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ORIGINAL ARTICLE

Computer-Delivered Social Norm Message Increases Pain Tolerance

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Abstract
Background Few experimental studies have been conducted on social determinants of pain tolerance.
Purpose This study tests a brief, computer-delivered social norm message for increasing pain tolerance.
Methods Healthy young adults (N=260; 44 % Caucasian; 27 % Hispanic) were randomly assigned into a 2 (social norm)×2 (challenge) cold pressor study, stratified by gender. They received standard instructions or standard instructions plus a message that contained artifically elevated information about typical performance of others.
Results Those receiving a social norm message displayed significantly higher pain tolerance, $F(1, 255)=26.95$, $p<.001$, $\eta_p^2=.10$ and pain threshold $F(1, 244)=9.81$, $p=.002$, $\eta_p^2=.04$, but comparable pain intensity, $p>.05$. There were no interactions between condition and gender on any outcome variables, $p>.05$.
Conclusions Social norms can significantly increase pain tolerance, even with a brief verbal message delivered by a video.

Keywords Social norm · Descriptive norm · Injunctive norm · Pain · Technology · Brief intervention · 2×2 factorial

Introduction

Given the significant burden of pain on society, much research has been devoted to understanding and improving various aspects of pain, including pain tolerance. Low pain tolerance is associated with a variety of adverse outcomes, including mental health issues, such as addictive behaviors [1–3]. Relatively less research has linked pain tolerance directly to positive outcomes. However, positive traits such as optimism [4–6], self efficacy [7–9], and hope [6, 10, 11] are associated with higher pain tolerance or lower pain intensity, and positive traits are in turn linked with a variety of adaptive outcomes [12–14]. Furthermore, lower pain perception is linked with other adaptive characteristics such as better emotional regulation [15] and higher emotional intelligence [16].

There is a long history of testing interventions for reducing pain and it has been well-established that pain tolerance can be increased using a variety of methods. Despite the popularity of the biopsychosocial model for understanding and improving pain, experimental methods using social approaches are limited compared with biological or psychological approaches [17, 18]. The dearth of social approaches for improving pain is not due to ineffectiveness. The power of social modeling was demonstrated in formative studies when participants exposed to intolerant models displayed lower pain thresholds [19, 20] and tolerance [21] in the cold pressor task. This work has been replicated with children observing an exaggerated maternal reaction displaying lower pain tolerance than controls [22]. Social modeling conveys benefit even when the model is not live, such as through video [23–25]. The present study aims to build further the evidence base for the utility of social approaches in improving pain tolerance, and to demonstrate that this can occur with a simple manipulation. Specifically, the goal is to demonstrate that a computer-delivered social normative message via a simple verbal expression (as opposed to a model) can significantly influence pain tolerance. A model provides an example of what a behavior or experience looks like (either live or via video) but does not necessarily give specific information about the typical performance of other individuals, or convey whether the behavior is socially desirable or not.

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Social norms refer to the accepted rules or beliefs within a particular culture [26]. Descriptive norms refer to what most people do, and they motivate by providing evidence as to what a typical behavior would look like [27]. Injunctive norms refer to what is commonly approved or disapproved of in a given culture [26]. The idea that social norms affect behavior has a long history in psychology [27–30], and current studies continue to link social norms and behaviors such as substance use [31], gambling [32], organ donation [33], and environmental consumption [26, 34]. Some studies have shown that the effectiveness of behavioral interventions resides with changing social normative beliefs [35, 36].

Research with social norms has also been applied to changing health related behaviors including intention to use condoms [37], receive flu shots [38], and eat fruits and vegetables [39], as well as alcohol consumption [40]. Results of these studies show that people are motivated by what others do (descriptive norm), especially when the behavior is viewed positively (injunctive norm). Presently, one experimental study has used a social norm approach to manipulate pain intensity [41] and one has used a social comparison approach to manipulate pain tolerance [42] in a cold pressor task. In the Wilson et al. study [41], the normative standard consisted of false feedback with exaggeratedly high (85 to 100, negative normative condition) or low (35 to 60, positive normative conditon) handwritten pain ratings from 11 confederates. Participants in the normative neutral condition received no feedback. This study demonstrated that normative feedback significantly impacts pain ratings, with significant differences between the negative and positive normative condition as well as between the positive and neutral condition.

