Vicarious experiences and detection accuracy while observing pain and touch: the effect of perspective taking

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Abstract

Objective: This study investigated the effects of observing pain and touch in others upon vicarious somatosensory experiences and the detection of subtle somatosensory stimuli. Furthermore, the effect of taking a first versus third-person perspective was investigated.

Methods: Undergraduates (N=57) viewed videos depicting hands being pricked (pain), hands being touched by a cotton swab (touch), and control scenes (same approaching movement as in the other video categories but without the painful/touching object), while experiencing vibrotactile stimuli themselves on the left, right or both hands. Participants reported the location at which they felt a somatosensory stimulus. Vibrotactile stimuli and visual scenes were applied in a spatially congruent or incongruent way. There were also trials without vibrotactile stimuli. The videos were depicted in first-person perspective and third-person perspective (videos upside down). We calculated the proportion of correct responses and false alarms (i.e., number of trials in which a vicarious somatosensory experience was reported congruent to the site of the visual information).

Results: Pain-related scenes facilitated the detection of tactile stimuli and augmented the number of vicarious somatosensory experiences compared with observing touch or control videos. Detection accuracy was higher for videos depicted in first-person perspective compared with third-person perspective. Perspective had no effect upon the number of vicarious somatosensory experiences.

Conclusion: This study indicates that somatosensory detection is particularly enhanced during the observation of pain-related scenes compared to the observation of touch or control videos. These research findings further demonstrate that perspective taking impacts somatosensory detection, but not the report of vicarious experiences.

Introduction

Our senses do not operate independently (Spence & Driver, 2004). For example, tactile perception is facilitated when viewing the body. Such findings suggest a strong link between vision and somatosensation (Kennett, Taylor-Clarke, & Haggard, 2001). Also, observing somatosensory stimuli being applied to another person influences the detection of tactile stimuli in the observer (Cardini, Haggard, & Lavadas, 2013; Gillmeister, 2014; Vandenbroucke et al., 2014a, 2014b). In line with this finding, brain processing studies have shown that somatosensory activity is enhanced when observing bodily sensations in others (Blakemore et al. 2005; Ebisch et al. 2008; Keysers, Kaas, & Gazola, 2010; Schaefer et al., 2005, 2012). An extreme variant of the modulation of somatosensory detection by observing touch or pain, is the actual experience of such sensations although no stimulus is presented ('vicarious somatosensory experiences'). Vicarious somatosensory experiences are intriguing as they indicate that tactile or nociceptive input may not be necessary to experience touch or pain (Fitzgibbon et al., 2010b).

Little systematic research is available on the occurrence of vicarious somatosensory experiences and the factors affecting this phenomenon (Fitzgibbon et al., 2010b, 2012; Osborn & Derbyshire, 2010; Vandenbroucke et al., 2013, 2014a). Vandenbroucke et al. (2013, 2014b) showed that individuals reporting vicarious pain in daily life ('pain responders') reported more vicarious somatosensory experiences during an experimental paradigm, but the frequency was very low. Using the same paradigm, Vandenbroucke et al. (2014a) showed that the presence of chronic pain did not affect the frequency of somatosensory experiences. Derbyshire, Osborn & Brown (2013) investigated the influence of prior pain experience and bodily ownership upon the experience of vicarious sensations. They showed that the tendency to report vicarious experiences was enhanced when the type of observed pain (e.g., toothache) had been commonly experienced by the observer him/herself. Interestingly, previous studies also demonstrated that the observation of pain facilitates the detection of tactile stimuli (Vandenbroucke et al., 2014a, 2014b).

It is yet unclear whether the modulatory effects of observing pain upon somatosensation are specific (or different) for pain, or may equally be present when observing touch. Some studies did not investigate the experience in terms of behavioral somatosensory detection in response to the observation of painful stimuli but rather looked at the somatosensory brain activity. Bufalari et al. (2007) showed a reduction of somatosensory activity with respect to baseline when observing non-painful tactile stimuli in comparison with an increase when observing painful stimuli. Cheng et al. (2008) reported that both observing painful and non-painful situations were associated with enhanced activation of somatosensory cortex as compared with baseline. Martínez-Jauand et al. (2012) showed that the observation of both pain and touch video clips led to an enhancement of P50 amplitudes as compared to viewing a hand without stimulation. Of particular relevance is the study of Valentini et al. (2012). These authors showed that viewing pain in another specifically modulates the neural activity in the onlookers' sensorimotor cortex, and that this modulation occurs only in the neural activity elicited by stimuli belonging to the nociceptive, rather than to another sensory modality. There is evidence that observing touch improves tactile discrimination (Kennett et al., 2001) and that observing pain enhances detection accuracy (Vandenbroucke et al., 2014a, 2014b). However, there is yet no research investigating whether there is a difference between observing touch versus pain in another. Some behavioral studies did focus upon the somatosensory modulation, but no study directly compared the effect between observing pain and touch. Some studies compared the effects between human parts being touched versus the observation of the same parts merely being approached (Cardini et al., 2011; Serino et al., 2008), between observing touch and experiencing touch (Blakemore et al., 2005; Keysers et al., 2004), between observing touch to a person versus touch to an object (Blakemore et al., 2005; Cardini et al., 2011; Serino et al., 2008), between experiencing touch versus observing an object being touched (Keysers et al., 2004) and between observing pain versus an object being pricked or approached (Vandenbroucke et al., 2014a, 2014b). The first aim of the present study was therefore to investigate whether the effects upon vicarious experiences or the detection of somatosensory stimuli differ between the observation of touch versus pain in another.

