dependent measure, we created two indices for familiar and unfamiliar charities (α = .77, .82), respectively, by averaging the willingness to donate ratings. The two-way

ANOVA revealed the anticipated interaction ($F(1,38) = 6.69$, $p < .05$; Figure 2), such that haptic roughness ($M = 4.98$) led to greater willingness to donate than smoothness ($M = 3.93$) for the unfamiliar charities ($F(1,38) = 4.91$, $p < .05$), but comparable levels of donation intentions for the familiar charities ($M = 5.00$ vs. $M = 4.98$, $F(1,38) = .00$, $p > .90$).

Insert figure 2 about here

The results of this study demonstrated the moderating role of target familiarity on the effect of haptic roughness on people's helping behaviors (hypothesis 2). While haptic sensation of roughness versus smoothness led to greater willingness to donate for lesser-known charities, they resulted in equally high donation tendency for well-known charities. In the next study, we examined whether empathy mediated this interactive effect between haptic sensation and target familiarity on helping behavior.

STUDY 4: HELP A CONFEDERATE

The primary purpose of study 4 was to test hypothesis 3 by examining the mediating role of empathy. In addition, we aimed to replicate the interaction observed in study 3 by using another helping context and adopting a real behavioral measure (i.e., help a confederate to solve some problems). This measure was modified from Weinstein and Ryan (2010, study 3).

Method

One hundred and two undergraduate students participated in the study for course credits. The design was a 2 (familiarity: familiar vs. unfamiliar) x 2 (haptic sensation: smooth vs. rough) between-subject design.

Each participant came to the lab individually. A confederate, who appeared as another participant, came to the lab at the same time. Before the experiment, we verified that all the participants were unacquainted with the confederate. In the lab, there were two desks next to each other. On the desk, there were a basin of water, a bottle of hand wash, a cleaning and dry towel, a computer, and a card with either letter A or B on it. Upon arrival, the participant and the confederate were greeted by the experimenter and were then seated in front of each desk. The confederate always sat at the desk with the letter A, while the participant always sat next to him at the desk with the letter B. They were told that they were going to do a series of unrelated tasks.

For participants in the familiar condition, they were asked to first perform a communication task with the confederate to increase familiarity between the dyad. The communication task was an abridged version of the Relationship Closeness Induction Task, which has been commonly used to generate relationships in a laboratory setting (Sedikides et al. 1999). The dyad was asked to engage in a natural conversation by asking each other two sets of questions, each set for 5 minutes. The first set consisted of introductory questions such as "What is your first name?", and the second set consisted of more personal questions such as "What would be the perfect lifestyle for you?". The confederate was trained to provide the same answers to different participants in the conversation. For participants in the unfamiliar condition, they did not perform this communication task. Next, like in previous studies, all participants completed the hand wash evaluation task which manipulated the haptic experience.

Having completed all the manipulations, the dyad was asked to do a creativity task individually on the computer. Specifically, each person was given a different item and was asked to generate as many usages as possible for the item. They were also presented with the following information that created an opportunity for the participant to help the confederate:

> *"By a random draw, all As (i.e., those sitting at the desk A) will be eligible to be entered in a competition to win a prize by generating the most usages of the given item, while all Bs will NOT be eligible. If you are A, please try to generate as many solutions as possible to win the prize. If you are B, you can either proceed with your own task, or help the A sitting next to you generate more solutions to win the prize. If you choose to help, you can terminate your helping at any time and go back to your own task."*

Therefore, the key dependent measure was whether the participant (i.e., always B in this context) helped the confederate (always A) or not.

After this task, participants completed a short survey containing several measures. The first one assessed their situational empathy level. Participants indicated, at this moment in time, the extent to which s/he could project him/herself and understand the target person's feelings in two scenarios (i.e., "Suppose that Amy was diagnosed with cancer" and "Suppose that Bob won a lottery of $2000"). Next, to ensure that the familiarity manipulation was successful, we asked participants to rate how much they feel psychologically close to the other participant, and how much they like the other participant in this session, as per Sedikides et al. (1999). Finally, they completed the same haptic experience manipulation check as detailed in study 1. All items were assessed on 7-point scales (1 = not at all, 7 = very much).

Results

Manipulation checks. As to the haptic manipulation, again the scrub hand wash felt rougher than the moisturizing hand wash (*Ms* = 4.71 vs. 2.81, $F(1,100) = 33.19$, $p < .001$). As to the familiarity manipulation, the two familiarity measures were averaged to create a familiarity index ($\alpha = .79$). Results revealed that the confederate was indeed perceived as more familiar in the familiar than the unfamiliar condition (*Ms* = 5.03 vs. 3.44, $F(1,100) = 58.66$, $p < .001$).

