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Citation for published version (APA):

D'Agostini, M., Karos, K., Kindermans, H. P. J., & Vancleef, L. M. G. (2020). Effects of (in)validation and plain versus technical language on the experience of experimentally induced pain: A computer controlled simulation paradigm. *Journal of Behavior Therapy and Experimental Psychiatry*, 67, [101473]. <https://doi.org/10.1016/j.jbtep.2019.03.008>

Document status and date:

Published: 01/06/2020

DOI:

[10.1016/j.jbtep.2019.03.008](https://doi.org/10.1016/j.jbtep.2019.03.008)

Document Version:

Publisher's PDF, also known as Version of record

Document license:

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Effects of (in)validation and plain versus technical language on the experience of experimentally induced pain: A computer controlled simulation paradigm

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ARTICLE INFO

Keywords:

Pain communication
(in)validation
Thermal pain
Computer controlled simulation
Virtual reality
Pain experience
Context

ABSTRACT

Background and objectives: Amongst social contextual influences on pain, the manner in which pain and painful procedures are communicated to patients is considered an important contributor to the subjective experience of pain. Threatening information, e.g., by the use of technical language, is suggested to increase pain reports. Validation, or communicating understanding towards another person reporting personal experiences, is suggested to reduce pain. The current study examines effects of both information language (technical vs. plain language) and validation (validation vs. invalidation) on the subjective experience of experimentally induced pain.

Methods: Pain-free participants ($N = 132$) were randomly assigned to one of four groups as formed by manipulations of validation and information language. After reading a description concerning the upcoming thermal stimulus formulated in technical or plain language, participants engaged in a computer controlled simulation (CCS; based on virtual reality technology). Participants received three thermal stimuli while interacting with an avatar who either validated or invalidated their experience during the CCS. Pain intensity and pain unpleasantness were assessed after each stimulus.

Results: The validation manipulation showed to be effective, but the information language manipulation did not induce differential threat expectancies. Results show no effect of validation or information language on subjective pain reports.

Limitations: Suboptimality of the information language manipulation and shortcomings of the CCS procedure might account for current findings.

Conclusions: The study offers an interesting model for the further experimental study of isolated and combined effects of (social) contextual factors on pain. Diverse future research avenues are discussed.

1. Introduction

The experience and interpretation of pain does not take place in a vacuum but rather is known to depend also on the social, physical, and emotional context in which physical adversity occurs (e.g., Arntz & Claessens, 2004; Levine & de Simone, 1991; Montoya, Larbig, Braun, Preissl, & Birbaumer, 2004; Rocha, Prkachin, Beaumont, Hardy, & Zumbo, 2003). Amongst other social contextual factors, the manner in which pain and painful procedures are communicated is of particular interest in a clinical context. For example, the quality of patient-practitioner communication has been found to contribute to pain ratings, patient satisfaction and treatment adherence (Mistiaen et al., 2016; Muñoz Alamo, Ruiz Moral, & Pérula de Torres, 2002; Ong, de Haes,

Hoos, & Lammes, 1995; Ruben, Blanch-Hartigan, & Hall, 2017). In patient-practitioner communication, both the information that is being provided (i.e., the content) and the style and form in which communication takes place are considered crucial elements (Mistiaen et al., 2016). Furthermore, non-verbal behaviors (e.g., facial expressions) during face-to-face communication are known to influence individuals' perception of the interaction as pleasant, supportive, or hostile (Ong et al., 1995).

Providing information about diseases and treatments influences various treatment-related outcomes, such as symptom management and treatment adherence (e.g. Falvo & Tippy, 1988; McPherson, Higginson, & Hearn, 2001). Importantly, the use of technical language (vs. plain language) to provide information is reported to reduce both the level of

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<https://doi.org/10.1016/j.jbtep.2019.03.008>

Received 24 August 2018; Received in revised form 18 March 2019; Accepted 27 March 2019

Available online 30 March 2019

0005-7916/ © 2019 Published by Elsevier Ltd.

satisfaction with the received information and the capability of understanding and recalling information in patients (Jackson, 1992). Positive suggestions and preparatory information regarding painful treatments reduce patient's pain while the usage of negatively loaded words to introduce a painful procedure is associated with higher pain ratings (See review Mistiaen et al., 2016; Lang et al., 2005; Koban, Jepma, Geuter, & Wager, 2017). In healthy participants, the use of technical language and threatening examples to describe an upcoming painful procedure was found to increase distress and threat expectancy for the upcoming pain procedure, and to lead to increased pain intensity reports and reduced tolerance for experimentally induced pain (Boston & Sharpe, 2005; Jackson et al., 2005; Karsdorp, Ranson, Schrooten, & Vlaeyen, 2012; Todd, Sharpe, Colagiuri, & Khatabi, 2016).

In addition to the content and language in which information is provided, both verbal and non-verbal reactions of others to the person in pain influence the pain experience (e.g., Flor, Kerns, & Turk, 1987; Cano, 2004; Hurter, Paloyelis, de C. Williams, & Fotopoulou, 2014). A promising communication strategy in this light is validation, which is characterized by the communication of understanding and legitimacy towards another person who reports personal experiences (Linehan, 1997). Validation has been found associated with a decrease in negative affect and increased treatment satisfaction in chronic pain patients (Shenk & Fruzzetti, 2011; Vangronsveld & Linton, 2012) and has been proposed as a valuable therapeutic tool to reduce pain (Edmond & Keefe, 2015). Nevertheless, empirical evidence for a direct effect of validation on the experience of pain is inconsistent. Experimental studies in which validating versus invalidating feedback was provided by the experimenter to healthy participants undergoing a bucket-lifting task found no effect on pain reports (Edmond, 2015; Linton, Boersma, Vangronsveld, & Fruzzetti, 2012). In contrast, healthy participants who felt highly validated by their romantic partner during the cold pressor task reported lower pain (Leong, Cano, Wurm, Lumley, & Corley, 2015). Correspondingly, young cancer patients reported higher pain during treatment procedures when they were invalidated by their primary caregiver (Cline et al., 2006). Possibly, these diverging findings between studies result from differences in perceived threat of pain and painful procedures. Indeed, cancer patients undergoing treatment procedures experience high levels of fear and anxiety, indicating increased threat perception, in relation to the treatment (Kuppenheimer & Brown, 2002). Along the same line of reasoning, the bucket-lifting task (Edmond, 2015; Linton et al., 2012) might be perceived as less threatening than the cold pressor task (Leong et al., 2015), often employed in experimental research as a stress-inducing procedure (e.g. Santa Ana et al., 2006; Speirs, Herring, Cooper, Hardy, & Hind, 1974). So, it could be that the effects of validation on pain are dependent upon threat perceptions.

The current study aimed to examine the unique and combined effects of information language and validation on subjective pain reports. Using recent advances in virtual reality technology, we designed a controlled computer simulation (CCS) paradigm to manipulate validation (validation vs. invalidation). Two CCS scripts were created in which an avatar (virtual human) either validated or invalidated participants' reports about their experience with experimentally induced thermal stimuli. Before engaging in the CCS interaction, participants read a description of the thermal stimulation procedure that was formulated in either technical or plain language. We hypothesized that higher pain intensity and pain unpleasantness would be reported in the invalidation compared to the validation group, and in the technical language group compared to plain language group. Based on the premise that effects of social contextual factors on pain are largely dependent on threat appraisals of pain (Corley, Cano, Goubert, Vlaeyen, & Wurm, 2016; Karos, Meulders, Goubert, & Vlaeyen, 2018; Vlaeyen et al., 2009) and the assumption that technical language increases threat expectancies (e.g. Boston & Sharpe, 2005), we furthermore expected the effect of validation to be especially pronounced when technical language was used to introduce the thermal stimulus.