A variable that may play a role in the production of vicarious experiences is perspective taking (Fitzgibbon et al., 2010b), i.e., whether one considers the observed pain or touch from first-person versus third-person (another's) perspective. It has been proposed that vicarious somatosensory experiences may be enhanced when a self-perspective is adopted (Fitzgibbon et al., 2010b). No study has investigated this idea. However, studies indicate that the installation of a first-person perspective, either by means of an experimental paradigm or by means of instructions or visual appearance facilitates/affects the detection of somatosensory stimuli (Loggia, Mogil, & Bushnell, 2008; Serino, Giovagnoli, & Lavadas, 2009; Serino et al., 2008). In the study of Loggia et al. (2008), similarity was manipulated by showing participants video interviews with an actor in which empathy for the actor was manipulated. At the end, participants saw the actor being exposed to similar stimuli as themselves. Those in the high-similarity group rated the painful stimuli as more intense. Saxe, Jamal, and Powell (2006) showed that viewing body parts in first-person perspective produced greater activation of the somatosensory cortex than viewing the same parts in third-person perspective. Jackson, Meltzoff, and Decety (2006) found a similar result for both imitating and viewing actions. Activations occurred in a wide area of the sensorimotor cortex and were greater for first-person perspective than for third-person perspective. At present, it is yet unclear whether taking a self-perspective (versus other-perspective) facilitates the experience of vicarious sensations. A second aim of the present study was to investigate the role of perspective taking upon vicarious somatosensory experiences and the detection accuracy of subtle vibrotactile stimuli.

In a variant of the crossmodal congruency task, participants were presented three categories of videos depicting pain-related situations (left and right hand in which one hand is being pricked), touch (left and right hand in which one is touched by cotton swab) and control situations (e.g. same motor movement of the approaching hand as in first and second category but without the painful/touching object). Participants received vibrotactile stimuli on the hand in the same spatial location (congruent trials) or in the opposite location (incongruent trials) as the visual stimuli, or on both hands. Participants were instructed to report as quickly as possible the spatial location of the administered somatosensory stimuli. Also trials in which no vibrotactile stimulation occurred were included as well as trials in which both hands of participants were stimulated. To investigate the effect of perspective taking, videos were presented in a first-person and a third-person perspective (videos presented upside down). False alarms (erroneously reporting a somatosensory stimulus in the same spatial location as the visual cue) in response to videos showing pain or touch were labeled ‘vicarious somatosensory experiences’.

First, we hypothesized that participants would report more vicarious experiences (false alarms) in response to the observation of pain compared with touch or control videos. Second, we expected that the observation of pain-related visual scenes would result in a better detection accuracy of vibrotactile stimuli compared with touch and control videos. We furthermore expected a crossmodal congruency effect (CCE) in which more vibrotactile acuity is observed when the visual and vibrotactile stimuli are congruent (i.e. presented in the same spatial location). We hypothesized this CCE effect to be dependent upon the type of visual information (pain-related versus touch versus control). More specifically, we expected a higher CCE when pain-related videos were shown as compared to non-pain related videos (touch and control). Third, we expected that pain-related videos presented in first-person perspective would facilitate detection accuracy and increase the report of vicarious experiences compared with pain-related videos presented in third-person perspective. In addition, we also explored the presence of neglect errors (i.e. only reporting the site congruent to the visual information when both hands are stimulated) during the observation of each category of video and perspective. As in previous studies (Vandenbroucke et al, 2013, 2014a,b), we investigated the putative role of some individual difference variables upon vicarious experiences. In the model of Fitzgibbon et al. (2010b), it is suggested that individual differences in empathy and hypervigilance to pain would lead to more vicarious experiences. For that reason, we assessed both variables through self-report questionnaires and explored their role in vicarious experiences and the detection of vibrotactile stimuli.