Decision on whether to help or not. Since the dependent variable was binary (i.e., help = 1, not help = 0), we conducted a binary logistic regression where the independent variables were the participant's familiarity towards the confederate, the haptic sensation type, and their interaction term. As predicted, there was a significant interaction between the familiarity and the haptic sensation (Wald $\chi^2 = 5.78$, $p < .05$). Specifically, when the participant was unfamiliar with the confederate, he or she was more likely to help the confederate in the rough condition (61.5%) than in the smooth condition (30.8%, $\chi^2(1) = 4.95$, $p < .05$; Figure 3a). By contrast, when the participant was familiar with the confederate, he or she was equally likely to help the confederate regardless of the haptic condition (80.0% vs. 96.0%, $\chi^2(1) = 3.03$, $p = .082$; Figure 3b).

We further examined the helping duration when help was offered by the participant. A 2 (familiarity: familiar vs. unfamiliar) x 2 (haptic sensation: smooth vs. rough) ANOVA revealed no significant treatment effect (*ps* > .24). This suggested that the haptic sensations may not have an effect on the degree of the helping behaviors.

Insert figure 3ab about here

Mediated moderation analyses. Most importantly, we examined the mediating role of empathy on the interactive effect of haptic sensation and target familiarity on helping likelihood. Following the procedure recommended by Hayes (2012), we used the bootstrapping approach to assess the mediated moderation. The 95% bias-corrected bootstrap confidence interval was obtained using 5000 bootstrap samples. As predicted, the results demonstrated that the 95% confidence interval did not include zero (.5110, 4.7357), indicating a significant mediating effect of empathy on the interactive effect between familiarity and haptic sensation on decision to help.

Discussion

Study 4 provided support to hypothesis 3 by directly assessing individual's situational empathy level. Specifically, for an unfamiliar helping target, empathy inherent in the personal connection was absent. Therefore, empathy elicited from the haptic roughness was driving the effect, resulting in greater helping likelihood. By contrast, for a familiar helping target, empathy inherent from the interpersonal relationship overrode empathy generated from haptic sensations, leading to equally high helping likelihood. Moreover, the results replicated findings in study 3, but using a different helping context and measuring real helping behavior.

STUDY 5: VOLUNTEER IN FURTHER EXPERIMENTS

This study aimed to provide further support for the mediating role of empathy by measuring dispositional empathy. Further, we used another measure of helping behavior, i.e., participants' willingness to assist the experimenter in further studies. This measure is widely used in the literature to assess helping intentions (Greitemeyer and Osswald 2010; Nelson and Norton 2005; Twenge et al. 2007). Familiarity and haptic sensation were manipulated in the same way as in study 4. We predicted a three-way interaction between familiarity, haptic sensation, and dispositional empathy. While we expected the same two-way interaction between familiarity and haptic sensation as observed before among low empathizers, such an interaction was not anticipated among high empathizers.

Method

Seventy-seven undergraduate students participated in the study for course credit. We used a 2 (familiarity: familiar vs. unfamiliar) x 2 (haptic sensation: smooth vs. rough) x empathy between-subject design. Dispositional empathy level was measured as a continuous variable.

Participants came to the lab individually. Upon arrival, the participant was asked to wait for a late participant. Unbeknownst to them, no other participant was expected, but the waiting time was used to conduct the familiarity manipulation. The participant either engaged in a conversation as per RCIT with the experimenter (familiar condition) or waited silently (unfamiliar condition). After 5 minutes, the participant was told that the session would start without further waiting. The haptic manipulation was then implemented with the hand wash task.

After the manipulations were conducted, the participant was asked to take a 3-minute break. At this moment, the experimenter handed over a short questionnaire, which asked the participant to indicate whether s/he was willing to participate in future studies for free in order to help the experimenter to complete her thesis. To avoid peer pressure and demand effect, participants were asked to put the questionnaire aside once they finished. The questionnaire was collected by the experimenter after the participant left the lab.

After the "break", participants completed the Multi-Dimensional Emotional Empathy Scale (Mayer, Caruso, and Salovey 1999), which assessed their dispositional empathy level. Sample items are "I feel like crying when watching a sad movie" and "I feel happy when I see people laughing and enjoying themselves". The MDEE Scale was measured on a 5-point scale (1 = strongly disagree, 5 = strongly agree). Finally, participants completed the haptic experience and the familiarity manipulation checks on 7-point scales (1 = not at all, 7 = very much).

Results

Manipulation checks confirmed the effectiveness of the manipulations. Again, the scrub hand wash felt rougher than the moisturizing hand wash (*M*s = 4.97 vs. 2.66; $F(1,75) = 36.79$, $p < .001$). The experimenter was perceived as more familiar in the familiar than the unfamiliar condition (*Ms* = 5.09 vs. 3.80, $F(1,75) = 26.08$, $p < .001$).