2. Methods

2.1. Participants

We conducted an a-priori power analysis to estimate the number of participants required to detect a medium effect size for the main effect of Group (i.e.: 4 groups formed by manipulation of validation and information language) in a repeated measure design (3 measures). This calculation indicated that 31 participants were needed in each group to obtain medium effect size ($\delta = 0.5$), with power ($1 - \beta$) set a 0.80, and $\alpha = 0.05$ (Gpower; Faul, Erdfelder, Lang, & Buchner, 2007).

132 female participants (mean age = 21.51 years, $SD = 2.40$; range 18–35 years) were thus recruited at Maastricht's university local community via the participant recruitment system SONA, advertisements in university buildings, and social media (i.e., Facebook). Only female participants were recruited to avoid possible confounding due to participants' gender, which is known to moderate the effect of communication style (Schimid Mast, Hall, & Rotter, 2007). The majority of participants were students (98%), studying at the Faculty of Psychology and Neuroscience (50%) or Health, Medicine, and Life Science (37%). Technical difficulties prevented storage of data for two participants, leaving data for 130 participants in the data file. Exclusion criteria were formulated as follows: current acute pain, history of chronic pain, cardiovascular disease (e.g. hypertension), metabolic disease (e.g. diabetes), use of analgesic medication on a regular basis, and pregnancy. Prior experience with experimental thermal stimuli was an additional exclusion criterion. All participants were requested to abstain from analgesic medication on the day of the experiment to reduce confounding due to the impact of such medication on pain reports. Participants received 1 course credit or a gift voucher (7.5 €) in exchange for participation. The Ethical Review Committee Psychology and Neuroscience (ERCPN) of Maastricht University approved the study protocol (ECPN number = 175_05_2017).

2.2. Design

In a 3 (Time) x 2 (Information language: technical vs. plain) x 2 (Validation: validation vs. invalidation) mixed factorial study design, participants were randomly assigned to one of four groups as created by the two between-subjects factors: 1. technical language – validation ($n = 33$); 2. technical language – invalidation ($n = 33$); 3. plain language – validation ($n = 32$); 4. plain language – invalidation ($n = 32$).

2.2.1. Technical versus plain language manipulation

Information language was manipulated via an information leaflet describing the thermal stimulation procedure in either technical or plain language (see supplementary material S6). Both descriptions introduced the thermal stimulator, the general study goals, and procedure, but differed regarding the language that was used in these descriptions. Medical, technical terms were used in one leaflet, while the other leaflet presented equivalent information in plain, daily language. Both information texts were developed for the purpose of this study and piloted for their effectiveness in inducing harm and threat expectancies regarding the upcoming thermal stimulus (see Todd, Sharpe, Colagiuri, & Khatabi, 2016). Fifty healthy college students participated in the pilot study, that was conducted online using Qualtrics (Qualtrics, Provo, UT). Participants were randomly distributed to one of both language texts and read either the technical ($n = 19$) or the plain language information ($n = 31$). Participants in the technical language group reported to expect the procedure to be significantly more harmful ($t(48) = 2.4$, $p = .02$, $d = 0.86$) and painful ($t(48) = 2.0$, $p = .04$, $d = 0.62$) than those in the plain language group. Participants in the technical language group also reported more worries regarding potential damaging effects of the stimulus ($t(48) = 1.7$, $p = .09$, $d = 0.58$) compared to those in the plain language group. However, this difference was not significant. After this pilot study, we asked a number of colleagues, who

were all experts in (experimental) pain research, to read over both information texts and comment on them. Based upon their advice, some minor textual modifications were made to come to the final descriptions as incorporated in the study.

2.2.2. Validation versus invalidation manipulation

Two controlled computer simulation (CCS) scripts were created in which a male avatar either validated or invalidated participants' reports regarding their experience with the thermal stimuli. Validating and invalidating statements were created on the basis of prior research (Edmond, 2015; Linton et al., 2012; Vangronsveld & Linton, 2012). Statements such as "It makes total sense you feel this way" and "Lots of people said they found it particularly stressful" are examples of validating responses. Statements such as "It does not make sense that you feel so stressed. Nobody else felt this stressed" and "There is no need to be so stressed! It is just a test" are example of invalidating responses. The avatar's statements were combined with non-verbal behaviors to strengthen their effectiveness and the natural perception of the message (Schmid Mast, 2009). Smiling and nodding were included as validating non-verbal behaviors; head shakes, sarcastic and frowning facial expressions were included as invalidating non-verbal behaviors (Vangronsveld & Linton, 2012; see supplementary material S7). Each script contained a total of 9 validating/invalidating messages, 3 per thermal stimulus. To mimic the natural flow of conversation, 4 message types were incorporated in the scripts: 1) textual statement alone (1 time); 2) non-verbal behavior alone (2 times); 3) textual statement + non-verbal behavior (4 times); and 4) no message (2 times). The "no message" type consisted of a brief expression without (in)validating content (e.g., "Hmmm", "Ok", and "Ok, right") and were included in each script to increase the natural perception and credibility of the interaction. For the "non-verbal behavior alone" message type, brief expressions like "Hmm", and "OK" were accompanied by non-verbal behaviors (e.g., frowning, smiling) to bring across (in)validating communication.

The interaction with the avatar took place in a question answer format, in which the avatar asked questions about the participant's feelings and experiences during the experimental procedure, thereby referring to the preceding and/or upcoming thermal stimulus. An example question is: "How tense did you feel"? Participants answered via selecting one of the shown options on the computer screen with the computer mouse. In the given example, possible response options were: "1) Not at all, 2) A little, 3) Moderately, and 4) A lot". The avatar then gave an (in)validating response that was customized to the answer option chosen by the participant. For instance, when the participant selected "Not at all", a possible avatar's invalidating response was "Weird ... I did not feel like that when I did it. I felt quite tense". However, when participant selected "A lot", a possible avatar's invalidating response was "Weird ... I did not feel like that when I did it. I was quite relaxed" (see supplementary material S8).¹

2.3. Materials

2.3.1. Computer controlled simulation (CCS)

The CCS environment consisted of an office room with a male avatar sitting behind a desk in front of the participant. A neutral office room was chosen, containing a desk, a window, a plant and a cabinet with two folders on it (see supplementary material S7). The avatar was dressed in casual clothes, and when he spoke, the subtitles of his speech were synchronically displayed on the screen. The avatar introduced himself as Thomas van der Werf, a male researcher working at the university. He was sitting in a neutral posture (straight back, arms

loosely resting on desk) behind the desk, holding a red button in his right hand. When a thermal stimulus was delivered, the avatar pressed this button, thereby contributing to the perception that the avatar administered the thermal stimulus.

The CCS was programmed in C# (C sharp). To create the avatar and environment 3D Studio Max (Autodesk, 2012; avatar), Blender 3D (2.78, Blender Foundation; environment) and Adobe Photoshop (CC, Adobe Systems Incorporated) were used. The simulation was displayed using Unity 3D (version 5, Unity Technology) on a 2D computer screen.