Method

Participants

Undergraduate psychology students (n=57) were recruited by means of an online system where they could subscribe for experiments. They were paid 10 euro for participation. Seventy-five percent were female. Seventy-nine percent of the participants were right-handed as reported by self-report. All were Caucasian. Average age of participants was 23.68 years (SD=4.62). Participants rated their general health on average as ‘Very good’. Sixty-three percent of the participants reported to have experienced pain during the last six months (average of 27.6 days in 6 months). Fourteen participants reported pain at present (score>0 on a Likert scale where 0 indicated ‘no pain’ and 10 ‘worst pain ever’; assessment before the experiment), but the average intensity was low (M=2.64, SD=1.78). All participants gave informed consent and were informed to be free to terminate the experiment at any time. None made use of this possibility. Ethical approval was obtained from the Ethics committee of the Faculty of Psychology and Educational Sciences.

Self report measures

Vigilance to pain was assessed by the Dutch version of the Pain Vigilance and Awareness Questionnaire (PVAQ; McCracken, 1997, Roelofs et al., 2002). This questionnaire consists of 16 items assessing awareness, consciousness and vigilance to pain on a six-point scale (0= never; 5= always). Higher scores on the PVAQ are indicative of greater pain-related vigilance and awareness. The questionnaire can be used in both clinical (McCracken, 1997; Roelofs, Peters, McCracken, & Vlaeyen, 2003) and non-clinical (McWilliams & Asmundson, 2001; Roelofs et al., 2002) samples. The Dutch version of the PVAQ is reliable and valid (Roelofs et al., 2002; 2003). Cronbach’s alpha in the present study was 0.91.

Empathic disposition was assessed by means of the Dutch version of the Interpersonal Reactivity Index (IRI; Davis, 1983; De Corte et al., 2007). The questionnaire contains 28 items and consists of 4 subscales: Perspective Taking (i.e., cognitively taking the perspective of another, e.g., “I sometimes try to understand my friends better by imagining how things look from their perspective.”), Fantasy (i.e., emotional identification with characters in books, movies etc., e.g., “When I watch a good movie, I can very easily put myself in the place of a leading character.”), Empathic Concern (i.e., feeling emotional concern for others, e.g., “I am often quite touched by things that I see happen.”) and Personal Distress (i.e., negative feelings in response to the distress of others, e.g., “When I see someone who badly needs help in an emergency, I go to pieces.”). Each item is answered on a scale ranging from 1 (‘does not describe me very well’) to 5 (‘describes me very well’). This questionnaire has shown to be reliable and valid (Davis et al., 1893; De Corte et al., 2007). Cronbach’s alpha’s in the current study were 0.78 (fantasy scale), 0.80 (personal distress), 0.64 (perspective taking) and 0.60 (empathic concern). Perspective taking and empathic concern were omitted from the analyses because of the low reliability score.

Vicarious pain experiences during daily life were measured by means of four items adapted from Banissy et al. (2009). Participants were asked to indicate on an eleven point scale (0-10; totally disagree - totally agree) the extent to which they agreed with the questions: “Do you feel pain in your own body when you see someone accidently bump against the corner of the table?”, “Do you have the feeling experiencing pain when you observe another person in pain?”, “Do you feel bodily pain when you observe another person in pain?”, “Do you feel a physical sensation (e.g. tingling, stabbing) when you observe another person in pain”. We have used this adapted instrument in previous studies (Vandenbroucke et al., 2013, 2014a). In the present study Cronbach’s alpha was 0.87.

Procedure

Behavioral paradigm

Preparation phase. First, for each participant, the threshold intensity level for the vibrotactile stimuli was individually determined prior to the experiment. Vibrotactile stimuli (50 Hz, 50 ms) were delivered by two resonant-type tactors (C-2 tactor, Engineering Acoustics, Inc.) consisting of a housing that was 3.05 cm in diameter and 0.79 cm high, with a skin contactor that was 0.76 cm in diameter. The vibrotactile stimuli were delivered on the skin between thumb and index finger. All stimulus characteristics (amplitude, duration and frequency) were entered through a self-developed software program that was used to control the tactors. Four different series of 20 stimuli/trials (two series for each hand) were randomly administered (80 stimuli/trials in total). First, a visual stimulus “X” was presented combined with a somatosensory stimulus on the left or right hand. Participants were instructed to report whether they felt a somatosensory stimulus (“yes” or “no”), which was coded by the experimenter by pressing the corresponding response button (see Vandenbroucke et al., 2014a, 2014b). Each series started at 0.068 Watt and this intensity decreased with 0.0002 W within each series when participants reported feeling a stimulus and increased with 0.0002 W when no sensation was reported. After 80 trials, this resulted in a threshold intensity for each hand which was based upon the mean intensity of the last stimuli (20th) of two series for that particular hand. From this threshold intensity (threshold left hand: M= 0.033W, SD= 0.008W, range: 0.002W-0.174W; threshold right hand: M=0.038W, SD=0.006W, range: 0.003W-0.163W), 1/8 was added to the threshold (above threshold), resulting in four different intensities (threshold and above threshold, one for each hand). Several intensities were implied in order not to habituate to the intensity as well as to enhance the chance to make vicarious errors.