To analyze the dependent measure, we coded the choice of whether to assist further experiments as 1 versus 0, and conducted a binary logistic regression using haptics (smooth = 0, rough = 1), familiarity (familiar = 0, unfamiliar = 1), dispositional empathy (continuous), and all possible interaction terms on this choice measure. As predicted, the results revealed a significant three-way interaction (Wald $\chi^2 = 4.02$, $p < .05$). Next, we used the SPSS macro PROCESS developed by Hayes (2012) to probe the simple interaction at one standard deviation above (i.e., high empathizers) and below (i.e., low empathizers) the mean of dispositional empathy scores. Consistent with our prediction, spotlight analyses (Irwin and McClelland 2001) revealed a significant two-way interaction only for low empathizers (Z = 2.30, $p < .05$). Moreover, the two-way interaction for low empathizers replicated what we observed in previous studies. When participants were unfamiliar with the experimenter, they were more likely to help in the rough (71.51%) than the smooth condition (22.44%, Z = 1.99, $p < .05$; Figure 4a). In contrast, there was no such difference in the willingness to help when participants were familiar with the experimenter (41.97% vs. 75.85%, Z = 1.28, $p = .20$; Figure 4b). However, for high empathizers, there was only a main effect of familiarity (Z = 2.26, $p < .05$). Although high empathetic participants were less likely to help the unfamiliar experimenter (70.90%) versus the familiar experimenter (97.79%), the haptic sensation had no impact on willingness to help (Z = -.32, $p > .7$).

Insert figure 4ab about here

Discussion

This study provided additional support for the mediating role of empathy. As predicted, for individuals who were chronically low in empathy, we replicated the previously observed interaction between haptic sensation and target familiarity. However, such an interaction was absent among chronically high empathizers, suggesting that high dispositional empathy overrode the differential situational empathy elicited by haptic roughness.

STUDY 6: A FIELD EXPERIMENT OF STREET FUNDRAISING

In the final study, we aimed to replicate the above effects in a real-world situation. We adopted the same donation context as used in studies 1 and 3, but conducted a real street fundraising event involving passersby as participants. We partnered with the National Breast Cancer Foundation to solicit donations in the fundraising event. To produce the unfamiliar condition, we created a fictitious foundation named “National Sjögren's Foundation”.

Method

One hundred and thirty three pedestrians in the downtown area of a large North American city participated in the study. We used a 2(charity type: familiar vs. unfamiliar) x 2(haptic sensation: smooth vs. rough) between-subject design.

The experimenter who acted as a street fundraiser approached each participant individually. Upon hearing a brief introduction about the organization from the experimenter, the participant was asked to complete a one-page short survey on a clipboard, which served as the haptic manipulation. Specifically, for the smooth condition, the back side of the clipboard was covered with a piece of projection sheet. In contrast, for the rough condition, the back side of the clipboard was covered with a piece of 60-grit sandpaper.

A pretest with 51 undergraduate students confirmed the effectiveness of the haptic manipulation. They were asked to rate the roughness of the clipboards on a 1 (not at all) to 7 (very much) scale as per two questions (i.e., “When you are holding the clipboard, to what extent do your hands feel rough and coarse?”, “To what extent do your hands feel smooth and sleek?”). The two questions were averaged (with the second one reverse coded) to create a roughness index ($\alpha = .94$). Results indicated that the clipboard with the sandpaper indeed felt rougher (M = 6.27) than the clipboard with the projection sheet (M = 2.13, $F(1,49) = 533.60$, $p < .001$).

In the one-page questionnaire, pedestrians first read a brief introduction of the foundation, and then indicated whether they would donate, and if so, how much. To avoid peer pressure and demand effect, participants were asked to complete the survey while the experimenter was talking to other participants. And they were asked to put the donation in an attached envelope if they offered to donate. At the end of the study, all the solicited donations were sent to the National Breast Cancer Foundation.

Results and Discussion

To analyze the data, we first conducted a binary logistic regression with the dependent variable as whether to donate (0=No, 1=Yes) and the independent variables as charity type, haptic sensations, and their interaction. Consistent with previous results, there was a significant interaction between the charity type and the haptic sensation (Wald $\chi^2 = 4.52$, $p < .05$). For the unknown National Sjögren's Foundation, people who were holding a rough clipboard (25.7%) were more likely to donate than those who were holding a smooth clipboard (3.1%, $\chi^2(1) = 6.72$, $p < .05$; Figure 5a). Yet, for the well-known National Breast Cancer Foundation, people who were holding a rough clipboard (29.4%) were equally likely to donate as those who were holding a smooth clipboard (25.0%, $\chi^2(1) = .16$, $p > .50$; Figure 5b).

Next, we conducted a 2x2 ANOVA on the donation amount for those who actually donated money. There was no treatment effect (*ps* > .14). The results again suggested that haptic experiences could only influence the decision of whether to help. Once such a decision was made, the haptic sensation did not seem to affect the degree of helping, which might be rooted from certain deeper intrinsic characteristics.