2.3.2. Thermal pain stimulation

Thermal stimulation was administered on the inner side of the wrist of the non-dominant hand using a Peltier-based, computerized thermal stimulator with a 3x3-cm² thermode (Medoc TSA-2001; Medoc Ltd, Ramat Yishai, Israel). Individual pain threshold was pre-calibrated in order to determine the intensity of the experimental thermal stimuli delivered during validation manipulation phase. The calibration procedure consisted of a series of four thermal stimulations with a gradually increasing temperature (at a rate of 1 °C/second) from baseline (32 °C). The participant pressed a button when the stimulus was first experienced as painful (threshold), after which the temperature immediately decreased (8 °C/second) back to baseline. Individual pain threshold was calculated as the average temperature over the last three trials (*Pain-threshold*).

The experimental thermal stimulus as used in the avatar interaction was designed as a tonic stimulus. It increased (1 °C/second) from baseline temperature (32 °C) to pain-threshold + 1 °C, to then oscillate between pain-threshold - 1 °C and pain-threshold + 1 °C for 15 s, and return back to baseline (8 °C/second) in the end (Boselie, Vancleef, & Peters, 2016). We chose to present a stimulus that oscillated around pain threshold to induce a certain level of ambiguity with respect to the sensation as being painful or not. As such, we aimed to prevent ceiling effects and allow room for the influence of contextual factors that we manipulated (Van Damme, Crombez, Wever, & Goubert, 2008).

2.4. Measures

2.4.1. Pain intensity and pain unpleasantness

The experienced painfulness and intensity of the thermal stimulus was assessed using a single VAS that was labelled at both extremes (0 = no sensation; 100 = extremely painful) as well as at the midpoint (50 = painful; adapted from Madden et al., 2016). The advantage of using this VAS is that two measures of the subjective sensory pain experience can be obtained. That is, by using the binary form, a measure of whether the stimulus was perceived as painful or not is obtained (*painfulness*: painful (> = 50) or non-painful (< 50)). By using the exact values as chosen on the VAS, a continuous measure of pain intensity is inferred (*pain intensity* - PI) from the same VAS.

Pain unpleasantness (PU) was measured on a single VAS measuring the unpleasantness of the sensation (0 = not at all; 100 = extremely). The difference between intensity and unpleasantness was clarified to each participant using the sound analogy (Price & Harkins, 1987).

2.4.2. Manipulation checks

2.4.2.1. Technical versus plain information. Following Todd et al. (2016), two VASs assessed the extent to which the information about the thermal stimulation induced threat expectancies: 1) "I think the upcoming procedure can be harmful for the forearm" (*harm expectancy*); 2) "I worry about the effects of the upcoming procedure on my arm during the task" (*worry*). Both VASs were labelled from 0 (strongly disagree) to 100 (strongly agree).

2.4.2.2. Validation versus invalidation. The effectiveness of the validation manipulation was assessed using six items that were modified after the Validating and Invalidating Behaviors Coding Scale (VIBCS; Fruzzetti, 2001). Three items measure the perception of being

¹ Note that a question-answer format was chosen to mimic a natural interaction between avatar and participants. Responses to validating and invalidating questions are not recorded and thus not analysed.

validated (e.g., “the avatar was responsive”) and three measure the perception of being invalidated (e.g., “the avatar was delegitimizing”). All items were rated on a VAS scale ranging between 0 (Never) and 100 (Always). The *validation manipulation check index* was calculated as the sum of scores on the validation manipulation check items and reversed-scores on invalidation manipulation check items.

2.4.3. State affect, pain catastrophizing, pain calibration stimulus, credibility, and experience with computers and video games

The *Positive and Negative Affect Schedule* (PANAS; Watson, Clark, & Tellegen, 1988) is a 20-item self-report measure comprising two subscales (10 items each) that measure positive affect (PA) and negative affect (NA). Each item is rated on a 5-point Likert scale (1 = not at all; 5 = very much). PANAS has been shown to be reliable and valid measure (Crawford & Henry, 2004).

The *Pain Catastrophizing Scale* (PCS; Sullivan, Bishop, & Pivik, 1995) consists of 13 items that assess the individual's tendency to think catastrophically in response to pain. All items are rated on a 5-point Likert scale (0 = not at all; 4 = always). The PCS has good validity and reliability (Osman et al., 2000).

Two VASs (100 mm) tapped into the perceived harmfulness (The thermal stimuli are harmful to my forearm; Threat harm) and worry (I worry about the risk at damage to my forearm of these stimuli; Threat worry) of the calibrated thermal stimulus. Each VAS was labelled strongly disagree (0) at one extreme and strongly agree (100) at the other extreme.

Two VASs tapped into the extent to which participants experienced the CCS as credible and realistic (simulation credibility) and how realistic they perceived the interaction with the avatar (interaction credibility). In addition, 2 VASs were included to tap into participants' prior experience with computers (computer experience) and video games (video-game experience; Schmid Mast, 2007). All VASs ranged from 0 (not at all) to 100 (extremely).

2.5. Procedure

Before the start of the experimental session, participants were randomly assigned to one of four groups based on a computer-generated randomisation sequence (www.random.org). Exclusion criteria were checked twice: before scheduling the appointment and at the beginning of the test session. Written informed consent was obtained from all participants upon their arrival to the lab.

Fig. 1 provides an overview of the experimental session procedure. At the start of the session, the PANAS was administered (baseline PA and baseline NA). Subsequently, the experimenter attached the thermode on the participant's non-dominant arm. For the rest of the experiment, the participant was sitting comfortably with the arm resting on the table and the thermode attached. The calibration procedure was initiated to determine the pain threshold of the participant. After this, the participant provided ratings of PI, PU, and threat appraisal for the thermal stimuli that were administered during calibration (PI calibration, PU calibration, Threat harm and Threat worry). Next, the participant read the information leaflet describing the thermal stimulus as used during the experimental sessions (technical versus plain language manipulation) and completed the manipulation check for the language manipulation. Next, the CCS interaction with the avatar (validation manipulation) commenced. To enhance feelings of immersion, participants wore headphones and the light in the test room was dimmed during the CCS. Three thermal stimuli were administered, respectively called *t1*, *t2*, *t3*. Each stimulus was preceded by the conversation between the participant and the avatar.

Immediately after three (in)validating responses using this question-answer format, the avatar pressed a button to administer the experimental thermal stimulus (15 s). After each thermal stimulus, the participant rated PI and PU on a tablet that was positioned on the desk in front of the participant. Following Arntz and Claessens (2004),

participants also completed VASs on perceived warmth and perceived painfulness. However, these qualities were included as filler items to derive attention from our main interest in PI and PU and are not analysed or reported.

Upon completion of the CCS, the participant filled in the validation manipulation check items, the PCS, VASs about credibility, computer/video game experience, and demographic questions tapping into basic information about the participants (age, educational level, study (if applicable), professional occupation (if applicable), and nationality). To end, participants were given the opportunity to answer an open-ended question regarding their ideas on the goal and hypotheses of the study. All questionnaires and VASs were administered via a tablet, using Qualtrics software (Qualtrics, Provo, UT).

Additional self-report measures (Fear of Pain Questionnaire, Difficulties in Emotion Regulation Questionnaire) were administered for exploratory purposes (see [Supplementary Table S5](#)).

Before leaving the lab, the participant was fully debriefed about study aims and received participant remuneration (credit/voucher).

The experimenter (female) was in an adjacent room to the participant room during the calibration procedure, the CCS interaction and while the participant read the information language leaflet. She only entered the participant room at the very beginning of the study to give oral instructions and collect the informed consent form, and at the very end of the session to provide the debriefing. The experimenter could monitor the participant during the entire experimental procedure via a video monitoring system. During the calibration phase, the experimenter communicated with the participant via an intercom system. The use of a standardized script ensured standardization of 1) the instructions given to the participants, and 2) the participant-experimenter interaction throughout the experiment. All experimental sessions took place at the Faculty of Psychology and Neuroscience, Maastricht University, between February and April 2017.