Second, participants were informed that during the experiment they would feel subtle stimuli, varying in intensity and length, on their left, right or both hands. Participants were instructed that different videos would be presented which they needed to watch attentively and that when a somatosensory stimulus was administered on both hands, the intensity could vary across hands and that also trials without any stimulus would be included. In reality, only two fixed predetermined intensities with a fixed duration were applied (threshold intensity and threshold intensity + 1/8).

Experiment phase. Visual stimuli consisted of three categories of videos (pain, control and touch) with a duration of 3000ms. The first, ’pain category’ included a scene depicting a left and right hand, with one of the two hands being pricked by a syringe (2000ms after video onset). The second category depicted a touch scene. A left and right hand were presented in which one of these hands was touched by a cotton swab (2000ms after video onset). The third ‘control category’ included a scene depicting a left and right hand in which one hand was approached by a hand without holding an object (same movement of the approaching hand as in the first and second category of videos). Videos were presented by INQUISIT Millisecond software (Inquisit, 2002) on a Dell screen with a 19-inch CRT-monitor. The computer screen was placed in front of the participants in a degree of approximately 22°. Participants' hands were placed underneath the screen. The left hand was placed at the left and the right to the right under the screen to make the perspective taking manipulation more salient.

-Insert Figure 1 about here-

Each trial began with a fixation cross (1000 ms duration) presented in the middle of the computer screen. Next, one of the videos was presented. In 75% of the trials, a vibrotactile stimulus was delivered 2450 ms after video onset either on the left hand, the right hand, or on both hands of the participant. In line with Banissy & Ward (2007), the somatosensory stimulus was administered with a delay of 450ms after the visual stimulus of penetration of the needle, or the touch of the cotton swab (see Vandenbroucke et al., 2014a, 2014b). For the control videos, the somatosensory stimulus was administered with a delay of 450ms after the approaching hand was closest to the resting hand (same time frame as in the other video categories). This resulted in the following trial types: congruent trials, incongruent trials, and trials in which no somatosensory stimuli were administered, or both hands of the participant received somatosensory stimuli. In congruent trials, somatosensory stimuli and visual stimuli were presented at the same spatial location (e.g., right). In incongruent trials, somatosensory stimuli and visual stimuli were presented in the opposite spatial location (e.g., left and right). The experiment started with 8 practice trials. The actual experiment phase consisted of five blocks of 96 trials, resulting in a total of 480 trials. There were 120 congruent trials, 120 incongruent trials, 120 trials without sensory stimuli and 120 trials with somatosensory stimuli at both hands. These three categories of videos were in an equal number presented in first-person perspective (240 trials; i.e. presented in same orientation as the hands of the participant) and third-person perspective (240 trials; i.e., the same videos turned upside down) (see Figure 1). The different categories, location of visual cue (touch, pain, control), congruency (congruent, incongruent, both hands stimulated, and both hand not stimulated) and perspective (first- versus third-person) were counterbalanced across videos. Order of trial types was randomized within each block. The somatosensory stimuli were equally distributed within and over each block, type of intensity (threshold and above threshold) and type of perspective (first versus third perspective).

An overview of all trial types is presented in Table 1. During each trial, participants were requested to report whether a somatosensory experience was felt by reporting as quickly as possible ‘YES’ and to discriminate the spatial location of the somatosensory stimuli by reporting “left”, “right” or “both” (see Figure 2). After the video had ended and 2000 ms had been elapsed, the Dutch word for ‘next’ was presented on the screen. Then, the experimenter coded the response by pressing the corresponding response button (left, right, both or no response) (see Figure 1). This way, the time to respond was equal for every participant. The experiment took approximately 1 hour.

Post-experiment phase. After the experiment, participants were requested to fill out self-report scales measuring hypervigilance for pain (PVAQ), empathic disposition (IRI) and the items measuring vicarious pain experiences during daily life, which took approximately 15 minutes.