Insert figure 5ab about here

GENERAL DISCUSSION

In this research, we examine how the texture of the haptic input, namely, its smoothness versus roughness, affects people's prosocial behaviors in a subsequent yet unrelated helping context. We hypothesize that exposure to the haptic sensation of roughness versus smoothness enhances empathy, which subsequently leads to greater willingness to help. Further, we propose an important boundary condition for the main effect, such that when the potential helper is familiar with the helping target, empathy inherent in the interpersonal connection would override any haptic effect, resulting in comparable level of helping likelihood. We also shed light to the underlying process by demonstrating that the interactive effect of haptic sensation and interpersonal familiarity on willingness to help is mediated by empathy.

Our hypotheses received systematic support from six studies, including laboratory, neuroscience, and field data. Study 1 established the basic main effect by showing that haptic sensation of roughness versus smoothness led to participants' higher willingness to donate towards two fictitious charities. Study 2 used direct measures of brain activity to demonstrate that exposure to haptic roughness may enhance attention and sensitivity to other's misfortune, and this effect appeared to be a later, more deliberate cognitive process. Study 3 provided a boundary condition by showing that such a main effect only existed towards unfamiliar targets. Studies 4 and 5 demonstrated that empathy mediated the interactive effect between haptic sensation and interpersonal familiarity. Finally, study 6 replicated our laboratory results in a real-world fundraising event. Further, our data in studies 4 and 6 suggested that the haptic sensations may only affect people’s decision on whether to help or not, but not the degree of help.

The current research makes two important theoretical contributions. First, it expands our understanding of the constellation of factors influencing people’s willingness to help. Prior research has primarily focused on the social and personality factors that affect a person's likelihood to help. In contrast, we demonstrate that non-social factors, specifically, the haptic sensation of roughness, can also have significant impact on helping behaviors.

Second, this research also advances our knowledge on haptic sensation, one of the least studied sensations in behavioral research (Ackerman, Nocera, and Bargh 2010; Field 2010; Peck and Childers 2008). Existing research in haptics has primarily focused on the issue of the presence versus absence of touch (e.g., Krishna and Morrin 2008; Martin 2012; Peck and Shu 2009; Peck and Wiggins 2006). Thus, little attention has been directed to examine the haptic attributes (e.g., texture; Lederman and Klatzky 1987), while touch is always present. Therefore, this research seeks to fill the gap in the haptic literature by studying the impact of one haptic attribute, namely, haptic texture (i.e., roughness vs. smoothness), on people’s actual behaviors in a subsequent yet unrelated context.

Our findings also raise a number of interesting questions that merit future investigation. First, it is important to examine whether all rough stimuli can induce empathy. In our experiments, we used stimuli with moderate roughness. It is possible that an intensely rough object might evoke a strong discomfort, overriding the empathy effect. Future research can seek to identify the optimal degree of roughness that elicits the maximum level of empathy. Second, having examined the texture of the haptic inputs, future research can investigate other haptic attributes, such as hardness, weight and temperature, and their impact on people's prosocial behaviors and other important cognition and behaviors. Finally, future research can explore how haptic and other senses might interactively affect cognition and behavior.

This research offers important implications for charitable institutions, and particularly those that are less known and struggling with limited donation rates. Our findings suggest that interjecting a little roughness into their outreach materials, for example, could be an innovative and cost-effective approach to increase empathy levels and thus ultimately enhance helping likelihood and donation rates. Our findings suggest that incidental exposure to rough haptic sensations has the capacity to systematically heighten our propensity for prosociality.

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Table 1. Performance data from study 2. The values shown for RTs are in ms.

Measure	Haptic Sensation	Image Type	
		Painful	**Neutral**
% "painful" responses	Smooth	0.916	0.031
	Rough	0.915	0.029
RTs	Smooth	748	747
	Rough	761	753

FIGURE 1. STIMULI AND DATA FROM STUDY 2

(A) Examples of the neutral and painful image conditions. (B) The group-averaged ERP waveforms as a function of condition. The three separate time windows of statistical analysis are indicated by the vertical dashed lines. (C) Mean amplitudes and standard errors of the ERP responses across conditions and time windows shown in (B). N = neutral image, P = painful image, * = *t* value of $p < 0.01$, ns = non-significant *t* value.

