Changes in self-perceived role identity modulate pain perception

Kut, E; Schaffner, N; Wittwer, A; Candia, V; Brockmann, M; Storck, C; Folkers, G
Changes in self-perceived role identity modulate pain perception

Abstract

Pain is an experience including physiological and psychological factors. We assume that emotions may be elicited and increased through self-perceived role identity and that change of role identity alters quality and intensity of pain perception. We used role-play strategies to assess whether pain can be better tolerated whenever, in an unavoidable and unpleasant context, role identity confers pain a meaningful and thus suitable character. We induced antithetic roles in 21 actors who received heat stimuli on their arms before and after role-play conditions. Pain tolerance, skin conductance and voice signals were measured. Pain tolerance increased for heroes/heroines and decreased for faint-hearts. Men showed higher pain tolerance. Heroes/heroines evaluated heat stimuli as more intense. Faint-hearts found pain stimuli more affectively loaded at lower temperatures. Women showed higher pain ratings. Hence, self-perception influences pain perception. Role-play strategies may be of value for new pain management strategies.
Changes in self-perceived role identity modulate pain perception

Elvan Kut a,1, Nils Schaffner a,1, Amrei Wittwer a,1, Victor Candia a, Meike Brockmann b, Claudio Storck c, Gerd Folkers a,*

a Collegium Helveticum, University of Zurich and ETH Zurich, Schmelzbergstrasse 25, CH-8092 Zurich, Switzerland
b Department of Speech Pathology, ENT Clinic, University Hospital Zurich, CH-8091 Zurich, Switzerland
c ENT Clinic, University Hospital Basel, CH-4031 Basel, Switzerland

Received 16 October 2006; received in revised form 22 March 2007; accepted 9 April 2007

Abstract

Pain is an experience including physiological and psychological factors. We assume that emotions may be elicited and increased through self-perceived role identity and that change of role identity alters quality and intensity of pain perception. We used role-play strategies to assess whether pain can be better tolerated whenever, in an unavoidable and unpleasant context, role identity confers pain a meaningful and thus suitable character. We induced antithetic roles in 21 actors who received heat stimuli on their arms before and after role-play conditions. Pain tolerance, skin conductance and voice signals were measured. Pain tolerance increased for heroes/heroines and decreased for faint-hearts. Men showed higher pain tolerance. Heroes/heroines evaluated heat stimuli as more intense. Faint-hearts found pain stimuli more affectively loaded at lower temperatures. Women showed higher pain ratings. Hence, self-perception influences pain perception. Role-play strategies may be of value for new pain management strategies.

Keywords: Pain; Emotion; Self perception; Gender; Heat; Pain tolerance; Role-play

1. Introduction

The two paintings of the Napolitano Gaspare Traversi (1722 ca.–1770) are strikingly similar (Fig. 1) but to the attentive observer, they vividly depict opposing pain perceptions in the face of the wounded sufferer: forced and on his own, he grimaces with intense pain, yet facing the proximity of a comforting woman he bravely and calmly endures the awful medical intervention. Apparently, the man perceives himself differently, and this changes his tolerance for the unbearable pain.

The effect of self-perceived role identity on pain perception, here defined as the product of the brain’s abstraction and elaboration of a nociceptive input (Basmajian and Jessell, 2000), has been investigated in gender role studies, including coping strategies (Keogh and Herdenfeldt, 2002), pain catastrophizing (Thorn et al., 2004), situational context (Kallai et al., 2004), gender role expectations (Robinson et al., 2001) and hyper-vigilance (Rollman et al., 2004) or anxiety (Edwards et al., 2000).

Miscellaneous evidence indicates that pain perception is influenced by physiological and psychological factors like testosterone and oestrogen (Craft et al., 2004), athletic status (Manning and Fillingim, 2002) and pain history (Rollman et al., 2004). Moreover, correlations between arousal (Lang et al., 1990) and skin conductance (SC) and voice parameters (Mendoza, 1998; Johnstone and Scherer, 2000) have been demonstrated. Pain includes sensory, affective and evaluative dimensions, whereas emotions can influence the affective dimension.
Recent studies showed a close connection of brain centers that involve pain and emotions (Eisenberger et al., 2003; Koyama et al., 2005; Vogt, 2005). Several authors (de Wied and Verba-ten, 2001; Meagher et al., 2001; Rainville et al., 2005) agree that pleasant affective states reduce pain perception, whereas unpleasant affective states exacerbate it. Consistently, dysfunctional emotional and cognitive processing has an important influence on pain perception (Klossika et al., 2006).

To induce emotions, pictures (Junghofer et al., 2006), films (Weisenberg et al., 1998), odours (Villemure et al., 2003), music (Robazza et al., 1994; Koelsch et al., 2006), mental imagery (Holmes and Mathews, 2005) and respiration (Philippot et al., 2002), hypnosis (Rainville et al., 2005) and games have been used. During games a strong identification with the played role identity occurs (de Quervain et al., 2004; Singer et al., 2006).