-Insert Table 1 about here-

-Insert Figure 2 about here-

Statistical analysis

False alarms

The number of false alarms was calculated from the incongruent trials and from the trials without any somatosensory stimuli when erroneously a somatosensory stimulus was reported in the same spatial location as the visual cue (i.e. site of the touch/prick or approaching movement). These false alarms were labeled ‘vicarious somatosensory experiences’ when the visual stimulus contained pain or touch. To test whether category of video predicted the number of false alarms, generalized linear mixed models for count data were applied. The use of linear models is considered less appropriate (Vives et al., 2006) when the frequency of responses has a skewed distribution that violates the normality assumption. Poisson regression is the basic model to analyze count data, but the variance of counts is often larger than the mean (overdispersion). The Negative Binomial (NB) regression, a Poisson regression with an overdispersion, may therefore better fit the data (e.g., Gardner et al., 1995). As count data may additionally exhibit a lot of zero counts, zero-inflated extensions of both models, called Zero-Inflated Poisson (ZIP) and Zero-Inflated NB (ZINB) models have been developed (see Karazsia et al., 2010, Loeys et al., 2012). Deviance tests and the Vuong test were used to select the best fitting count distribution for the dependent variable. After the best fitting count model was chosen, a first model with ‘video category’ as predictor was added. In a further exploration of the data, hypervigilance for pain, and dispositional empathy and their interaction with video category were added in separate models to test whether they had a moderating role. Dummy coding was used for the categorical variables. Regression coefficients are exponentiated (eB) and called Rate Ratios (RRs). In percentages—100 x (eB - 1)—RRs reflect the percentage decrease (RR<1) or increase (RR>1) in the expected frequency of false alarms for each 1-unit increase in the continuous predictor. In a second series of analyses, the above mentioned analyses were repeated with ‘perspective’ (first-person versus third-person) as predictor. In a third model both video category and perspective were added as predictors. R (version 2.15.1) was used to fit the count models.

Detection accuracy

To investigate whether type of video category and type of perspective taking modulated the detection of vibrotactile stimuli, the proportion of correct responses (left versus right) for congruent and incongruent trials for each category of visual information was calculated (pain-related, touch and control). A 3 (video category: pain-related, touch versus control) x 2 (congruency: congruent versus incongruent) x 2 (perspective: first-person versus third-person) repeated measures ANOVA was performed, with congruency, video category and perspective entered as within-participant variables. In a further exploration, hypervigilance for pain and dispositional empathy were added as a covariate in separate models to test whether they had a moderating role. Repeated measure ANOVAs were conducted with an alpha < 0.05, using SPSS statistical software, version 21.0 for Windows.

Neglect errors

The number of neglect errors was calculated based upon those trials in which both hands were stimulated, defined as reporting only the site congruent to the visual information (i.e. site of the touch/prick or approaching movement) and missing the actual vibrotactile stimuli on both hands. Generalized linear mixed models for count data were applied again to test whether the number of neglect errors was dependent upon the type of video and perspective. After the best fitting count model was chosen, a first model with ‘type of video’ as predictor was added. In a further exploration, hypervigilance for pain and dispositional empathy and their interaction with type of video were added in separate models to test whether they had a moderating role. In a second series of analyses, ‘perspective’ (first-person versus third-person) was added as predictor. In a third model both video category and perspective were added as predictors. R (version 2.15.1) was used to fit the count models.

Results

Descriptives

Mean scores, standard deviations and correlations are presented in Table 2. Spearman correlations were computed for the non-normally distributed variables (Kolmogorov-Smirnoff, p<.05). Without taking type of video in account, false alarms were made in 2.94% of the incongruent trials and trials without vibrotactile stimuli (402 false alarms from a total of 13680 trials). Vicarious somatosensory errors in response to the observation of pain-related scenes were made in 4.10% of the incongruent trials and trials without vibrotactile stimuli (187 vicarious somatosensory errors from a total of 4560 trials). Of these vicarious somatosensory errors, 48.66% occurred when the pain-related video was in first-person perspective (91 from a total of 187 vicarious somatosensory errors). Vicarious somatosensory errors in response to the observation of touch scenes were made in 2.41% of the incongruent trials and trials without vibrotactile stimuli (110 vicarious somatosensory errors from a total of 4560 trials). Of these vicarious somatosensory errors, 49.09% occurred when the touch video was in first-person perspective (54 from a total of 110 vicarious somatosensory errors). In 20.63% of the trials in which both hands were stimulated, neglect errors were made (1411 neglect errors from a total of 6840 trials). Neglect errors were made in 22.63% of all trials with pain-related videos (516 neglect errors from a total of 2280 trials). Of these neglect errors, 255 (49.42%) occurred when the pain-related video was shown in first-person perspective.

-Insert table 2 about here-

False alarms and vicarious experiences

The NB model was found to be the best fitting count model. In a first step, video category was added as a predictor. Results showed that the number of false alarms was dependent upon type of video presented. The observation of pain-related videos resulted in 81% increase in false alarms compared with control videos (RR=1.81) (p<.001). The observation of pain-related videos resulted in 70% increase in false alarms or vicarious experiences compared with touch videos (RR=1.81) (p<.001). No significant difference was found between touch videos and control videos regarding the number of false alarms made (p=.70). In order to explore the role of individual differences in PVAQ and the IRI, several additional models were run with PVAQ or IRI as additional predictor to explore its modulating role. No interactions were found between type of video and PVAQ (all p>.18), personal distress (all p>.28) and fantasy scale (all >.41).