The Jackson and Phillips [42] study demonsrated that an upward social comparison message (“well, one study found that people last more than three minutes on the task”) produced significantly longer pain tolerance time than a downward social comparison message (“well, one study found that people last less than 45 s on the task”). Unfortunately, this study did not contain a no-treatment control group. In addition, experimental conditions were not “blinded” in either the Wilson et al. [41] or Jackson and Phillips [42] study; this carries limitations such as the possibility of demand characteristics.

The present research study tests a computer-delivered, norm-based intervention that consists of framing an experiment with information about the length of time that most people keep their hand submerged in very cold water (the experimental pain induction technique is known as a “cold pressor task”; CPT) with the goal of increasing pain tolerance. Using a computer to deliver the manipulation builds on previous research by ensuring blinding of experimental condition, as well as supporting innovations in behavioral medicine through the use of technology. A similar study in regards to providing specific time-based performance expectations was conducted previously, stating that “the typical man/woman lasts 30 s/1.5 min in this task.” The control group received standard instructions with no expectation [43]. The well-established gender difference in cold pressor pain tolerance was replicated in the no expectation condition, and eliminated in both treatment conditions, suggesting that pain threshold disparities were corrected with a gender-based standard. Given that the theoretical framework was gender role expectations rather than social norms, analyses did not include a control group versus a treatment group comparison, and researchers were not blinded to treatment condition as researchers delivered written instructions orally.

Given the role of social learning and gender role expectations on pain perceptions and responses [44–47], the present study included a challenge framework to tap gender typical male response. Previous research has demonstrated that the appraised gender relevance of stressors produces differential response between men and women in experimental tasks [48–50]. In addition, pilot work for the present study indicated that males responded favorably to both a challenge and no-challenge framework, whereas females responded only to the no-challenge framework [51]. Thus, in addition to a normative message group and a control group, the experimental design will manipulate a challenge statement in order to find the best way to increase pain tolerance times for men and women. Detecting gender-specific moderators of response to pain manipulations is important given notable differences in pain response between men and women [52]. A no-challenge statement will serve as a gender-typical neutral control.

It is hypothesized that: (1) the social norm condition will produce higher pain tolerance than the control condition, (2) men will have higher pain tolerance than women, and (3) there will be an interaction between condition and gender, such that men in any social norm condition (challenge or no challenge) will have higher pain tolerance than any control condition (challenge or no challenge), whereas women will have higher pain tolerance in the social norm+no-challenge condition. Pain threshold and pain intensity will be evaluated as secondary outcome variables, and directional hypotheses are not made.

Method

Participants

Healthy men ($n=80$) and women ($n=180$) were drawn from a research pool in partial fulfillment of a course requirement at a Southwestern university. A total of 298 individuals were screened for medical eligibility such as circulatory problems or trauma to the nondominant hand. Thirty-eight individuals were ineligible based on medical exclusion criteria, with the most common reasons being history of fainting or seizures, currently taking pain medication, thyroid problems, and trauma to the nondominant hand. All eligible participants consented to the study in writing. Participants ranged in age from 18 to 41 (M=20.7; SD=3.5), and they predominantly identified as Caucasian (44 %) and Hispanic (27 %).

Measures

Hand Size A tape measure was used to take three measurements of the non-dominant hand in inches: length, width, and circumference. Participants held their hand flat, with their palm up and fingers together. Hand size has been positively correlated with pain tolerance in previous research, given a larger surface for the distribution of cold stimuli [11].

Cold Pressor Apparatus The pain stimulus, a refrigerating bath (JeioTech Inc.), continually circulated 0° Celsius water. Participants submerged their nondominant hand up to the wrist for as long as tolerable, with an uninformed maximum duration of 5 min.

Pain Threshold, Tolerance, and Verbal Pain Intensity Measures Pain threshold was the amount of time elapsed until participants first reported "pain." *Pain tolerance* was the total amount of time participants kept their hand in the water. Both variables were measured with a stopwatch, with timing beginning at hand immersion to the wrist. After the task, participants verbally indicated the *pain intensity* of the task (0–100 pain index, with zero indicating no pain, and 100 the worst pain imaginable).