From own experience we know how self-perceived role identity allows us to tolerate pain more easily. For example, parents encourage their children to adopt a brave and strong attitude in order to diminish unpleasantness during a painful medical intervention aimed at protecting them from- or alleviating a distressing illness. Thus, understanding the alleviating power of a vaccination and empathizing with an archetype, which has the implicit ability to tolerate danger and to overcome pain (e.g., a hero), can transform the painful procedure into a meaningful and tolerable experience.

Therefore, we assume that (a) pain can be better tolerated whenever role identity is embedded in an unavoidable, unpleasant context, but which confers pain a meaningful and thus suitable character, and (b) that the self-perceived identity changes emotions accordingly, and affects intensity and quality of pain perception.

### 2. Methods

#### 2.1. Subjects

Twenty-one healthy volunteers experienced in assuming roles, either by regularly playing role-playing games or acting on stage, were recruited for the study. Two participants were excluded (See below under Section 2.9). Mean age of participants was 28.2 years (s.d. ± 10.0). Ten women (mean age 31.2 years, s.d. ± 12.7) and nine men (age 24.9 years, s.d. ± 4.5) were included in the study. Handedness was determined using a standard handedness inventory (Oldfield, 1971). All volunteers gave fully, written informed consent for the project, which was approved by the local ethics committee. The study was conducted according to the guidelines of the Declaration of Helsinki for the treatment of experimental subjects. To exclude acute or chronic pain and the effect of pain medication among volunteers, each participant was screened with a home-made questionnaire. Participants were also asked not to drink caffeinated or alcoholic beverages 6 h prior to the experiment.

#### 2.2. Role induction

We created two experimental and two control conditions. Experimental conditions were the two opposite roles hero/heroine and faint-heart. A scientific text (http://presse.verwal tung.uni-muenchen.de//einsichten_buch/lebenswissenschaften/zhwei.pdf (2004)) or 10 min silence without any other accompanying task served as control conditions. Both role conditions were presented to every study participant at random and in counterbalanced order. Half of the participants received the scientific text, and the other half the silence condition at random. For role induction, role-plays inspired by the famous fantasy role-playing game DUNGEONS&DRAG-ONS™ (Wizards of the Coast, Inc., Washington, USA) were written. To improve role empathy of men and women, role identities were written gender-specific concerning the main character. At six different points in time, participants were
given choices as to what to do or where to go within a labyrinth embedded in the story line, which was not affected by the different decisions. Likewise, volunteers had to answer different questions in written form at the end of, and orally during, the text condition regarding its scientific content. All story lines and the control text were spoken and recorded in a sound studio by a professional male speaker. They all had a total length of 13 min. The resulting sound files were machine finished using the software Garageband 2.0 by Apple Computer Inc., and played to the participants by means of speakers placed half a meter in front of them with and arbitrary but constant room-filling loudness.

2.3. Role stimuli

The story lines described the main character whose identity should be adopted. The herolheroine role identity implied a winner image with strong personality and athletic build, and had the motivated task to save a princess. In contrast, the faint-heart character meant the role identity of a victim with weak personality, and no motivated task for his/her suffering at all. Both roles started as robber–knights attacked a kingdom. While the faint-heart was threatened in his castle, the hero was on his way to liberate a princess. Both entered a fatal labyrinth. In contrast to the hero the faint-heart was violently forced into it, without any hope to escape. He resented his fate, and was plagued by fire, rats and vertigo. On his search for the princess, the hero overcame these dangers. Both characters ended up facing a guardian, who unjustifiably punished the faint-heart and offered a deal to the hero: he was free to escape with the princess, provided that he was willing to suffer for her.

The volunteers received painful heat stimuli seconds after the main character of the story line endured pain (See under “Experimental procedure”). The pain test stimulus was incorporated in the hero and the faint-hearted condition alike. Most importantly, at this point in time, the herolheroine focused on the motivating task of saving the princess, while the faint-heart did not, thus experiencing emotionally unmotivated pain. It is important to repeat that actual pain stimuli and story line did not, thus experiencing emotionally unmotivated pain. It is important to repeat that actual pain stimuli and story line never overlapped.