In a separate model, perspective was added as a predictor. Results showed that the number of false alarms was independent of type of perspective (p=.89). In a third model both type of video and type of perspective were added as predictors. No interaction occurred between video category and perspective (all p>.64).

Detection accuracy

A 2 (congruency: congruent versus incongruent) x 2 (type of perspective: first-person versus third-person) x 3 (type of video: pain versus touch versus control) repeated measures ANOVA showed a main effect for type of video (*F*(2,112)=41.49, *p*<.001). Overall, pain-related videos resulted in a better detection of vibrotactile stimuli compared with control videos (*t*(56)=7.99,*p*<.0001, Cohen’s d=0.68, [95% CI:0.49, 0.86]) and touch videos (*t*(56)=4.29,*p*<.0001, Cohen’s d=0.27, [95% CI:0.15, 0.39]). Detection accuracy while observing touch videos was significantly higher compared with observing control videos (*t*(56)=-5.48,*p*<.0001, Cohen’s d=0.37, [95% CI:0.23, 0.51]). Also a main effect for congruency occurred (F(1,56)=64.23,*p*<.0001, Cohen’s d=0.43, [95% CI:0.32-0.54]), indicating a higher detection accuracy in congruent compared to incongruent trials.

An interaction was found between congruency and type of video: the CCE was dependent on the type of video presented (*F*(2,112)=7.42,*p*=.001). A paired sample t-test showed the CCE was present for each type of video (pain video (*t*(56)=-6.66,*p*<.0001, Cohen's d=-0.63, [95% CI:-0.84, -0.43]); control video (*t*(56)=-3.11,*p*=.003, Cohen's d=-0.23, [95% CI:-0.38, -0.08]); touch video (*t*(56)=-4.48,*p*<.0001, Cohen's d=-0.32, [95% CI:-0.47, -0.18]). The congruency effect was, however, significantly larger for pain videos compared with control videos (*t*(56)=3.56,*p*=.001, Cohen's d=0.65, [95% CI:0.26, 1.05]) and touch videos (*t*(56)=2.66,*p*=.01, Cohen's d=0.46, [95% CI:0.10, 0.82]). The congruency effect was not significantly different for touch videos and control videos (*t*(56)=-1.10,*p*=.28, Cohen's d=-0.21, [95% CI:-0.58, 0.16]) (see Figure 3). Also a main effect of perspective was found (*F*(1,56)=24.59,*p*<.0001, Cohen's d=-0.20, [95% CI:-0.28, -0.12]), indicating that observing videos in first-person perspective resulted in better detection compared with videos shown in third-person perspective. No interaction was found between type of perspective and type of video category (*F*(2,112)=1.75,*p*=.18), between type of perspective and congruency (*F*(1,56)=2.60,*p*=.11) and between type of perspective, type of video category and congruency (*F*(2,112)=.55,*p*=.58). Centered PVAQ and IRI subscales were entered separately as covariates. No main effects were found for PVAQ, *F*(1,55)=.20,*p*=.66, fantasy scale, *F*(1,55)=.85,*p*=.36, and personal distress, *F*(1,55)=.00,*p*=.99.

-Insert Figure 3 about here-

Neglect errors

The NB model was found to be the best fitting count model. In a first step, type of video was added as a predictor. Results showed that the number of neglect errors during the observation of pain-related stimuli was dependent upon video category. The observation of pain-related videos resulted in a 19% increase in neglect errors compared with control videos (RR=1.19; p=.008). No difference was found between control and touch videos (p=.37) and between pain and touch (p=.08). In order to explore the role of individual differences in PVAQ and the IRI, several additional models were run with PVAQ or IRI as an additional predictor and in interaction with group to explore its modulating role. No interactions were found between video category and PVAQ (all p>.26) and FS (all p>.30). The effect of personal distress upon the number of neglect errors was significantly different for touch and pain-related videos (p=.01). The number of neglect errors decreased for every 1-unit increase in personal distress by 1% (RR=.99) when touch videos were presented, and increased with 2% when pain-related videos were presented (RR=1.02). Second, in a separate model, type of perspective was added as a predictor. Results showed that the number of neglect errors was independent of type of perspective (p=.51). In a third model, both type of video and perspective were added as predictors. No interaction occurred between video category and perspective (all p>.24).