2.6. Statistical analysis

All statistical analyses were run using IBM Statistics SPSS 25. Descriptive analyses were performed and data were checked for normality. The distribution of the following variables was highly skewed: Threat Harm (calibration), Threat Worry (calibration), manipulation check information language, manipulation check validation items. For these variables, non-parametric analyses were adopted.

A series of one-way ANOVAs was conducted to check for baseline differences between the four groups on PCS, Baseline NA, Baseline PA, age, Pain-threshold, PI calibration, and PU calibration, computers and video games experience. Kruskal-Wallis H Test over the four groups were performed on Threat Harm and Threat Worry items at calibration stage. Follow-up analyses were performed using pairwise comparisons (Bonferroni corrected).

Mann-Whitney U Tests were used to test the effects of the manipulation of information language and validation on their respective manipulation check measures. For cross-validation, Mann-Whitney U Tests were performed with information language as between-subject factor and validation manipulation check index as dependent variable; and with validation as between-subject factor and information language manipulation check items as dependent variables.

To test the effects of information language and validation on PI and PU, two 3 (Time: *t1*, *t2*, *t3*; WS) x 2 (Information language: technical vs. plain; BS) x 2 (Validation: validation vs. invalidation; BS) mixed factorial ANCOVAs were performed, with PI-continuous and PU as dependent variables. In case the assumption of sphericity was violated, Greenhouse-Geisser corrections are reported. Uncorrected degrees of freedom and corrected *p*-values are reported together with ϵ and the effect size indication η_p^2 . Additionally, a 2 (information language: technical vs. plain) x 2 (validation: validation vs. invalidation) ANCOVA was performed on the proportion of thermal trials that was rated as painful, i.e., a score higher or equal to 50 on the painfulness

Fig. 1. Flowchart of experimental session procedure.

Note. The participant first completed the PANAS (baseline positive and negative affect). After attaching the thermode on participant's arm, the experimenter started the calibration procedure to establish individual pain-threshold. Next, participants rated PI (1 item, PI calibration), PU (1 item; PU calibration), threat appraisal (2 items, threat harm and threat worry). The participant read the information about the upcoming thermal stimulation (information language manipulation) and completed the information language manipulation check items. The interaction with the avatar was then initiated (validation manipulation) and 3 thermal stimuli were delivered. Each thermal stimulus was accompanied by (in)validating interaction with the avatar. Participants rated PI and PU after each thermal stimulus. In the end, the participant completed the validation manipulation check and questions tapping into demographic information, pain catastrophizing level (PCS), credibility of procedure and VR environment (credibility ratings) and prior experience with computer and video games (prior experience).

VAS. Moreover, One Way ANCOVA's were carried out to test for differences between the four groups at each time point, using pairwise comparisons (Bonferroni corrected). In all these analyses, Pain-threshold and PCS were included as covariates to control for their influence on pain reports (Weissman-Fogel, Sprecher, & Pud, 2008). Both covariates were centered prior to being entered in the mixed factorial ANCOVA. However, despite being generally considered a trait variable, PCS has been suggested to be sensitive to experimental manipulations, thereby reflecting situational rather than trait catastrophizing when PCS is completed at the end of an experimental session (Thorn et al., 2004). For this reason, we performed sensitivity analyses in which PCS was omitted as a covariate. Given the specific interest in group differences, we also performed a series of one-way ANCOVA's for each dependent variable at each separate time point. Pairwise comparisons (Bonferroni corrected) were inspected to decide on differences between the groups.

Lastly, two one-way ANOVAs were conducted to check for group differences on the credibility items.

3. Results

3.1. Baseline demographics

Table 1 displays descriptive statistics of age, Pain-threshold, PCS, baseline PA, baseline NA, PI calibration, PU calibration, Threat harm, and Threat worry (calibration), computer experience, and video-game experience for each of the four groups. Supporting successful randomisation, no significant differences were observed between the four groups on age, PCS, Baseline PA, Baseline NA, computer & video-game experience, Pain-threshold, and their experience with the calibration stimulus (PI calibration, PU calibration (all $p > .13$). Kruskal-Wallis H tests showed that groups did not differ on Threat harm and Threat worry (all $p > .49$).

3.2. Manipulation checks

Table 2 displays the descriptive statistics of the information language manipulation check items (i.e., worry and harm expectancy) and the validation manipulation check index per group. Participants in the validation group reported significantly higher scores on the validation manipulation check index compared to the invalidated participants ($U = 12.00$, $p < .01$, $r = -0.85$), indicating the validation manipulation was effective. No significant difference was found between plain and technical language groups on the information language manipulation check items worry ($U = 1989.00$, $p = .56$, $r = -0.01$) and harm expectancy ($U = 2049.00$, $p = .77$, $r = -0.13$), suggesting that the information language manipulation did not induce higher threat expectancies for the upcoming thermal stimulation in the technical language group compared to the plain language group. Furthermore, there was no difference between validation and invalidation on the information language manipulation check items (worry ($U = 2069.00$, $p = .84$, $r = -0.15$); harm expectancy ($U = 1965.00$, $p = .50$, $r = -0.20$)). In addition, no effect was found of information language on the validation manipulation check index ($U = 2092.00$, $p = .92$, $r = -0.01$).

3.3. Pain outcome variables

3.3.1. Pain intensity (PI)

Results of the $3 \times 2 \times 2$ ANCOVA on PI scores showed a main effect of time ($F(2,248) = 18.19$, $\epsilon = 0.87$, $p < .001$, $\eta_p^2 = 0.13$). Pairwise comparisons, using Bonferroni correction showed a significant reduction in PI from the first to the second (mean difference = 6.98, $p < .001$), but not from the second to third thermal stimulus (mean difference = -0.60 , $p = 1$). The covariate Pain-threshold was significant ($F(1,124) = 62.40$, $p < .001$; $\eta_p^2 = 0.36$), as was the time*PCS interaction ($F(2, 248) = 0.476$, $\epsilon = 0.87$, $p = .01$, $\eta_p^2 = 0.04$). No further main or interaction effects were observed. Fig. 2

Table 1

Descriptive statistics of age, PCS, PANAS (baseline NA and baseline PA), Pain-threshold, ratings on computer & video-game experience items and ratings after the calibration procedure (PI calibration, PU calibration, Threat harm, Threat worry) per group.