2.4. Pain stimuli

Noxious heat stimuli were administered to the volar forearm of the non-dominant hand using a 30 × 30-mm Peltier device (Medoc, Ramat-Yishai, Israel; TSA-II) placed at 2/3 of the distance from wrist to elbow. Individual pain threshold was measured to determine the turning point from warm into pain perception using the search method starting at 43 °C: participants were asked to increase or decrease the magnitude of the heat stimulus by themselves to the point they felt it changing from “hot” to “painful”. Pain tolerance was determined by the method of limits: participants were asked to stop the increasing heat stimulus at the moment they could not stand the heat any longer. Four measurements starting at 35 °C, with a rise of 0.6 °C/s, were averaged. To avoid physical injuries the pain tolerance measurement stopped automatically at a maximal temperature of 52 °C. Prior to the actual measurements subjects were made familiar with the heat stimuli and the handling of the controlling device (Granot et al., 2003). Pain tolerance, the variable of interest, was measured always prior to pain threshold. This was done in order to avoid washout of role-induced effects due to the considerably longer time delays needed to measure sensory thresholds.

2.5. Autonomic reactivity

Skin conductance level (SCL) was measured with a Variopon Measurement System (Becker Meditec, Karlsruhe, Germany), an 8-channel recording system. After filtering and a tenfold-amplification (Anti-Alias filter to cut off high frequencies), data were digitized (12 Bit resolution) and saved on a compact flash card. For measurements, one single channel was used. Channel parameters were set as follows: sampling rate 256 Hz, saving rate 16 Hz, range 0.1–100 µS and resolution of 0.001 µS. During SCL recordings, current across electrodes was held constant at 0.5 V by means of a 16 Bit-resolution unit. Before recording, the palm of the non-dominant hand was cleansed with distilled water and two Ag/AgCl electrodes (5 mm contact area diameter, Marquette Hellige Medical Systems, Freiburg, Germany) filled with lubricating jelly (SCL-Paste, 0.5% NaCl, Becker Meditec, Karlsruhe, Germany) were placed adjacentlly on the hypothenar eminence of the palm. In order to analyze peak amplitudes of the recorded skin conductance signals triggered by pain measurements, signal peaks were related to each one of the four pain tolerance stimuli (pre- and post event every condition) by using the automatically recorded time as a marker, upon the participants’ stopping of the pain stimulus. Peak amplitude was calculated by subtracting the value at the beginning of the rising phase of the recorded signal from the value at the apex of the same signal slope. Thereafter, the median corresponding to the four peak heights of the pain tolerance measurements was calculated and used for statistical analysis. In order to control for possible differences in skin conductance levels due to the role-specific adjustments of the characters of the story line, SCL of heroes/ heroines, female and male faint-hearts were separately averaged throughout the role-playing story (including their pain stimuli associated responses at the end). To correlate the average SCL of male and female participants of the same condition, the length of the first part of the female role-playing story was adjusted to the male story line. Due to detached electrodes, data of two participants (one woman, one man) were excluded from SCL analysis.

2.6. Voice measurement

Participants were asked to phonate the vowel /a/ at two different moments of each run: once right at the beginning of the run, and a second time close to the end of the role-playing story, the scientific text or after the 8 min silence. Voice signals were recorded by means of a personal computer using the “Göttinger Heiserkeitsdiagramm” (Rehder und Partner Medizintechnik, Hamburg). From the recorded voice signals only middle parts without voice onset and offset phase were used to obtain Fundamental Frequency \((F_0)\), Jitter (variation of \(F_0\) and Shimmer (variation of amplitude). Voice parameter analysis was carried out off-line after the experiment. Two participants (one woman, one man) had to be excluded from the voice analysis-data, because their voices were strongly irregular and showed symptoms of functional voice disorders.
2.7. Subjective reports

After each pain tolerance measurement participants were asked to rate the pain they felt at the point they could not stand it any longer by means of (a) visual analogue scales, and (b) the McGill Pain Questionnaire (MPQ) (Melzack, 1975). Two 10-cm visual analogue scales (VAS) were used. In the first one, used to evaluate pain intensity, 0 indicated "no pain" while 10 represented the "worst pain experienced". The second scale was used to assess pain unpleasantness (Price et al., 1983), with 0 indicating "neutral" and 10 "extremely unpleasant". The German version (Stein and Mendl, 1988) of the MPQ was evaluated according to the methodology originally employed by Melzack and Togerson (Melzack, 1975). The rank values of the words chosen per each subscale were added up to obtain a score for the sensory and affective subscales. At the end of both role conditions participants had to complete further VAS and a home-made Role-play questionnaire: three VAS with end values of 0 indicating "not at all" and 10 "very strong" were used to assess for (1) a reason to stand the pain, (2) the intensity of role empathy, and (3) the intensity of role empathy in comparison to acting or playing other role-plays. To assess whether the implicit character imbedded in the corresponding story line was truly captured, participants were asked to freely label the nature of the emotional state they experienced using single words or short phrases, a method commonly used in research on emotions (Scherer, 2005). 92% of the given adjectives were quoted in a standard German Synonyms’ Dictionary (Duden, 2004) and were included in the analyses. Adjectives were then split into the three categories "Appropriate", "Antonym" or "Strange" to the role identity of a heroin or faint-heart facing pain. Category frequencies were expressed in percentages. In addition, in order to assign an emotional valence to the named words, a word B was considered a synonym of another word A, when B was directly found in the list of synonyms for word A in the dictionary, or when B was connected to A via another synonym C that was directly found in the list of synonyms for word A. To assign a normative valence and arousal score to the named words, the following strategy was used: (1) a translation for the German word was done by means of LEO, a world-wide-web accessible German-English dictionary (http://dict.leo.org/) (2) the translated word was then searched in the Affective Norms for English Words (ANEW), which provides a set of normative emotional ratings for a large number of words in the English language (Bradley and Lang, 1999), and the corresponding valence and arousal scores for that word were recorded (3) when the first translated word was not found in the ANEW, the next synonym of the German word, as found in the German Dictionary (See above), was used. All named adjectives were represented by one of their synonyms found in the ANEW-catalogue, whose All Subjects norms were used.