Discussion

This study had two objectives. First, we investigated whether the observation of touch and pain differentially facilitated the report of vicarious experiences and the detection of subtle somatosensory stimuli during an experimental paradigm. Second, we tested whether perspective taking (first-person versus third-person) influenced these outcomes. We also explored the effects of some potential moderators as proposed by Fitzgibbon et al. (2010b, 2012), i.e., dispositional empathy and hypervigilance to pain. Participants were presented three categories of videos, showing pain-related scenes (left and right hand in which one hand is being pricked), touch scenes (left and right hand in which one is touched by cotton swab) and control situations (e.g. same approaching movement of the hand as in the other categories, but without holding any object). Videos were presented in first-person (self) perspective and third-person (other) perspective in which videos were turned upside down. Participants occasionally received vibrotactile stimuli themselves in the same spatial location (congruent trials) or in the opposite location (incongruent trials) as the visual cue (touch/prick or approaching movement). Participants were instructed to report as rapidly as possible the spatial location of the administered somatosensory stimuli.

The results can be readily summarized. First, observing pain in another increased the number of vicarious experiences and improved the accuracy of detecting somatosensory stimuli. Second, we did not observe an increase of vicarious experiences when pain or touch was observed in first-person perspective, compared with third-person perspective. Nevertheless, observing pain and touch in first-person perspective improved the detection accuracy of somatosensory stimuli. Third, no moderating role was found for observer's characteristics, such as hypervigilance and dispositional empathy. Our results corroborate previous findings as it shows that vicarious experiences are not frequently reported but can be measured by means of an experimental paradigm (Vandenbroucke et al., 2013, 2014a,b). Of particular relevance to this study was whether the effects are specific for pain.

Our primary finding that participants reported more vicarious somatosensory experiences when pain-related videos were shown compared with control and touch videos indicates that vicarious experiences while observing pain are not simply due to the observation of a hand being approached or touched. It shows that vicarious experiences become more frequent when observing pain-related situations, in comparison with touch situations. No difference was obtained regarding the number of vicarious somatosensory experiences while observing touch compared with control videos. Mirams et al. (2010) found that merely viewing a hand increases the number of false alarms as compared to not viewing a hand. In our study, false alarms may have been also facilitated in the control condition as there was no condition in which no hand was seen. Also in our control videos, human features such as a hand were still present.

Detection accuracy was also affected by the type of video presented. Participants were better in detecting the vibrotactile stimuli while observing pain-related situations compared with both touch and control videos. Observing touch resulted in a better detection compared with observing control videos. In line with our hypotheses, spatially congruent visual information resulted in a better detection compared with incongruent trials. As expected, this congruency effect was present when touch and control videos were shown, although to a lesser extent compared with the presentation of pain-related videos. These effects are consistent with previous research comparing the effects of pain-related videos and control videos upon somatosensation (Vandenbroucke et al., 2014a). The increased detection accuracy while observing touch in this study is congruent with previous studies demonstrating that observing non-painful touch may facilitate somatosensory experiences (e.g. Cardini et al., 2013; Serino et al., 2008). Common pathways exist in experiencing touch and pain, such as multimodal neurons which both respond to nociceptive and non-nociceptive inputs (Mouraux and colleagues, 2011). Besides these common pathways in experiencing touch and pain, our results suggest that the different video categories (pain, touch, control) modulate somatosensation differently. This difference is consistent with the existence of different neurophysiological mechanisms of viewing painful and non-painful bodily sensations in others (Bufalari et al., 2007). One possible explanation for these results is that participants may have been more aroused when viewing the pain videos as compared to when viewing the control and touch videos. As pain captures attention and may induce threat, it may have been more arousing (in a way this is an inherent feature of pain stimuli). Another important mechanism is the involvement of attentional processes. Attention may enhance sensory processing of somatic information when observing bodily experiences in others irrespective of whether they are painful or not. Martinez-Jauand and colleagues (2012) showed enhanced P50 amplitudes by the sight of bodily sensations irrespective of whether participants were observing either a painful or non-painful bodily sensation. It suggests that images of body parts interacting with an object are able to capture participant’s attention to a larger extent than images of a body without receiving stimulation. Further research may focus upon possible explanatory variables for our findings, for example the mediating role of arousal and attentional processes. Serino et al. (2008) demonstrated enhanced detection of subthreshold tactile stimuli on observers' faces when they saw a face being touched by hands rather than a face being merely approached by hands. This effect was not found for touch on a non-bodily stimulus, namely, a picture of a house. An explanation could be that because of the presentation of an inanimate object of the house, perception is already diminished independent of an approaching or touching condition. Beck and colleagues (2013) showed no modulation of detection while observing touch to monkey faces expressing different facial expressions (fearful, happy or neutral) which does occur presenting human faces, illustrating that the simple presentation of human features may influence detection accuracy. A particular strength in the present study is therefore, that even in the non-painful videos in this study, human features were still present. The effects in our study are unlikely due to the mere observation of the human body as human hands were present in all video categories.