	Invalidation						Validation					
	Medical (n = 33)			Plain (n = 32)			Medical (n = 33)			Plain (n = 32)		
	M(SD)	Min	Max	M(SD)	Min	Max	M(SD)	Min	Max	M(SD)	Min	Max
Age	21.80(2.60)	18	29	21.40(2.40)	18	28	21.80(2.40)	18	27	21.20(2)	18	25
PCS	21.67(8.97)	8	40	19.81(7.17)	7	38	16.79(9.87)	2	44	20.22(7.75)	10	41
Baseline PA	29.06(6.90)	15	43	29.13(5.60)	17	39	27.88(6)	16	4	29.34(4.84)	21	38
Baseline NA	13.73(2.78)	10	20	15.06(3.69)	10	25	14.76	10	24	14.53(3.72)	10	30
Pain-threshold	41.85(3.52)	34.70	47.60	42.47(3.14)	35.00	47.70	42.94(3.06)	35.20	49.60	42.20(3.62)	35.90	48.70
Computer experience	28.80(30.06)	0	100	29(19.91)	0	81	29(24.47)	0	82	31.70(25.60)	4	100
Video-game experience	70.80(24.60)	10	100	67.56(24.72)	0	100	68.55(23.35)	7	100	64.70(19.91)	19	100
PI calibration	46.76(10)	29	63	51.37(12.60)	22	77	47.42(13.25)	13	81	47.56(14.10)	14	73
PU calibration	41.92(20.43)	4	84	49.50(24.60)	0	90	43.48(26.18)	0	100	45.66(23.65)	6	100
Threat harm	10.70(17.30)	0	77	14.88(20.86)	0	85	13.21(25.30)	0	100	12.78(15.06)	0	57
Threat worry	8.15(12.64)	0	50	7.63(12.31)	0	60	10.94(21.10)	0	100	8.63(13.40)	0	58

Notes. PCS = Pain catastrophizing scale; Baseline PA = Positive affect assessed in the beginning of the experimental session; Baseline NA = Negative affect assessed in the beginning of the experimental session; Pain-Threshold = the average threshold temperature (degrees Celsius) over the last three calibration trials; computer experience: ratings on the computer experience item; video game experience: ratings on the video game item; PI calibration = pain intensity measured immediately after calibration procedure; PU calibration = pain unpleasantness measured immediately after calibration procedure; Threat harm & Threat worry = threat appraisal items administered immediately after calibration procedure.

Table 2

Descriptive statistics of ratings on information language manipulation check items (i.e., worry and harm expectancy) and validation manipulation check index per group.

	Invalidation						Validation						
	Technical language (n = 33)			Plain language (n = 32)			Technical language (n = 33)			Plain language (n = 32)			
	<i>M(SD)</i>	Min	Max	<i>M(SD)</i>	Min	Max	<i>M(SD)</i>	Min	Max	<i>M(SD)</i>	Min	Max	
Validation manipulation check index	25.90(15.94)	0	62.17	26.35(15.05)	0	55.33	81.61(12.34)	56	67	100	79.67(11.98)	53	100
Information language manipulation check worry	11.73(16.97)	0	75	9.81(13.64)	0	65	14.45(24.12)	0		100	8.78(12.37)	0	61
Information language manipulation check harm expectancy	11.42(15.67)	0	75	8.56(11.92)	0	58	15.76(25.94)	0		100	9.75(9.75)	0	51

Fig. 2. Mean and standard error of pain intensity ratings adjusted for the covariates (individual pain threshold and PCS score) per group for each of the three thermal trials.

displays the mean and standard error of PI adjusted for both covariates per group over time. Pairwise comparisons as resulting from the one-way ANCOVAs on PI did not reveal significant differences between the groups on any of the three time points (all $p > .21$).

Results of the 2×2 ANCOVA on the proportion of thermal trials that were rated as painful (painfulness) showed that the covariate Pain-threshold ($F(1,124) = 53.02, p < .001, \eta_p^2 = 0.30$) was significant. No other main or interaction effects were observed. Pairwise comparisons showed no differences between the groups at any of the time points (all $p > .34$). Results of the sensitivity analyses excluding pain catastrophizing as a covariate revealed the same pattern of findings.

Descriptive statistics and full results of AN(C)OVA are reported in supplementary tables (see [Tables S1–S4](#)).

3.3.2. Pain unpleasantness (PU)

Results of the $3 \times 2 \times 2$ ANCOVA on PU showed a significant reduction in PU ratings over time ($F(2, 248) = 33.92, \epsilon = 0.86, p < .001, \eta_p^2 = 0.22$), with a significant reduction in PU from t1 to t2 (mean difference = 11.59, $p < .001$), but not from t2 to t3 (mean difference = $-1.48, p = .69$). The covariate Pain-threshold was significant with $F(1,124) = 33.03, p < .001, \eta_p^2 = 0.21$. No other main or interaction effects were observed. [Fig. 3](#) displays the mean and standard error of PU, adjusted for both covariates, per group over time. Pairwise comparisons did not show any group differences in PU at any of the three time points (all $p > .35$). Results of the sensitivity analyses without PCS as covariate showed a similar pattern of results.

Fig. 3. Means and standard error of pain unpleasantness ratings adjusted for the covariates (individual pain threshold and PCS score) per group for each of the three thermal trials.

Table 3

Descriptive statistics of ratings on simulation & interaction credibility items.

	Invalidation						Validation					
	Technical language (n = 33)			Plain language (n = 32)			Technical language (n = 33)			Plain language (n = 32)		
	M(SD)	Min	Max	M(SD)	Min	Max	M(SD)	Min	Max	M(SD)	Min	Max
Simulation credibility	40.24(24.18)	0	93	41.78(31.43)	4	94	35.52(22.70)	2	78	31.8(19.3)	0	68
Interaction credibility	44.61(25.23)	6	94	39.72(26.60)	1	97	49.15(29.01)	4	100	51.53(26.54)	1	99

Descriptive statistics and full results of ANCOVA are reported in supplementary tables (see [Tables S1–S2](#)).

3.3.3. CCS credibility

No differences were observed between the groups on the credibility items with $F(3, 126) = 1.08$, $p = .36$, $\eta_p^2 = 0.02$ for the credibility of the simulation, and $F(3, 126) = 1.21$, $p = .30$, $\eta_p^2 = 0.02$ for the credibility of the avatar interaction ([Table 3](#)).

4. Discussion

Pain is a highly subjective experience that is susceptible to contextual influences (e.g., [Arntz & Claessens, 2004](#); [Montoya et al., 2004](#); [Rocha et al., 2003](#)). The current study examined the effects of social contextual elements on pain reports in a controlled laboratory study. More specifically, the language used to explain upcoming thermal stimuli (i.e., technical vs. plain) and the communication strategy (i.e., validating versus invalidating) used to interact with the recipient on these stimuli was manipulated. Results showed no effect of information language and validation on pain intensity and pain unpleasantness ratings. Taken together, results seem to suggest that, given the current experimental set-up, information language and validation have no strong impact on the subjective experience of a thermal stimulus that oscillates around pain threshold level in terms of its experienced painfulness and unpleasantness. However, a number of factors should be considered for their influence on the current results.

First, while the manipulation of validation was found to be successful, the manipulation of information language was suboptimal: describing the thermal stimulus procedure in technical language did not yield higher threat expectancies in this group compared to the group that read the description in plain language. Several reasons might underlie the suboptimality of the information language manipulation in inducing differential threat expectancies. A first reason concerns the positioning of the information language manipulation in the experimental procedure. Participants read the descriptive information and answered the manipulation check questions immediately following the pain threshold calibration procedure. Participants therefore may have interpreted the information about the upcoming stimuli based on their previous experience with the calibration stimuli, which was appraised as low threatening in all groups (ratings around 10 on 100 VASs; see [Table 1](#)). To prevent the calibration procedure to influence the information language manipulation, future experiments might consider the use of two test sessions, separating the calibration phase from the actual experimental phase. Second, the majority of participants were students from either the psychology or medicine department and are probably quite familiar with the vocabulary used in the technical language information text, reducing its power to induce threat. Indeed, health-literacy level of the recipient might be a relevant factor to consider when investigating the effect of information about treatment procedures and symptoms (e.g., pain; [Sudore et al., 2009](#)). We could not test for this presumed role of health literacy since we omitted to check for the extent to which the descriptions were perceived as technical, plain, difficult, or easy to understand. The fact that the technical language text was found effective in yielding threat expectancies on the thermal stimulus in the pilot study, but not in the main study is