McGill Pain Questionnaire Short Form The McGill Pain Questionnaire Short Form (MPQ-SF) is a pain rating scale that consists of 15-descriptor items; items 1–11 relate to sensory pain dimensions (e.g., shooting), and items 12–15 relate to affective pain dimensions (e.g., fearful) [53]. Participants rated items on a 4-point scale, ranging from zero (no pain) to four (severe). Total scores can range from 0 to 60, with higher scores representing higher pain levels. The MPQ-SF had a Cronbach's alpha of .87 in the present study.

Manipulation Check Measures On a 0- to 10-point scale, participants rated how important it was to do well on the task, how hard they tried on the task, how believable they found the message in the video, and how much the message in the video influenced their behavior in the CPT.

Design and Procedure

The study used a 2 (social norm message vs. no norm message)×2 (challenge message vs. no challenge message) randomized design, stratified by gender. The study was stratified by gender due to different effect sizes for men and women in previous research [51] and commensurately different sample size requirements, requiring 17 men per group to detect a large effect (d=1.0) and 45 women per group to detect a medium effect (d=.60), at the .05 level with .80 power [54]. The proportion of men (31 %) and women (69 %) in the study approximated the demographics at the university. This yielded four groups into which males and females were randomized in proportion to one another: (1) social norm message+challenge frame; (2) no social norm message+challenge frame; (3) social norm message+no challenge frame; and (4) no social norm message+no challenge frame).

Participants signed up for the study via an electronic system. When arriving at the lab, they were screened for medical conditions which could pose a safety risk. In addition, participants could not be currently taking pain medication. Those who were medically eligible for the study were explained the nature of the study and provided written consent. After participants' nondominant hand was measured, they completed pre-experimental survey measures. Next, the participants were seated in front of a computer with headphones to view an instructional video for the experimental task.

The instructional video provided an overview of the CPT and instructed participants on what to do (e.g., how to put their hand in the water, to state pain when they first feel pain, and to withdraw their hand when the water was no longer tolerable). The principal investigator, identified as a professor at the university where the research was conducted, spoke in the video. The video contained gender-tailored role models demonstrating the task (e.g., a male demonstration in the video for male participants), as well as the experimental message or control message. The research assistant left the room during the video to keep them unaware of the experimental group assignment in order to minimize response bias. Gender matching of researchers and participants (e.g., male research assistants worked with male participants) was done to minimize participant reactivity to the opposite sex in the CPT [55].

The CPT was conducted using an industrial circulating water bath (Jeio Tech Inc.) which maintained a consistent temperature of 0 (±1)°C. Participants were instructed to place their nondominant hand in the bin of water up to wrist, and keep their hand in the water for as long as tolerable. They were instructed to state pain when they first felt pain, and to withdraw their hand when the water was no longer tolerable. This was followed by a statement that the length of time between when people state pain and withdraw their hand varies (standard message; control), or the standard message plus a social norm message. The social norm message was an overestimation of the length of time that most college men/women keep their hand in the cold water (three and a half minutes for men; 90 s for women; this gender-tailored time is set approximately one standard deviation above the actual norm). The time briefly appeared on the screen in a text message to accompany the verbal statement. Furthermore, the verbal social norm message contained an empirically supported statment [11] that individuals who keep their hands in longer have better psychological resilience and tend to meet the goals they set for themselves. At the end of the video, the principal investigator delivered the challenge or control frame, by stating “Now you are ready for the experiment” (control message), or “Now you are ready for the cold water challenge” (challenge message).

There was an uninformed time limit of 300 s for hand immersion per safety protocol. Research assistants used a stopwatch to measure pain onset and hand withdrawal, and the CPT was videorecorded to verify measurement by independent raters. Immediately following the task, participants were given a towel to dry their hand and asked to verbally rate pain on a 0–100 scale. Then, they completed postexperimental survey measures. Participants were fully debriefed following the procedure and asked if they were doing okay physically and emotionally (97 % were). All participants received a referral to Student Health and Counseling Services should they have had concerns. The entire experiment lasted approximately 30 min. The study was approved by the Institutional Review Board at the university where the research was conducted.