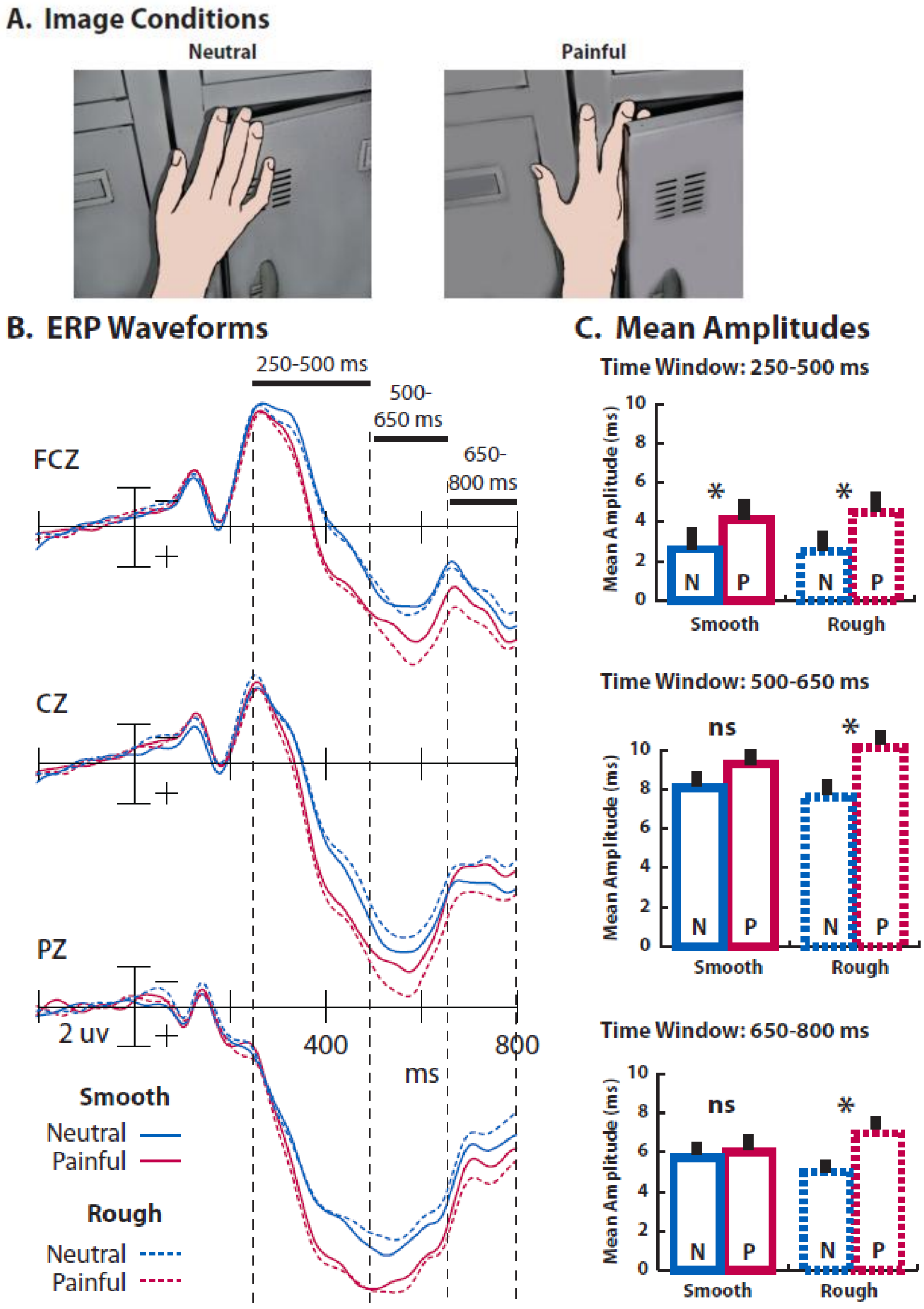
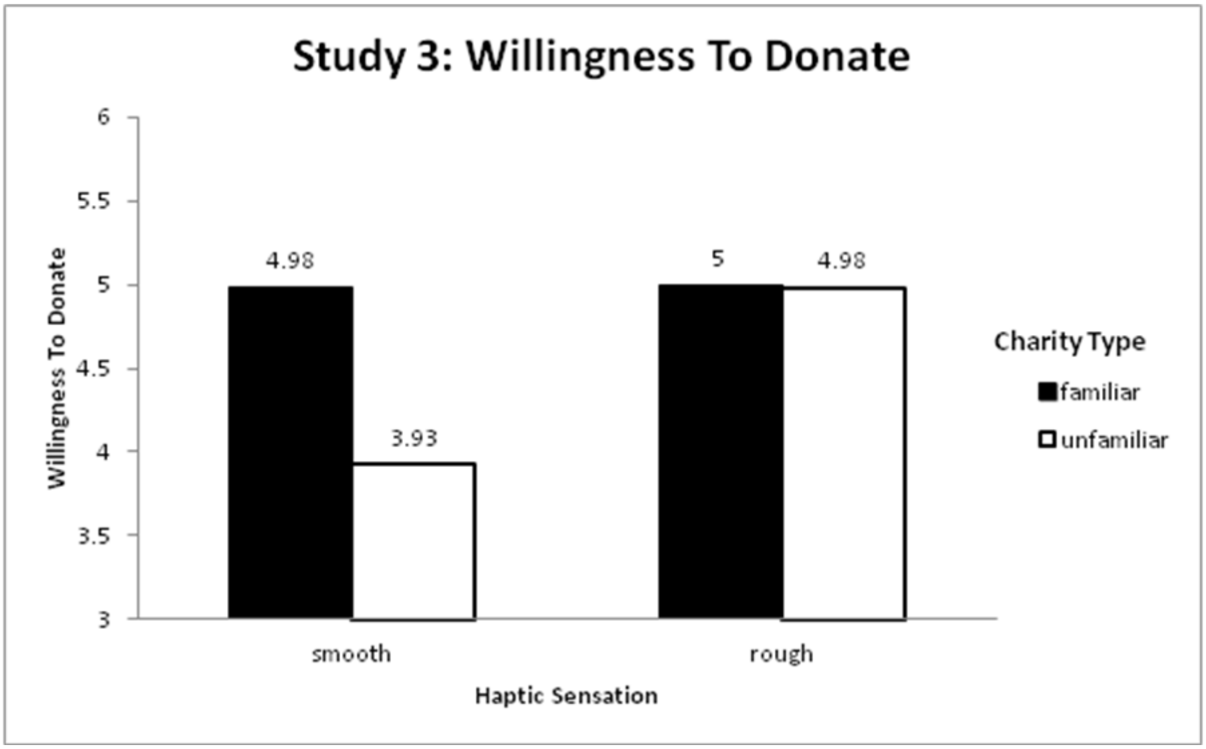
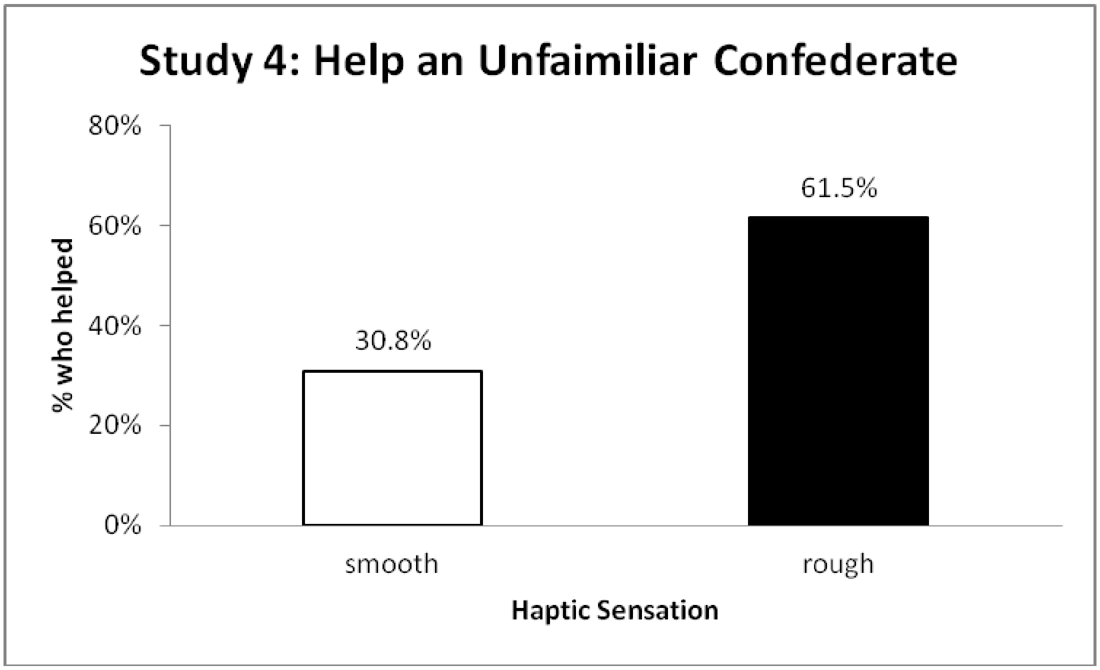