In order to evaluate which emotional states would be associated with each role identity under painful conditions, a group of volunteers not aware of the study under consideration (three men and four women, mean age 34.9 s.d. ± 14.9, all with academic educational background) were asked to respond in written to the question: “which emotions would you expect of a heroin/faint-heart facing danger and physical pain?”, by using single words or short phrases in the same way as described above for participants in the main study. The given adjectives were treated in the same form as for role-players. The words of this group were then compared to those named in the main study group. Results were reported as percentage of congruent answers amongst groups.

2.8. Experimental procedure

Participants lay on a couch in half-lying position but still were able to easily read the instructions displayed in a monitor placed at an arbitrary, yet constant, distance in front of them. The experimenter affixed the thermode and the electrodes for SCL recording, as explained under “Pain Stimuli”. Video and SCL were recorded from that moment on. Thereafter participants were instructed on how to self-control the delivery of the painful stimuli by using two response buttons connected to the TSA-II. In addition, two different acoustic signals indicated either a tolerance or a threshold measurement. Participants were instructed to concentrate on pain stimuli during pain measurements throughout conditions. Participants were blindfolded with an appropriate mask for the full length of the experiment, except for the periods in which they had to complete a questionnaire. An experimental session consisted of three runs comprising both roles and one of the control conditions (Fig. 2). At the beginning of each run, participants’ voice signal was recorded followed by pain tolerance first, and then pain threshold measurements. Subsequently, subjective ratings concerning pain tolerance were collected. Thereafter, a role-playing story, the scientific text or the silent condition followed. Eight minutes after the start of a condition, the second voice measurement was carried out. Pain tolerance and pain threshold were both measured a second time immediately at the end of any condition. In order to sustain the role identity effects during pain measurements, the role-playing story continued for 25 s after the first two stimuli of the second series consisting of four pain stimuli. Time interval...
between the four pain stimuli was always held constant and there was no overlap between listening periods and pain stimuli. After voice-, pain tolerance- and pain threshold measurements, subjective pain ratings were again collected. Subsequent to both role conditions the questionnaire concerning role empathy was completed. After 5 min rest a new run was started. To control for confounding factors associated to circadian variations, all participants were tested starting either at 5 or 6 pm. The total duration of an experimental session was approximately 2 h. Volunteers were debriefed after the three experimental runs were completed, and they received a monetary compensation for their participation in the study.

2.9. Statistical analyses

Two participants were excluded from all data analyses because their pain tolerance exceeded the security limit set at 52 °C. Ten women (nine right-handed, one left-handed), and nine men (eight right-handed, one left-handed) were included. Whenever the factor Gender was considered in an analysis, this was done to secure that the observed differences were not a result of gender-specific effects. Most of the studies on acute and chronic pain showed that women are more sensitive to pain (Rollman et al., 2004). We first compared results of the control conditions “Scientific Text” (n = 10, five women, five men) and “Silence” (n = 9, five women, four men) with a one factorial repeated measurements analysis of variance (ANOVA) involving the factor Time (pre vs. post). Values of pain measurements, vocal and SCL recordings, as well as subjective reports did not show significant differences among the two control conditions. Thus, both, the “Scientific Text” and “Silence” control groups were merged into a single control group for further comparisons. To evaluate the effect of role induction on pain tolerance and pain threshold, respectively, repeated measurements analyses of variance with the between-subject factor Role (hero/heroine, faint-heart and control), and the within-subject factors Time (pre/post) and Gender were separately calculated. Post-hoc comparisons were made by means of paired single t-tests. Single repeated measurements ANOVAs were computed on VAS ratings of pain intensity and pain unpleasantness. In addition, for the sensory and affective subscales of the MPQ, also individual repeated measurements ANOVAs were used. To assess for the effect of time (Run1/Run2/Run3; See under Section 2.8) on pain intensity and pain unpleasantness, a one factorial repeated measurements ANOVA on the scores resulting from the arithmetic addition of pre- and post-role induction in any of the three runs was calculated. Both ANOVAs included the between-subject factor Gender and the within-subjects factor Run. To assess for changes in participant’s emotional status during and after role induction, voice measurements, skin conductance level and role-play questionnaires were again evaluated by means of ANOVAs and Spearman’s Rank correlations. Significance level was set at 0.05 for all statistical calculations. P-values in the ANOVAs were corrected using the Greenhouse–Geisser correction. For post-hoc t-test comparisons, the significance level was adjusted using the simple Bonferroni correction by dividing 0.05 by the number of possible single multiple comparisons in the corresponding effect (i.e., α-corrected: 0.0033 for the Role × Time interaction and α-corrected: 0.016 for the Time effect (Run1/ Run2/Run3) in the VAS ratings).