Analytic Approach

The three hand measures (length, width, and circumference) were strongly correlated. Therefore, a composite hand size score was created by averaging the three hand measures. Descriptive statistics showed that two outcome variables, pain threshold and pain tolerance, were positively skewed. The log 10 transformation was performed to improve normality, as it is best suited for positively skewed data and if standard deviations are proportional or larger than the mean [56]. Untransformed means and standard deviations are reported to improve interpretability of the results. Three-way ANCOVAs were conducted with hand size as a covariate, social norm condition, challenge condition, and gender as fixed factors, and pain threshold, tolerance, and pain intensity as separate outcome variables. After the challenge condition was collapsed, analyses were run using a two-way ANCOVA with hand size as a covariate, social norm condition (with challenge condition collapsed across social norm groups) and gender as fixed factors, and the same outcome variables. Partial eta squared is the effect size and interpreted as follows: .01 small, .06 medium, and .14 large [54]. Follow-up tests were conducted to evaluate pairwise differences among means using the Bonferroni adjustment for multiple comparisons.

Results

Preliminary Analysis

There were no significant differences in demographic characteristics across conditions ($p > .05$). Descriptive analyses suggested no differences between the challenge ($M_{tolerance}$= 99.52; SD=98.28) and no challenge ($M_{tolerance}$=99.52; SD= 95.68) condition on study outcomes ($p > .05$), nor were there any interactions with the challenge condition and gender or social norm condition on any primary or secondary analyses in the three-way ANCOVA. Therefore, the four conditions were collapsed into two: social norm (challenge and no challenge) and control (challenge and no challenge) for subsequent analyses.

Manipulation Check

Table 1 provides information about perceptions of the task and message, as well as effort in the CPT. Participants across conditions had similar perceptions of the task, reporting that it was moderately important to do well on the task, they displayed moderately high effort, and they found the message in the video moderately believable. Those in the control conditions reported less influence on their behavior than those in the social norm groups ($p < .05$).

Table 1 Manipulation check by condition

Condition and gender	Manipulation check items							
	Importance[a]		Effort[b]		Believability[c]		Influence[d]	
	M	SD	M	SD	M	SD	M	SD
Norm group								
Males	6.30	3.15	7.25	2.88	5.95	2.75	7.08	2.87
Females	6.45	2.68	7.86	1.90	6.80	2.96	7.44	2.78
Combined	6.40	2.82	7.67	2.25	6.54	2.91	7.33*	2.80
Control group								
Males	7.25	2.47	7.98	1.59	4.94	3.43	3.00	3.11
Females	6.90	2.18	8.22	1.89	5.81	3.20	3.04	3.33
Combined	7.01	2.27	8.15	1.80	5.56	3.28	3.03*	3.26

*$p < .05$, significant difference

[a] How important was the task?

[b] How hard did you try?

[c] How would you rate the believability of the message in the video?

[d] How much did the message in the video influence you?

Table 2 Outcomes by Condition and Gender

Condition and Gender	Outcome							
	Pain Tolerance		Pain Threshold		Verbal Pain Rating		McGill Pain Questionnaire	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Norm Group								
Males	207.75[a]	110.48	42.03[c]	55.44	46.45	24.07	15.87	7.20
Females	84.01	72.88	21.29	20.54	50.36	25.64	20.23	9.12
Combined	122.08[b]	103.16	27.58[d]	36.04	49.15	25.14	18.86	8.78
Control Group								
Males	104.30[a]	95.86	21.33[c]	13.07	55.43	26.37	17.28	8.41
Females	64.81	76.47	15.05	14.44	54.27	26.40	19.63	9.38
Combined	76.96[b]	84.54	17.02[d]	14.28	54.62	26.29	18.93	9.13

Note. Shared letter superscripts indicate significant differences. [a, b] $p<.001$; [c, d] $p<.01$

Primary Analysis

Pain Tolerance Table 2 displays untransformed mean values for pain tolerance by condition and gender. There was a significant main effect for social norm condition, $F(1, 255)=26.95$, $p<.001$, $\eta_p^2=.10$, indicating that those receiving a social norm message had longer pain tolerance than those who did not (see Fig. 1). The main effect for gender was significant, $F(1, 255)=13.69$, $p<.001$, $\eta_p^2=.05$, with men displaying longer pain tolerance than women. The interaction between norm condition and gender was non-significant, $F(1, 255)=3.0$, $p=.09$, $\eta_p^2=.01$.