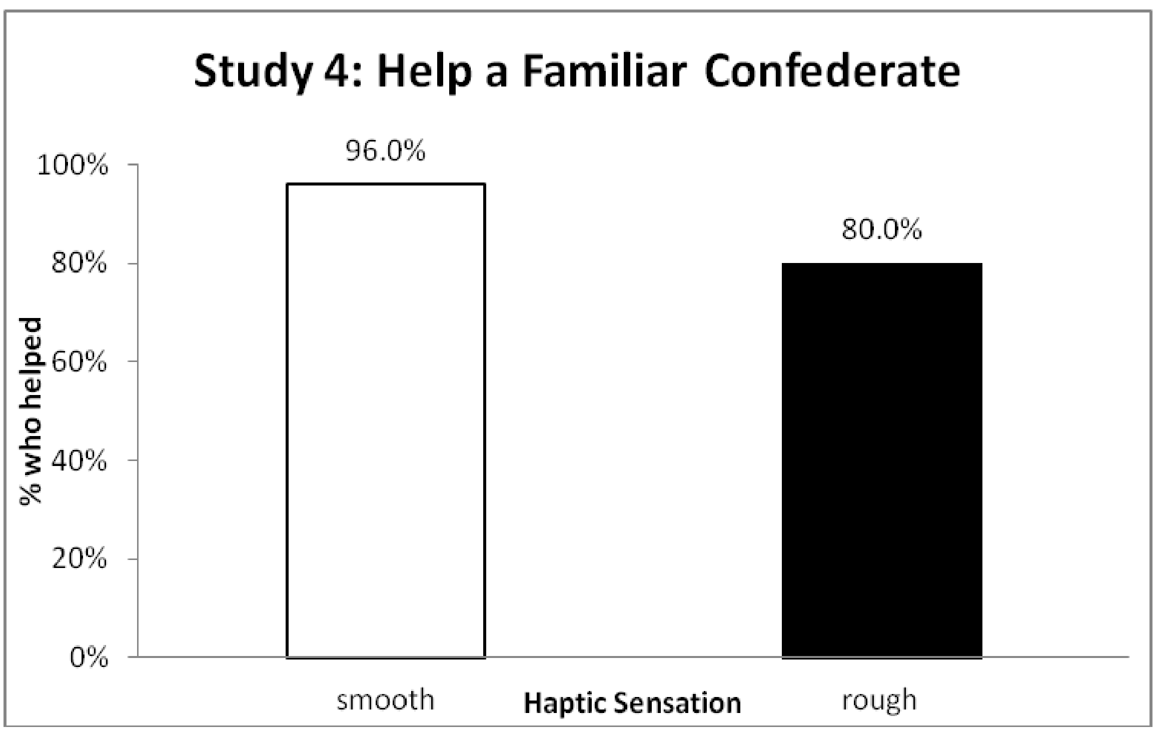
FIGURE 2: INTERACTION BETWEEN FAMILIARITY AND HAPTIC SENSATION ON WILLINGNESS TO DONATE (STUDY 3)