3. Results

3.1. Pain tolerance and pain threshold

The ANOVA for pain tolerance was significant for the within-subjects factor Role (F2,34 = 9.580, P = 0.001). Most importantly, the interaction Role × Time was highly significant (F2,34 = 21.461, P = 0.000; Fig. 3). Post-hoc t-tests showed that pain tolerance increased significantly with the induction of the heroi/heroine role (t18 = −3.707, P = 0.002), however it significantly decreased in the case of the faint-heart role (t18 = 3.867, P = 0.001). Listening to a scientific text or 10 min silence without any other task led to a significant decrease in pain tolerance as well (t18 = 4.491, P = 0.000). The interaction Role × Time × Gender was not significant (F2,34 = 1.566, P = 0.229). The between-subjects factor Gender revealed that overall men showed higher pain tolerance than women (F1,17 = 5.435, P = 0.032; Fig. 4). In contrast to pain tolerance, pain threshold measurements did not significantly differ in any of the main factors or their interactions. Corrected α level for post-hoc t-tests: 0.0033 (See under Section 2.9).

3.2. McGill Pain Questionnaire (MPQ)

The ANOVA for the sensory subscale of the MPQ was significant for the interaction Role × Time (F2,34 = 9.244, P = 0.002). Post-hoc t-tests revealed that only heroes/heroines increased their sensory pain ratings significantly (t18 = −4.041, P = 0.001; Fig. 5a). The ANOVA for the affective subscale of the MPQ was significant for the interaction Role × Time as well (F2,34 = 6.462, P = 0.005). The post-hoc comparisons revealed that only faint-hearts significantly increased
their affective pain ratings ($t_{18} = -3.584, P = 0.002$; Fig. 5b). The between-subjects factor Gender revealed that overall, female volunteers gave higher MPQ ratings than men (sensory: $F_{1,17} = 11.404, P = 0.004$; affective: $F_{1,17} = 7.462, P = 0.014$). Control conditions showed no significant change in sensory and affective subscale scores. Corrected $z$ level for post-hoc $t$-tests: 0.0033 (See under Section 2.9).

3.3. Visual Analogue Scale (VAS) for pain intensity and pain unpleasantness

The ANOVA for the VAS on pain intensity ratings was significant for the interaction Role $\times$ Time ($F_{2,34} = 3.936, P = 0.032$). Post-hoc $t$-tests showed a significant increase of pain intensity ratings for heroes/heroines ($t_{18} = -4.043, P = 0.001$). Neither role nor control conditions altered VAS ratings for pain unpleasantness. The ANOVA for the effect of time (Run1/Run2/Run3) on pain intensity was significant for the within-subjects effect Time ($F_{2,34} = 3.664, P = 0.047$) as well as the corresponding ANOVA for pain unpleasantness ($F_{2,34} = 8.013, P = 0.004$): over time, scores on both measures increased. The between-subjects factor Gender was not significant. Nevertheless, post-hoc $t$-tests of pain intensity scores did not survive Bonferroni corrections. Conversely, mean pain unpleasantness ratings increased significantly from Run1 to Run3 ($t_{18} = -3.302, P = 0.004$). Corrected $z$ level for post-hoc $t$-tests: 0.0033 and 0.016, respectively (See under Section 2.9).