remarkable, and emphasizes the importance of piloting the manipulation in a setting that is comparable to the actual experiment. Note that participants in the pilot study, which was conducted online, did not have any visual or experiential prior knowledge on the thermal stimulation device when reading the information sheet. It is thus possible that threat expectancies in the pilot study are partly explained by unfamiliarity with the apparatus. In contrast, participants in the laboratory study read the texts and provided threat expectancy ratings in the lab environment after the calibration phase. At this stage, prior knowledge about the apparatus/stimuli and the knowledge that one is in a safe lab environment might have hampered occurrence of differential threat expectancies by reading through the different texts. Moreover, in examining effects of validation to be dependent on a threatening perception, it might be more appropriate to create actual threatening instructions in future studies, using suggestions of tissue damage, or of increasing pain rather than technical language solely ([Boston & Sharpe, 2005](#)). Finally, when designing our study, we opted to induce the information language manipulation via information leaflets instead of real-life interpersonal communication. This choice was driven by our interest in disentangling effects of the validation and information manipulations and their interaction on the pain outcomes. However, the use of technical language in real-life interpersonal communication is considered relevant for patient-doctor communication as well and might affect pain outcomes in a different manner. Future studies could address this question further by offering the information language manipulation via real-life interpersonal communication, for example by the avatar providing the information about the thermal stimulus.

Irrespective of the success of the information language manipulation, we did not observe an effect of validation on pain intensity and pain unpleasantness reports. Prior research already yielded mixed results regarding effects of validation, with some reporting beneficial effects of validation on subjective pain reports ([Leong et al., 2015](#); [Cline et al., 2006](#)) while others did not observe such effects ([Linton et al., 2012](#)). These mixed findings point at a complex relation between validation and pain and suggest other variables may moderate its effect on pain. We hypothesized that the effects of validation on pain are dependent upon the threat perception of pain and painful procedures. Alike other social influences, validation might also particularly affect pain in circumstances that are perceived as highly threatening (e.g., [Vlaeyen et al., 2009](#)). We aimed to induce this threat by introducing a thermal stimulus that oscillated around pain threshold level in technical language, but this manipulation failed. The combination of a mildly painful stimulus with non-threatening information and the safety of the experimental setting could have resulted in a rather safe perception of the thermal stimulation procedure as a whole, thereby hampering effects of validation to become apparent on pain ratings. Moreover, the pain-free status of our sample might hold that they experience the thermal stimuli and interacting about them as less threatening than people with an illness, who experience painful procedures as highly distressful ([Kuppenheimer & Brown, 2002](#)). The type of pain stimulus itself could also have resulted in decreased threat perception. We chose a stimulus that oscillated around pain threshold to mimic an ambiguous stimulus that allowed effects of our manipulations to be apparent. The drawback of this choice might be that such an ambiguous stimulus lacks

the potential to become threatening.

In addition to perceived threat, other variables can be identified as moderators for effects of validation on pain reports. For instance, characteristics of the source of a message (e.g., level of familiarity with the source) have repeatedly been found to influence the way the recipient evaluates and takes in account the information received (e.g. Bordia, DiFonzo, Haines, & Chaseling, 2005). Similarly to Linton et al. (2012), we introduced the avatar as a researcher at the university, and hence as a person who is unfamiliar to the participant. On the contrary, Leong et al. (2015) and Cline et al. (2006) observed an effect of validation on pain using a source of message who was a close other (e.g. romantic partner or parent). It is possible that the participant easily dismissed the invalidating message because this information was provided by a person who is unknown and unrelated to them, resulting in minimal impact of invalidating messages on pain reports. In future research, it would be valuable to take the message source in consideration when examining validation effects on pain reports. Here, it might be of interest to evaluate potential differential effects of a practitioner (significant other in terms of technical knowledge), a romantic partner (significant other in terms of interpersonal relationship) and experimenter (non-significant other).

Finally, it seems worthwhile to mention that (in)validating messages were delivered in the context of three thermal stimuli, which introduced the WS factor Time in our design. Multiple thermal stimulations and a prolonged interaction between avatar and participant are considered necessary in order to manipulate validation and allow effects thereof to become apparent in the context of experimental acute pain (Edmond, 2015; Linton et al., 2012). The effect of Time was found to be significant, presumably reflecting learning effects attributable to prior experience with the oscillating thermal stimulus from the first to the second and third thermal stimulus. Importantly though, the effect of validation was found to be nonsignificant despite the prolonged interaction between avatar and participant.

Despite its shortcomings, this study offers an interesting model for researchers interested in investigating the effects of social contextual factors on pain experience. The CCS is a promising tool to study the role of social contextual elements, including communicative behaviors, on the way in which pain is experienced. The use of the CCS enables us to manipulate validation while controlling for confounding factors that are likely to influence the evaluation of the conversation (e.g., changes in daily performance of the validating experimenter), and thus reducing variability across interactions (e.g. Linton et al., 2012). The possibility to interact with the avatar is furthermore proposed to increase ecological validity over other experimental methods (e.g., watching a videotaped interaction; Schmid Mast, Hall, & Roter, 2007). A potential clinical use of the CCS concerns the training of medical students and health care providers in diverse communication skills. Indeed, research has shown that virtual reality (VR) can be effectively used in training medical students' emphatic communications skills (e.g., Kleinsmith, Rivera-Gutierrez, Finney, Cendan, & Lok, 2015). Conversely, the CCS also comes with some limitations. Notwithstanding the success of the validation manipulation, some participants indicated that the conversation was somewhat artificial with the avatar being too direct in his message. Moreover, the presence of subtitles on the screen could have distracted from the facial expressions and/or intonation used by the avatar. These shortcomings emphasize the importance of piloting the CCS validation manipulation in a setting that is comparable to the actual experiment. Last, using CCS rather than a full-immersive VR setting might have negatively impacted the level of immersion and the perception of the situation as real. In fact, some participants reported that they did not take the avatar's answers serious, since they were clearly aware that it was a computer. Using a full-immersive VR methodology in future studies might overcome at least some of these shortcomings.

Taken together, this study emphasizes the need for further research investigating the interactive effects of validation and providing information on the experience of pain. Communicating information about

current or anticipated pain occurrences is a common part of daily medical practice in both acute and chronic health conditions. In examining effects of communication, it is important to consider both face-to-face and written communication as both forms of transferring factual information about disease and symptoms are common in clinical practice. For instance, practitioners often give information brochures to their patients for further reading on their condition (Hill-Briggs & Smit, 2008), and patients easily turn to the internet and other online platforms to learn about their condition (Newhouse, Atherton, & Zieband, 2018). Gaining more insight in the effects of communication about pain on pain experience is crucial to understand how to train health-care professionals to react and inform their patients and will benefit the way pain is explained and communicated to patients in written (online) communications.

5. Declaration of interest and acknowledgments

The authors have no conflict of interest to declare.

Martina D'Agostini was partially supported for her work on writing up this study by the "Asthenes" long-term structural funding [METH/15/011]. Kai Karos is a doctoral researcher supported by the Research Foundation Flanders, Belgium [111015N].

We thank Richard Benning for programming the computer controlled simulation, Thomas Fuller for helping us in operationalising the validation/invalidation scripts (audio files), and Laura Denissen for her help in data collection.

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.jbtep.2019.03.008>.