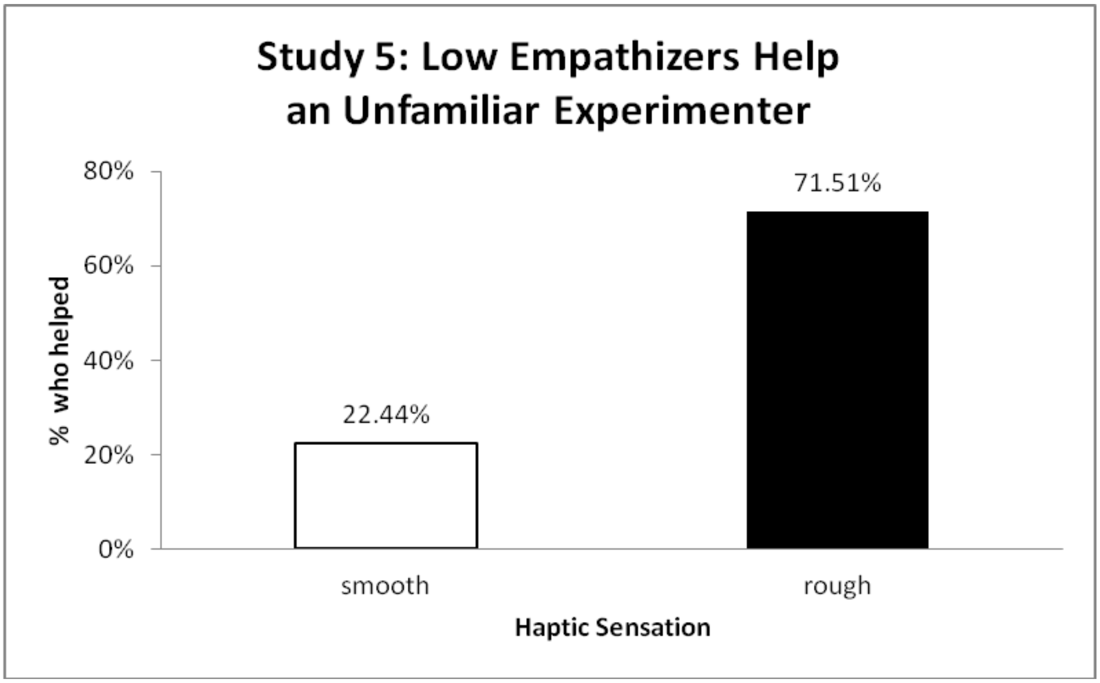
FIGURES 3A: HELP AN UNFAMILIAR CONFEDERATE (STUDY 4)