3.4. Role-play questionnaire

The ANOVA for VAS ratings for pain meaningfulness was significant for the within-subjects factor Role ($F_{1,17} = 12.401, P = 0.003$). Pain had more meaning for heroes/heroines than for faint-hearts. Conversely, the between-subjects factor Gender was not significant as well as any interaction. The nonparametric Spearman Rank correlation revealed a significant correlation between the increase in pain tolerances of heroes/heroines (differences post–pre) and their corresponding VAS ratings on meaningfulness of pain collected at the end of the role induction ($q = 0.569, P = 0.011$). We found no such correlations for faint-hearts ($q = -0.167, P = 0.495$). VAS ratings on role empathy at the end of role induction of heros/heroines ($71.4 \pm 21.8$ s.d.) and faint-heart ($65.3 \pm 22.3$ s.d.) did not differ significantly from each other ($F_{1,17} = 0.031, P = 0.862$). The between-subjects factor Gender had no impact on role empathy either ($F_{1,17} = 2.920, P = 0.016$). In addition, the repeated measurements ANOVA for VAS ratings of the intensity of role empathy during the experimental procedure compared to during normal role-playing games showed no significant
difference for the within-subjects factors Role \((F_{1,17} = 0.411, P = 0.530)\) or the between-subjects factor Gender \((F_{1,17} = 0.606, P = 0.447)\); (heroines/heroines: 56.6 ± 25.5 s.d., faint-hearts: 60.5 ± 20.2 s.d.). Freely chosen words or phrases at the end of each role condition indicating whether the implicit character imbedded in the corresponding story line was truly captured were mostly appropriate to the role identity of a heroine/heroine or a faint-heart facing pain. In the heroine/heroine condition 58% of the adjectives belonged to the category “Appropriate”, whereas 27% were “Antonyms” to the role identity of a hero. The remaining 15% were “Strange” adjectives. In the faint-heart condition 89% of the adjectives fell into the category “Appropriate” and 11% into the category “Strange”. At the end of the experimental session, participants reported no significant preference in having empathized with one role or the other: three men and four women preferred the heroine identity, four men and two women preferred the faint-heart identity, while the remaining six reported they have equally empathized with both roles.

In their majority, the synonyms named by the seven volunteers not aware of the present study matched those named by role-players: 64% of the synonyms correspond to a hero/heroine identity facing pain, and 73% correspond to a faint-heart identity facing pain. All synonym groups were represented by one of their synonyms that were found to have a number with valence and arousal scores in the ANEW-catalogue. These synonyms were congruent with high-valence-high-arousal words, in the case of a hero/heroine identity, and with low-valence-high-arousal words, in the case of faint-hearts. [ANEW-numbers for the words representing the synonyms named by role-play participants after the hero identity condition and its percentage of appearances, considering all 33 adjectives pertaining to this identity condition: \(8 = \text{afraid (6%)}\), \(9 = \text{aggressive (3%)}\), \(62 = \text{capable (3%)}\), \(79 = \text{confident (3%)}\), \(95 = \text{curious (3%)}\), \(135 = \text{easygoing (9%)}\), \(206 = \text{helpless (18%)}\), \(241 = \text{joyful (6%)}\), \(263 = \text{love (3%)}\), \(323 = \text{power (9%)}\), \(415 = \text{stupid (3%)}\), \(494 = \text{win (3%)}\), \(668 = \text{brave (27.3%)}\), \(1011 = \text{tender (3%)}\); results of seven volunteers unaware of the present study (number of adjectives = 33): \(8 = \text{afraid (15.1%)}\), \(9 = \text{aggressive (3%)}\), \(11 = \text{alert (3%)}\), \(14 = \text{ambition (6%)}\), \(18 = \text{angry (3%)}\), \(53 = \text{brutal (3%)}\), \(79 = \text{confident (6%)}\), \(95 = \text{curious (3%)}\), \(104 = \text{defiant (9%)}\), \(135 = \text{easygoing (18%)}\), \(201 = \text{hate (3%)}\), \(323 = \text{power (3%)}\), \(335 = \text{punishment (3%)}\), \(668 = \text{brave (15.1%)}\), \(713 = \text{danger (6%)}\); ANEW-numbers for the words representing the synonyms named by role-play participants during the faint-heart identity condition and its percentage of appearances, considering all 38 adjectives pertaining to this identity condition: \(8 = \text{afraid (21%)}\), \(12 = \text{alone (10.5%)}\), \(18 = \text{angry (2.6%)}\), \(28 = \text{astonished (2.6%)}\), \(120 = \text{disappoint (2.6%)}\), \(206 = \text{helpless (36.8%)}\), \(329 = \text{prison (2.6%)}\), \(713 = \text{danger (3%)}\), \(827 = \text{jolly (2.6%)}\), \(852 = \text{lost (10.5%)}\), \(880 = \text{mistake (2.6%)}\); results of seven volunteers unaware of the present study (number of adjectives = 33): \(8 = \text{afraid (48.5%)}\), \(24 = \text{aroused (18%)}\), \(197 = \text{guilty (3%)}\), \(206 = \text{helpless (24.2%)}\), \(601 = \text{panic (6%)}\); Bold values represent equivalence between both groups].