References

- Arntz, A., & Claessens, L. (2004). The meaning of pain influences its experienced intensity. *Pain*, 109(1), 20–25. <https://doi.org/10.1016/j.pain.2003.12.030>.
- Bordia, P., DiFonzo, N., Haines, R., & Chaseling, E. (2005). Rumors denials as persuasive messages: Effects of personal relevance, source, and message characteristics. *Journal of Applied Social Psychology*, 35(6), 1301–1331. <https://doi.org/10.1111/j.1559-1816.2005.tb02172.x>.
- Boselie, J. J., Vancleef, L. M., & Peters, M. L. (2016). The effects of experimental pain and induced optimism on working memory task performance. *Scandinavian Journal of Pain*, 12, 25–32. <https://doi.org/10.1016/j.sjpain.2016.03.001>.
- Boston, A., & Sharpe, L. (2005). The role of threat-expectancy in acute pain: Effects on attentional bias, coping strategy effectiveness and response to pain. *Pain*, 119, 168–175. <https://doi.org/10.1016/j.pain.2005.09.032>.
- Cano, A. (2004). Pain catastrophizing and social support in married individuals with chronic pain: The moderating role of pain duration. *Pain*, 110, 656–664. <https://doi.org/10.1016/j.pain.2004.05.004>.
- Cline, R. J. W., Harper, F. W. K., Penner, L. A., Peterson, A. M., Taub, J. W., & Albrecht, T. L. (2006). Parent communication and child pain and distress during painful pediatric cancer treatments. *Social Science & Medicine*, 63(4), 883–898. <https://doi.org/10.1016/j.socscimed.2006.03.007>.
- Corley, A. M., Cano, A., Goubert, L., Vlaeyen, J. W. S., & Wurm, L. H. (2016). Global and situational relationship satisfaction moderate the effect of threat on pain in couples. *Pain Medicine*, 17(9), 1664–1675. <https://doi.org/10.1093/pm/pnw022>.
- Crawford, J. R., & Henry, J. D. (2004). The Positive and Negative Affect Schedule (PANAS): Construct validity, measurement properties and normative data in a large non-clinical sample. *British Journal of Clinical Psychology*, 43, 245–265. <https://doi.org/10.1348/0144665031752934>.
- Edmond, S. N. (2015). *The Influence of Validation of pain-related Thoughts and Feelings on Positive and negative affect* Doctoral Dissertation. Retrieved from <https://dukespace.lib.duke.edu/dspace/handle/10161/10459>.
- Edmond, S. N., & Keefe, F. J. (2015). Validating pain communication: Current state of the science. *Pain*, 156(2), 215–219. <https://doi.org/10.1097/01.j.pain.0000460301.18207.c2>.
- Falvo, D., & Tippy, P. (1988). Communicating information to patients: Patient satisfaction and adherence as associated with resident skill. *Journal of Family Practice*, 26(6), 643–647.
- Faul, F., Erdfelder, E., Lang, A.-G., & Buchner, A. (2007). G*Power 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences. *Behavior Research Methods*, 39(2), 175–191.
- Flor, H., Kerns, R. D., & Turk, D. C. (1987). The role of spouse reinforcement, perceived pain, and activity levels of chronic pain patients. *Journal of Psychosomatic Research*, 31, 251–259. [https://doi.org/10.1016/0022-3999\(87\)90082-1](https://doi.org/10.1016/0022-3999(87)90082-1).