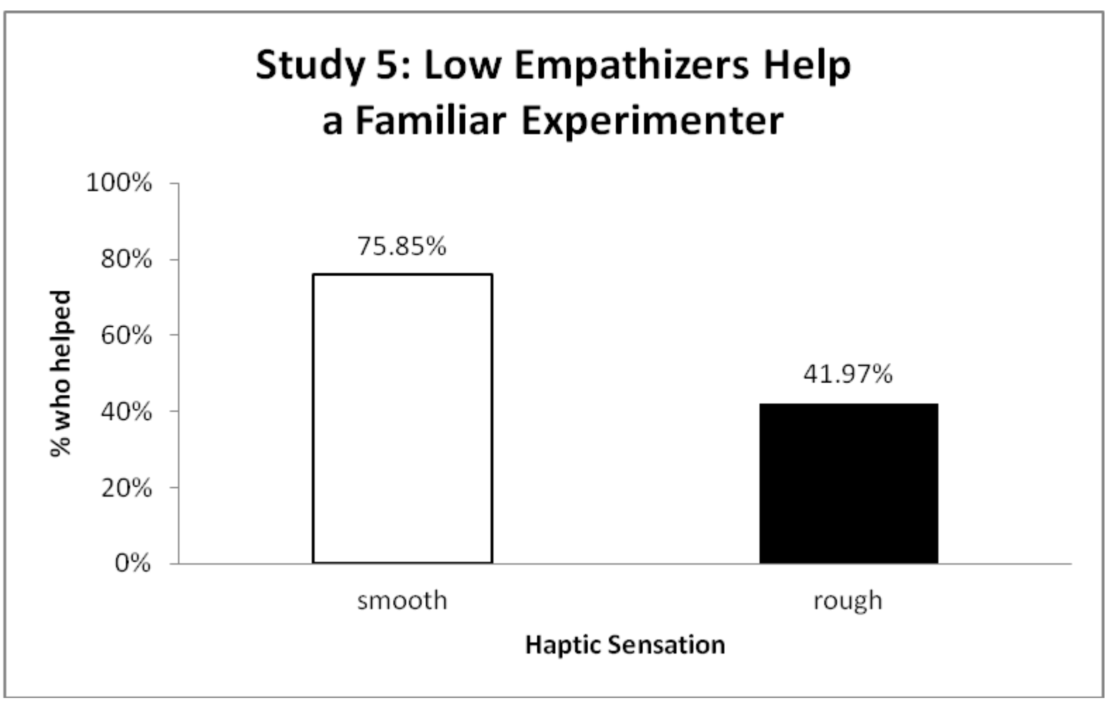
FIGURES 3B: HELP A FAMILIAR CONFEDERATE (STUDY 4)



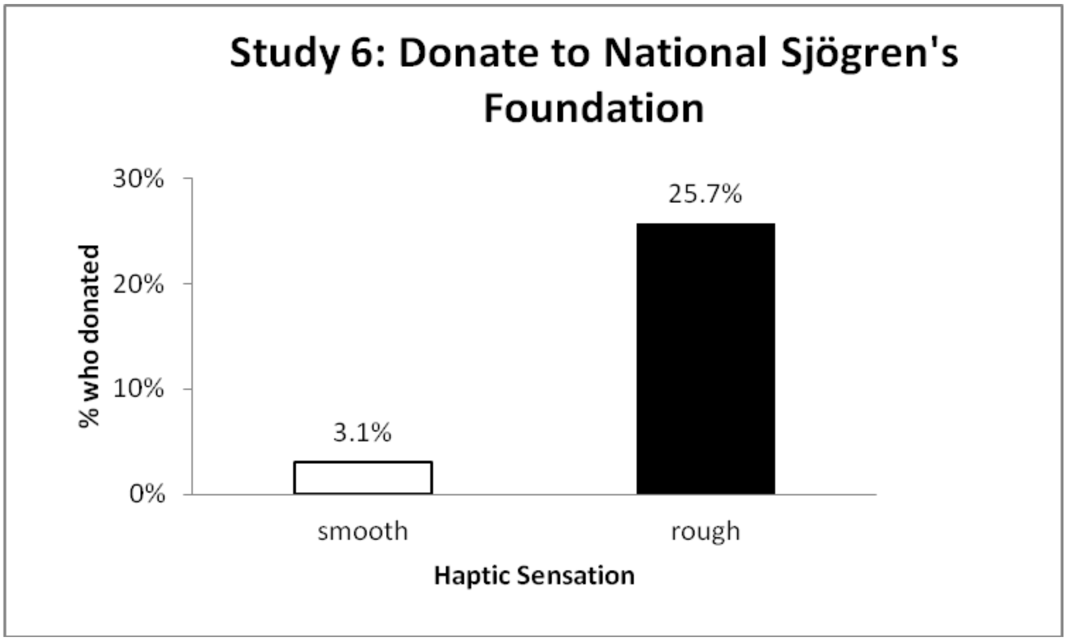
FIGURES 4A. LOW EMPATHIZERS HELP AN UNFAMILIAR EXPERIMENTER (STUDY 5)



FIGURES 4B. LOW EMPATHIZERS HELP A FAMILIAR EXPERIMENTER (STUDY 5)



FIGURES 5A. DONATE TO NATIONAL SJÖGREN'S FOUNDATION (STUDY 6)



FIGURES 5B. DONATE TO NATIONAL BREAST CANCER FOUNDATION (STUDY 6)