3.5. Autonomic responses

Both skin conductance levels (SCL) of heroines and heroes and SCL of female and male faint-hearts correlated highly significantly \((p = 0.824, P = 0.000)\) and \(p = 0.662, P = 0.000\), respectively. Moreover, same signal traces of heroines and heroes together significantly correlated with those of faint-hearts \((p = 0.787, P = 0.000\); Fig. 6). The repeated measurements ANOVA for stimulus-related peak height of SCL during pain tolerance measurements was highly significant for the interaction Role \(*\) Time \((F_{2,36} = 17.722, P = 0.000)\). The between-subjects factor Gender was not significant. Post-hoc t-tests showed that the induction of the heroine role leads to increased stimulus-related SCL peaks \((t_{16} = -4.327, P = 0.001)\), whereas the test results of faint-hearts and control conditions did not alter stimulus-related SCL peaks at all \((faint-heart: t_{16} = 2.746, P = 0.014; \text{control: } t_{16} = 0.971, P = 0.346)\). Corrected \(z\) level for post-hoc t-tests: 0.0033 (See under Section 2.9).

3.6. Voice measurement

The repeated measurements ANOVA for the voice measurements with the within-subjects factors Time and Role and the between-subjects factor Gender revealed highly significant differences of Fundamental Frequency \((F_0)\) for the factor Gender: men showed lower \(F_0 (F_{1,15} = 56.117, P = 0.000)\). Jitter and Shimmer of participant’s voices were not significantly different under any of the measured conditions.

4. Discussion

Emotion and pain perception are strongly related. We studied the influence of self-perceived role identity, and its associated emotional status on both, subjectively and objectively assessed pain perceptions. We used role-play strategies to implicitly induce two antithetic role identities.

**Heroes/heroines** tolerated more heat and gave these stimuli higher pain scores in the sensory subscale of the MPQ, and associated affective pain ratings were not altered. **Heroines/heroines** showed higher pain intensity ratings and unchanged pain unpleasantness scores. These results suggest that the heroine/heroine identity can attenuate affective components of pain perception. **Faint-hearts** showed higher affective MPQ ratings together with less pain tolerance after role induction.
Only faint-hearts revealed significant affective MPQ scores, suggesting that this identity can amplify affective and sensory components of pain perception. Control conditions showed a lower pain tolerance with unchanged subjective pain ratings. Thus, role-playing strategies targeting emotions can modulate pain perception.

We also assessed the influence of self-perceived role identity and its associated emotional dimension “arousal” on acoustic vocal parameters and on skin conductance level (SCL). SCL of participants correlated during both role-playing stories (Fig. 6); this suggests similar levels of attention throughout role conditions. Higher stimulus-related SCL peaks after the hero/heroine role induction probably resulted from the increased pain intensity perception at higher tolerance values. Since stimulus-related SCL peaks did not decrease in the faint-heart and control conditions, we conclude that these participants stopped the pain stimuli at lower heat temperatures due to truly role-induced decrease in pain tolerance, and not due to different motivation. In contrast to previous reports (Mendoza, 1998; Johnstone and Scherer, 2000), vocal parameters did not allow for final conclusions. Lack of sensitivity and specificity (Zyski et al., 1984; Ludlow, 1987) may explain our results.

Heroes/heroines attributed more meaning to pain, and this correlated with more pain tolerance only of heroines and heroes. Faint-hearts showed less pain tolerance. Indeed, the faint-heart role was written free of passages containing tasks or motivations that would make pain meaningful and suitable. Thus, pain was better tolerated as role identity conferred pain a meaningful and suitable character.

Moreover, 58% of the freely named adjectives and phrases at the end of the hero/heroine role-playing story described an emotional state best fitting the role identity of a hero facing pain. Similarly, after the faint-heart condition, 89% of participants’ descriptions were appropriate to a faint-heart facing pain. Importantly, the terms “hero/heroine” or “faint-heart” were never explicitly mentioned. As revealed in a group of individuals unaware of this study (See Section 2.7), 64% of the synonyms pertaining to a hero-identity facing pain, and 73% of those corresponding to a faint-heart identity facing pain matched those named by the participants. All synonyms of role-players were found to have valence and arousal scores in the ANEW-catalogue and were congruent with two antithetic emotional states: a high-valence-high-arousal state in the case of a hero-identity and a low-valence-high-arousal state in the case of faint-hearts. Seemingly, our story lines induced the intended identities and associated emotions, and this may have altered pain perception.

Role and control conditions did not alter VAS unpleasantness. These scores increased over time, presumably after repeated noxious stimuli. Because VAS pain scores of heat pain have been shown to be stable over a time of 0–60 min (Granot et al., 2003), it is possible that the repeated completion of VAS resulted in higher ratings.