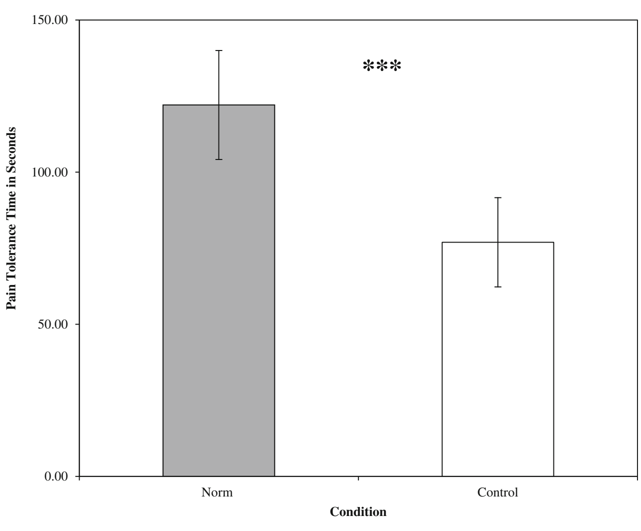

Fig. 1 Cold pressor pain tolerance times by social norm message condition (norm versus control). *Error bars* represent 95% confidence intervals. ***$p<.001$

Secondary Analysis

Pain Threshold Table 2 displays untransformed mean values for pain threshold by condition and gender. There was a main effect for condition, $F(1, 244)=9.81$, $p=.002$, $\eta_p^2=.04$, indicating that those who received a social norm message showed significantly higher pain threshold than those who did not. The main effect for gender was significant, $F(1, 244)=8.00$, $p=.005$, $\eta_p^2=.03$, with men showing higher pain threshold than women. The interaction between condition and gender was not significant, $F(1, 244)=.013$, $p=.908$, $\eta_p^2<.01$.

Pain Intensity

Verbal Pain Rating Table 2 displays mean values for verbal pain rating by condition and gender. There were no main effects for social norm condition, $F(1, 255)=3.49$, $p=.063$, $\eta_p^2=.01$ or gender, $F(1, 255)=1.03$, $p=.311$, $\eta_p^2<.01$. The interaction between social norm condition and gender was also non-significant, $F(1, 255)=.57$, $p=.452$, $\eta_p^2<.01$.

McGill Pain Questionnaire Table 2 displays mean values for the McGill Pain Questionnaire score by social norm condition and gender. There were no main effects for social norm condition, $F(1, 238)=.11$, $p=.745$, $\eta_p^2<.01$ or gender, $F(1, 238)=3.61$, $p=.059$, $\eta_p^2=.02$. The interaction between social norm condition and gender was not significant, $F(1, 238)=.66$, $p=.42$, $\eta_p^2<.01$.

Discussion

This study is, to our knowledge, the first to show that pain tolerance and threshold can be increased significantly by exposing individuals to a simple social norm message delivered via computer. Individuals who were exposed to a norm, which inflated the actual norm, displayed a relatively large increase in pain threshold and tolerance. This effect was twice that of the gender difference in pain tolerance, which is noteworthy given that gender differences in pain response are well established [52]. Results of this study extend the evidence base for the role of social approaches in pain response and demonstrate the promise of technologically based approaches.

The biopsychosocial model is a widespread approach to understanding health issues, including pain, maintaining that biological, psychological, and social factors interact to produce behavioral responses [57]. However, the social component of the model has been understudied compared with the model's biological and psychological counterparts [17, 18]. Nonetheless, social communication models of pain maintain that the linkage of pain to social contexts serves an evolutionary survival function [58]. Social norms are thought to be responsible for cultural and familial differences in pain response [18]. Furthermore, gender role expectations are known to influence pain perceptions [44–46]. Social communication models are posited to account for a frequently observed lack of correspondence between pain stimulus dose and pain responses [58, 59].