- Fruzzetti, A. (2001). *Validating and invalidating behaviours coding scale*. Reno, NV: University of Nevada.
- Hill-Briggs, F., & Smit, A. S. (2008). Evaluation of diabetes and cardiovascular disease print patient education materials for use with low-health literate populations. *Diabetes Care*, 31(4), 667–671. <https://doi.org/10.2337/dc07-1365>.
- Hurter, S., Paloyelis, Y., de C. Williams, A. C., & Fotopoulou, A. (2014). Partners' empathy increases pain ratings: Effects of perceived empathy and attachment style on pain report and display. *The Journal of Pain*, 15(9), 934–944. <http://doi.org/10.1016/j.jpain.2014.06.004>.
- Jackson, L. D. (1992). Information complexity and medical communication: The effects of technical language and amount of information in a medical message. *Health Communication*, 4(3), 197–210. https://doi.org/10.1207/s15327027hc0403_3.
- Jackson, T., Pope, L., Nagasaka, T., Fritch, A., Lezzy, T., & Chen, H. (2005). The impact of threatening information about pain on coping and pain tolerance. *British Journal of Health Psychology*, 10(3), 441–451. <https://doi.org/10.1348/135910705X27587>.
- Karos, K., Meulders, A., Goubert, L., & Vlaeyen, J. W. S. (2018). The influence of social threat on pain, aggression, and empathy in women. *The Journal of Pain*, 19(3), 291–300. <https://doi.org/10.1016/j.jpain.2017.11.003>.
- Karsdorp, P. A., Ranson, P. A., Schrooten, M. G., & Vlaeyen, J. W. (2012). Pain catastrophizing, threat, and the informational value of mood: Task persistence during a painful finger pressing task. *Pain*, 153(7), 1410–1417. <https://doi.org/10.1016/j.pain.2012.02.026>.
- Kleinsmith, A., Rivera-Gutierrez, D., Finney, G., Cendan, J., & Lok, B. (2015). Understanding empathy training with virtual patients. *Computers in Human Behavior*, 52, 151–158. <https://doi.org/10.1016/j.chb.2015.05.033>.
- Koban, L., Jepma, M., Geuter, S., & Wager, T. D. (2017). What's in a word? How instructions, suggestions, and social information change pain and emotion. *Neuroscience & Biobehavioral Reviews*, 81(Pt A), 29–42. <https://doi.org/10.1016/j.neubiorev.2017.02.014>.
- Kuppenheimer, W. G., & Brown, R. T. (2002). Painful procedures in pediatric cancer: A comparison of interventions. *Clinical Psychology Review*, 22, 753–786. [https://doi.org/10.1016/S0272-7358\(02\)00105-8](https://doi.org/10.1016/S0272-7358(02)00105-8).
- Lang, E. V., Hatsiopoulou, O., Koch, T., Berbaum, K., Lutgendorf, S., Kettenmann, E., ... Kapchuk, T. J. (2005). Can words hurt? Patient-provider interactions during invasive procedures. *Pain*, 114(1), 303–309. <https://doi.org/10.1016/j.pain.2004.12.028>.
- Leong, L. E., Cano, A., Wurm, L. H., Lumley, M. A., & Corley, A. M. (2015). A perspective-taking manipulation leads to greater empathy and less pain during the cold pressor task. *The Journal of Pain*, 16(11), 1176–1185. <https://doi.org/10.1016/j.jpain.2015.08.006>.
- Levine, F. M., & de Simone, L. L. (1991). The effects of experimenter gender on pain report in male and female subjects. *Pain*, 44(1), 69–72. [https://doi.org/10.1016/0304-3959\(91\)90149-R](https://doi.org/10.1016/0304-3959(91)90149-R).
- Linehan, M. (1997). Validation and psychotherapy. In A. Bohart, & L. Greenberg (Eds.). *Empathy reconsidered: New Directions in psychotherapy* (353–392). Washington, DC: American Psychological Association.
- Linton, S. J., Boersma, K., Vangronsveld, K., & Fruzzetti, A. (2012). Painfully reassuring? The effects of validation on emotions and adherence in a pain test. *European Journal of Pain*, 16(4), 592–599. <https://doi.org/10.1016/j.ejpain.2011.07.011>.
- Madden, V. J., Bellan, V., Russek, L. N., Camfferman, D., Vlaeyen, J. W. S., & Moseley, G. L. (2016). Pain by association? Experimental modulation of human pain thresholds using classical conditioning. *The Journal of Pain*, 17(10), 1105–1115. <https://doi.org/10.1016/j.jpain.2016.06.012>.
- McPherson, C. J., Higginson, J., & Hearn, J. (2001). Effective methods of giving information in cancer: A systematic literature review of randomized controlled trials. *Journal of Public Health*, 23(3), 227–234. <https://doi.org/10.1093/pubmed/23.3.227>.
- Mistiaen, P., van Osch, M., van Vliet, L., Howick, J., Bishop, F. L., Di Blasi, Z., et al. (2016). The effect of patient-practitioner communication on pain: A systematic review. *European Journal of Pain*, 20(5), 675–688. <https://doi.org/10.1002/ejp.797>.
- Montoya, P., Larbig, W., Braun, C., Preissl, H., & Birbaumer, N. (2004). Influence of social support and emotional context on pain processing and magnetic brain responses in fibromyalgia. *Arthritis & Rheumatism*, 50(12), 4035–4044. <https://doi.org/10.1002/art.20660>.
- Muñoz Alamo, M., Ruiz Moral, R., & Pérula de Torres, L. A. (2002). Evaluation of a patient centred approach in generalized musculoskeletal chronic pain/fibromyalgia patients in primary care. *Patient Education and Counseling*, 48(1), 23–31. [https://doi.org/10.1016/S0738-3991\(02\)00095-2](https://doi.org/10.1016/S0738-3991(02)00095-2).
- Newhouse, N., Atherton, H., & Ziehl, S. (2018). Pain and the internet: Transforming the experience? In E. Gonzalez-Polledo, & J. Tarr (Eds.). *Painscapes* (pp. 129–155). London: Palgrave Macmillan. https://doi.org/10.1057/978-1-349-95272-4_7.
- Ong, L. M., de Haes, J. C., Hoos, A. M., & Lammes, F. B. (1995). Doctor-patient communication: A review of the literature. *Social Science & Medicine*, 40(7), 903–918. [https://doi.org/10.1016/0277-9536\(94\)00155-M](https://doi.org/10.1016/0277-9536(94)00155-M).
- Osman, A., Barrios, F. X., Gutierrez, P. M., Kopper, B. A., Merrifield, T., & Grittmann, L. (2000). The pain catastrophizing scale: Further psychometric evaluation with adult samples. *Journal of Behavioral Medicine*, 23(4), 351–365. <https://doi.org/10.1023/A:1005548801037>.
- Price, D. D., & Harkins, S. W. (1987). Combined use of experimental pain and visual analogues scales in providing standardized measurement of clinical pain. *The Clinical Journal of Pain*, 3, 1–8.
- Rocha, E. M., Prkachin, K. M., Beaumont, S. L., Hardy, C. L., & Zumbo, B. D. (2003). Pain reactivity and somatization in kindergarten-age children. *Journal of Pediatric Psychology*, 28 1, 47–57. <https://doi.org/10.1093/jpepsy/28.1.47>.
- Ruben, M. A., Blanch-Hartigan, D., & Hall, J. A. (2017). Non-verbal communication as a pain reliever: The impact of physician supportive non-verbal behavior on experimentally induced pain. *Health Communication*, 32(8), 970–976. <https://doi.org/10.1080/10410236.2016.1196418>.
- Santa Ana, E. J., Saladin, M. E., Back, S. E., Waldrop, A. E., Spratt, E. G., McRae, A. L., et al. (2006). PTSD and the HPA axis: Differences in response to the cold pressor task among individuals with child vs. adult trauma. *Psychoneuroendocrinology*, 31(4), 501–509. <https://doi.org/10.1016/j.psypneuen.2005.11.009>.
- Schimid Mast, M., Hall, J. A., & Roter, D. L. (2007). Disentangling physician sex and physician communication style: Their effects on patient satisfaction in a virtual medical visit. *Patient Education and Counseling*, 68(1), 16–22. <https://doi.org/10.1016/j.pec.2007.03.020>.
- Schmid Mast, M. (2009). On the importance of non-verbal communication in the physician-patient interaction. *Patient Education and Counseling*, 67(3), 315–318. <https://doi.org/10.1016/j.pec.2007.03.005>.
- Shenk, C. E., & Fruzzetti, A. E. (2011). The impact of validating and invalidating responses on emotional reactivity. *Journal of Social and Clinical Psychology*, 30, 163–183. <https://doi.org/10.1521/jscp.2011.30.2.163>.
- Speirs, R. L., Herring, J., Cooper, W. D., Hardy, C. C., & Hind, C. R. (1974). The influence of sympathetic activity and isoprenaline on the secretion of amylase from the human parotid gland. *Archives of Oral Biology*, 19(9), 747–752. [https://doi.org/10.1016/0003-9969\(74\)90161-7](https://doi.org/10.1016/0003-9969(74)90161-7).
- Sudore, R. L., Landefeld, C. S., Pérez-Stable, E. J., Bibbins-Domingo, K., Williams, B. A., & Schillinger, D. (2009). Unravelling the relationship between literacy, language proficiency, and patient-physician communication. *Patient Education and Counseling*, 75, 398–402. <https://doi.org/10.1016/j.pec.2009.02.019>.
- Sullivan, M. J. L., Bishop, S. R., & Pivik, J. (1995). The pain catastrophizing scale: Development and validation. *Psychological Assessment*, 7, 524–532. <https://doi.org/10.1037/1040-3590.7.4.524>.
- Thorn, B. E., Clements, K. L., Ward, L. C., Dixon, K. E., Kersh, B. C., Boothby, J. L., et al. (2004). Personality factors in the explanation of sex differences in pain catastrophizing and response to experimental pain. *The Clinical Journal of Pain*, 20(5), 275–282.
- Todd, J., Sharpe, L., Colagiuri, B., & Khatibi, A. (2016). The effect of threat on cognitive biases and pain outcomes: An eye-tracking study. *European Journal of Pain*, 20(8), 1357–1368. <https://doi.org/10.1002/ejp.887>.
- Van Damme, S., Crombez, G., Wever, K. N., & Goubert, L. (2008). Is distraction less effective when pain is threatening? An experimental investigation with the cold pressor task. *European Journal of Pain*, 12, 60–67. <https://doi.org/10.1016/j.ejpain.2007.03.001>.
- Vangronsveld, K. L., & Linton, S. J. (2012). The effect of validating and invalidating communication on satisfaction, pain and affect in nurses suffering from low back pain during a semi-structured interview. *European Journal of Pain*, 16, 239–246. <https://doi.org/10.1016/j.ejpain.2011.07.009>.
- Vlaeyen, J., Hanssen, M., Goubert, L., Vervoort, T., Peters, M., van Breukelen, G., et al. (2009). Threat of pain influences social context effects on verbal pain report and facial expression. *Behaviour Research and Therapy*, 47(9), 774–782. <https://doi.org/10.1016/j.brat.2009.05.008>.
- Watson, D., Clark, L. A., & Tellegen, A. (1988). Development and validation of brief measures of positive and negative affect: The PANAS scales. *Journal of Personality and Social Psychology*, 54(6), 1063–1070. <https://doi.org/10.1037/0022-3514.54.6.1063>.
- Weissman-Fogel, I., Sprecher, E., & Pud, D. (2008). Effects of catastrophizing on pain perception and pain modulation. *Experimental Brain Research*, 186(1), 79–85. <https://doi.org/10.1007/s00221-007-1206-7>.