Attention can influence emotional components of pain perception (Bantick et al., 2002; Villemure and Bushnell, 2002). Negative emotions can increase pain-directed attention (Rainville et al., 2005), and emotional salience of stimuli facilitates attention (Phelps, 2006). Emotional vocal stimuli have a strong impact on brain dynamics, and attention magnifies this effect (Grandjean et al., 2005). If the hero condition had a higher cognitive load capturing more attention, a pain stimulus would be then less of a distraction, resulting in higher tolerance values. Highly demanding tasks might distract attention from pain causing lower subjective intensity values (Veldhuijzen et al., 2006). Interestingly, we observed a significant increase and not a decrease of pain intensity ratings for heroes/heroines.
The hero/heroine role gave rise to a wide array of terms corresponding to both positive and negative cognitions and emotions. This may, again, suggest a more complex cognitive load. This incongruence might be more apparent than real: while a brave attitude refers to confident behavior in the face of dangers and is related to actively face and endure anything threatening (Webster’s, 1989), this may not liberate the individual from antagonistic and concomitantly acting cognitions and emotions: the capacity to overcome dangers and the associated fears and worries confers on a person the qualification of a hero/heroine. Alternatively, the knowledge on cognitions and emotions related to a faint-hearted, as for example fear and helplessness, might be rather common to humans, increasing the description’s certainty for such a role.

Anxiety-induced hyperalgesia has been reported (Rhudy and Meagher, 2000), whereas highly arousing negative affective states can attenuate pain (Janssen and Arntz, 1996). If anxiety were involved in our results this would agree with the antithetic tolerance values of heroes/heroinones and faint-hearts. If fear mediated our effects, attenuated instead of exacerbated pain perception would be expected during the faint-heart condition. The faint-heart story may have lowered subjects’ motivation. Nevertheless, participants did not prefer one role to the other and SCL correlated during both role-playing stories.

For every participant we used one out of two conditions to control for the effects of listening to a spoken text, answering questions, and for the speaker’s voice. Pain tolerance was comparably lower after the faint-heart and control conditions. It is probable that hearing a hardly understandable scientific text or waiting blindfolded without knowing what will happen next led to unpleasant affective states promoting a low pain tolerance. In addition, MPQ and VAS scores for control conditions remained unchanged. Therefore, only a change in self-perceived role identity resulted in measurable differences in the perception of sensory and affective pain components together with pain tolerance.

The interaction of self-perceived role identity and gender on pain perception was insignificant. For pain tolerance, the variable of interest, we showed like others (Fillingim et al., 1998) that for induced heat pain, men have, overall, higher pain tolerance. Like others (Yospovitch et al., 2004), we did not see gender differences in pain threshold, a marker we used to determine the turning point from warm into pain perception. Thus, different aspects of pain experience may lead to diverging results among genders.

Our data do not permit direct insights into action mechanisms. It is unlikely that results were influenced by hormonal status because the same individuals experienced both roles. Moreover, circadian factors were controlled. Future studies including analysis of cortisol levels may indicate to which extent role-induced functional modulation of the hypothalamic–pituitary–adrenal (HPA) axis was involved in these results. This is thinkable, as stress activates the HPA-axis (Glaser and Kiecolt-Glaser, 2005).

The inclusion of comparable role-play strategies may limit the adverse effects of pain on endocrine and immune function on skin wound healing (Kiecolt-Glaser et al., 1998). Also caregivers may benefit from training protocols using role-play strategies targeting self-enhancement and positive emotions related to the social meaningfulness of the work they do. This may reduce their short and long term risk of health deterioration (Kiecolt-Glaser et al., 1998; Glaser and Kiecolt-Glaser, 2005; Tosevski and Milovancevic, 2006).

Neuroimaging studies may show whether empathizing with an archetype whatsoever, activates anterior insular-, and cingular regions of the brain, like during empathic pain (Singer et al., 2004), or whether specific forms of empathy (e.g., role empathy vs. pain empathy) are differently associated to more affective (Singer et al., 2004) or more sensory (Avenanti et al., 2005) patterns of activity. Such studies may address the question as to whether during pain under a new role-induced identity, a global or a partial activation of the pain matrix occurs, and whether dynamic changes in the activity of the endogenous opioid system can be observed (Apkarian et al., 2005; Sprenger et al., 2005).

Our data suggest an important role of self-perceived role identity, and its associated emotional status, on pain perception. Whether the observed effects will last longer when role induction sessions extend over several days is an open question. The small sample size and the specialized nature of the participants involved leave open the question as to whether our findings could be generalized to pain populations. Nevertheless, these data should be at least of heuristic value. Modulation of self-perceived role identity in emotionally meaningful settings may contribute to a beneficial influence on pain management.

Competing interests statement

The authors declare that they have no competing financial interests.

Acknowledgements

We thank H. Milz, B. Danuser, M.C. Hepp-Reymond, A. Abd-el-Razik, P. Gomez, R. Bill, J. Fehr, R. Eglolf, O. Kettiger and R. Movassagh for help during the preparation of this work, which was supported by the cogito foundation.