Putting social theories of pain to the test, investigators have demonstrated that social modeling affects pain response in research participants [60, 61]. Moreover, these effects extend beyond self-report to psychophysiological measures of pain [19, 62]. These effects have been explained by a shift in attentional focus from somatic to social cues [60]. Similar to the effects of modeling, the present study demonstrates that brief social normative messages impact pain response. Given the brevity and relative ease of the present approach compared with modeling studies, implications for practice exist.

A number of possible applications to behavioral medicine could be made. First, the present results suggest that both descriptive and injunctive norms can be applied to information delivered to patients with the aim of modifying behavior. Normative messages could be delivered as an adjunct to frame primary biological (e.g., medication) or psychological (e.g., therapy) treatment, such as "men who use mindfulness experience less pain and better functional abilities." Second, the present study suggests that when held to higher standards (e.g., an inflated pain tolerance time), individuals modify their behavior to resemble those standards. Although ethical issues would exist with disseminating false standards, a different type of normative message based on deviance regulation theory [26] could be a next step. The application of deviance regulation theory has been linked to increased intention to get flu shots [38]. Determining whether increased intention translates to action would be an important future research direction, as would expanding the investigation to different target health behaviors.

Considering the study results further, the social normative message directly targeted pain tolerance (time elapsed in the water), but it also affected pain threshold (time to initial recognition of pain). Those who received a social norm message had significantly higher pain threshold (i.e., longer time to pain onset) than those who did not. Interestingly, pain intensity was comparable between groups despite those in the social norm treatment being exposed to a painful stimulus for significantly longer. This is consistent with a number of previous studies which have found that pain tolerance and subjective experience of pain are uncorrelated [42, 63–66]. In manipulation studies in which correlations between pain tolerance and pain intensity have been present, they are often inversely related [67–74]. It is possible that successful interventions enhance perceived control, which is adaptive for pain perception [75–77].

With regard to the lack of association between pain tolerance and pain intensity in the present study, it seems that the normative message provided an anchor for behavior in a novel task. This social anchor not only shaped an individual behavioral response, it shaped the appraisal of the experience. Whereas it presumably could be expected that those exposed longer to a painful stimulus would experience commensurately higher pain, this did not occur. Instead, pain tolerance increased in the social norm condition without an accompanying increase in pain intensity. This provides indirect support for social models which have been used to explain discrepancies between pain stimulus dose and pain responses [58, 59].The results have implications for the treatment of pain and other conditions involving distress.

Gender differences in pain threshold and tolerance in the present study are consistent with previous research [52], although not all studies find consistent gender differences in pain perceptions [78]. Contrary to the hypothesis, there was no interaction between challenge condition and gender on pain tolerance. It had been expected that the challenge message would tap a gender stereotypical masculine role that women would not respond to. However, it seems likely that the challenge message was not explicitly masculine enough. Previous research revealed that men and women react differently to distress tasks based on gender-role-typed messages [48–50]. Future studies wishing to use messages to manipulate gender differences in pain response would be advised to use more explicitly gender-typed messages, such as those related to occupational or physical ability for men, or to nurturing ability or appearance for women [48].

Limitations of the present study include the use of self-report pain measures without corroborating psychophysiological pain measures. However, previous studies have demonstrated consistency between verbal pain reports and psychophysiological response in social modeling studies [19, 62]. Furthermore, college students were chosen for testing the theoretical model, but replication is needed with more diverse and representative samples. Finally, social norm approaches are capable of widespread administration for a low cost, but they have been criticized for having short-lived results [26, 40]. Therefore, future research should focus on developing strategies for transferring behavior change from social norm approaches to more enduring change.

The present study extends previous literature about the effects of social modeling on pain response to the discovery of comparable effects using a brief, computer-delivered normative message. Furthermore, current normative message-based approaches to health behavior change were extended to a previously untested target issue, acute pain tolerance. The innovation of the present strategy lies in its bridging of paradigms by applying a social normative theory to pain tolerance, which until now has been treated primarily with a clinical approach. This is consistent with research which has called for more interdisciplinary work and integration of theories to advance improvements in health [79, 80]. It would be valuable to translate and apply the methods in this study to a variety of behavioral health topics including clinical pain and related issues such as addictive behaviors.

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Conflict of Interest The authors have no conflict of interest to disclose.

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