Also, type of perspective was important regarding to detection accuracy: participants were better in detecting the vibrotactile stimuli when videos were presented in first-person compared with third-person perspective. Contrary to our expectations, the role of perspective was not dependent upon the type of visual information, suggesting that any hand observed in first-person perspective compared with third-person perspective facilitated detection. The effect of perspective taking upon detection accuracy is in line with research done by Serino et al. (2009). These researchers showed that vision facilitated tactile perception mostly when self-other similarity is high (e.g. by manipulating the visual appearance and political opinions between observer and the observed person). The number of vicarious somatosensory experiences was independent of type of perspective. This suggests that perspective taking may be important but is largely dependent upon the outcome (vicarious somatosensory experiences versus general accuracy in detecting somatosensory stimuli).

In general, the effects of observing pain and touch and the role of perspective taking were stronger regarding detection accuracy compared with the experience of vicarious experiences. This is in line with the view that vicarious experiences while observing touch or pain are a more extreme variant of the modulation of somatosensory detection in a minority of people (Vandenbroucke et al., 2013, 2014b). Percentages range from 1.6% for vicarious touch (Banissy et al., 2009), 16.20% for vicarious pain in amputees (Fitzgibbon et al., 2010a), to 6.61% (Vandenbroucke et al., 2013, study 1), 22.90% (Vandenbroucke et al., 2013, study 2) and 30% for vicarious pain in a general population (Osborn & Derbyshire, 2010). The variability is probably dependent upon the criteria used for categorizing individuals as vicarious pain responders. Stability has been observed at a group level of vicarious pain responders reporting vicarious pain in daily life, but some variation may occur at the individual level (Vandenbroucke et al., 2014b). The study described in this paper has unique contributions to the literature compared with previous studies in our lab (Vandenbroucke et al., 2013, 2014a, 2014b) as it makes the direct comparison between observing pain, touch and control videos upon the report of vicarious experiences and somatosensory modulation.

Regarding the number of neglect errors, observing pain-related scenes resulted in a higher number of neglect errors compared with observing control scenes, but no differences were found between the observation of pain-related versus touch scenes. Personal distress in the context of empathy influenced the number of neglect errors differently for touch and pain-related videos. Fewer neglect errors were made when more personal distressed while observing touch videos, and vice versa regarding pain-related videos. One possible explanation may be that when observing pain-related information in combination with the experience of personal distress, people become more attentive to the site of the pain-related information, resulting in more neglect errors.

Some limitations deserve further consideration, which point to directions for future research. First, we included video clips showing hands being pricked. It may well be that these videos represent pain experiences of lower intensity than the images and movies (e.g. broken leg) used in the study of Osborn and Derbyshire (2010). Further studies have to investigate whether effects differ as a function of pain intensity. It may well be that high-intensity scenes may lead to more vicarious experiences.

Second, we designed our videos to be as similar as possible both in terms of visual features as in represented actions. For that reason, the control videos consisted of a hand approaching another hand but without holding an object. Morrison et al. (2013) showed that separate somatosensory regions responded more strongly when the observed action targeted noxious objects compared with neutral objects, irrespective of the action carried out with them. This suggests an encoding of tactile object properties independent of action properties. Besides the differential influence of the presence of absence of an approaching object, also the type of object could have played a role in our study (e.g. a cotton swab versus a needle), in which a needle could have been more salient.

Third, video clips were shown in peripersonal space as the computer screen was placed just above participants' hands. Visual cues presented near the hands may facilitate the detection of stimuli delivered on these hands compared with visual cues further away (see De Paepe et al., 2014). The fact that our video clips were presented close to the body may have overruled some hypothesized effects of perspective taking.

Fourth, in contrast to Vandenbroucke et al. (2013, 2014b), undergraduate students were participants. Future research may include participants reporting vicarious experiences in daily life (vicarious pain responders) and controls to investigate the effects of observing touch and pain upon somatosensation and vicarious experiences and their potential different impact in both groups.

Finally, future research may attempt to manipulate activity in the brain regions presumed to play a critical role in perspective taking. For example the temperoparietal junction (TPJ) is linked to self-other representations, including perspective taking (e.g., Aichhorn et al., 2006), agency discrimination (e.g., Farrer and Frith, 2002) and empathy (e.g., Völlm et al., 2006). To get further insight into the role self-other representations upon somatosensation, it would be interesting to manipulate activity of TPJ and investigating its role in somatosensation while observing touch, pain and control videos in an experimental setup as described in our study.

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Figure legends

Figure 1. Time line of a trial including vibrotactile stimulation

Figure 2. Example of a possible trial

Figure 3. The relationship between type of video and congruency

Tables

Table 1. Detection accuracy for all video types.

Table 2. Pearson/Spearman correlations, mean scores and standard deviations of all measures