RESEARCH
EDUCATION
TREATMENT
ADVOCACY

PUBLISHED BY ELSEVIER

The Journal of Pain, Vol 16, No 4 (April), 2015: pp 326-334
Available online at www.jpain.org and www.sciencedirect.com

On the Importance of Being Vocal: Saying "Ow" Improves Pain Tolerance

Genevieve Swee* and Annett Schirmer*,†,‡

*Department of Psychology, National University of Singapore, Singapore.
†Duke/National University of Singapore Graduate Medical School, Singapore.
‡Life Sciences Institute Neurobiology/Ageing Programme, National University of Singapore, Singapore.

Abstract: Vocalizing is a ubiquitous pain behavior. The present study investigated whether it helps alleviate pain and sought to discern potential underlying mechanisms. Participants were asked to immerse one hand in painfully cold water. On separate trials, they said "ow," heard a recording of them saying "ow," heard a recording of another person saying "ow," pressed a button, or sat passively. Compared to sitting passively, saying "ow" increased the duration of hand immersion. Although on average, participants predicted this effect, their expectations were uncorrelated with pain tolerance. Like vocalizing, button pressing increased the duration of hand immersion, and this increase was positively correlated with the vocalizing effect. Hearing one's own or another person's "ow" was not analgesic. Together, these results provide first evidence that vocalizing helps individuals cope with pain. Moreover, they suggest that motor more than other processes contribute to this effect.

***Perspective:* Participants immersed their hand in painfully cold water longer when saying "ow" than when doing nothing. Whereas button pressing had a similar effect, hearing one's own or another person's "ow" did not. Thus, vocalizing in pain is not only communicative. Like other behaviors, it helps cope with pain.**

Key words: *Swearing, nonverbal behavior, placebo effect, cold pressor, speaking.*

Ouch, ow, owie! Exclamations such as these seem to be common, spontaneous responses to sudden experiences of pain. But what motivates them? Why do they occur irrespective of whether sufferers are alone or in company? One answer to these questions is that vocalizing is an automatic response that serves both long- and short-range communicative functions such as to attract help, ward off an aggressor, or declare defeat. Another, perhaps more doubtful, possibility is that vocalizing has additional noncommunicative functions such as helping sufferers to cope with discomfort. In this article, we pursued this latter possibility, providing a review of relevant research on vocal and other pain responses. Additionally, we present one of our own studies with first evidence that saying "ow" modulates pain.

Despite the ubiquity of crying out in pain, to date, few attempts have been made to explore its functionality. Moreover, what has been done focused not on vocalizing but on expletive speech. A relevant study by Stephens et al[31] employed a cold pressor paradigm in which participants submerged one hand into ice-cold water. The authors found that both direct and self-reported measures of pain differed when participants were swearing as compared to when they were using neutral speech. Swearing enabled participants to keep their hand submerged in the water longer, it increased their heart rate, and it reduced the magnitude of perceived pain. Stephens and Umland[32] largely replicated these results and identified a relevant interindividual variable. Specifically, they found that a habitual use of expletives is associated with a reduced difference in pain tolerance when swearing and when using neutral speech.[32]

Although swearing in pain is certainly common, it is an acquired response that shows large linguistic, situational, and cultural variation.[14] In contrast, "proper" vocal responses such as "ow" are less contextually constrained and seem phonologically universal as they

Received September 21, 2014; Revised November 9, 2014, December 17, 2014, January 5, 2015; Accepted January 13, 2015.

This research was funded by the NUS Department of Psychology. The authors declare no conflicts of interest.

Address reprint requests to Annett Schirmer, PhD, Department of Psychology, Faculty of Arts and Social Sciences, National University of Singapore, 9 Arts Link, Block AS4, Level 2, Singapore 117570. E-mail: schirmer@nus.edu.sg

1526-5900/$36.00

http://dx.doi.org/10.1016/j.jpain.2015.01.002

have cross-linguistic analogues such as "eina" in South Africa, "ahia" in Italy, or "aiyo" in Chinese. Shared among these is an /a/-sound during which the mouth simply opens, the tongue lies flat, and the lips remain unrounded. It is a simple sound that requires little articulatory control while maximizing volume output. As such, it may be used quite easily and effectively when in pain.

When considering a potential analgesic effect of vocal exclamations such as "ow," one may wish to dissociate possible contributing factors. Specifically, analgesia may arise from the motor act of vocalizing, from hearing the ensuing sound, and/or from associated cognitions. In the following, we will discuss these factors in some detail and report existing studies speaking to their possible action.

Like other behaviors, vocalizing requires an involvement of the motor system. There are muscles that raise and lower the ribs and that support phonation and articulation. Research suggests that activity of these and other muscles could moderate pain.[24,37] For example, Peretz and Gluck[24] found that children instructed to breathe deeply as if blowing bubbles experienced less pain from an injection and showed reduced pain behaviors (eg, eyelid squeezing) than children instructed to breathe normally. Additionally, there is evidence from finger movements in adults. Pain induced to one hand was endured longer and perceived as less painful when participants tapped fingers of the contralateral hand than when they sat still.[4,21] Interestingly, the stimulation of motor cortex[22] and motor imagery[20] were shown to have similar effects.

In addition to being a motor act, vocalizing involves the production of a sound that is audible to bystanders as well as to the vocalizer himself or herself. Research on the effects of hearing one's own voice and on perceiving sounds more generally implies that the sound heard by the vocalizer could be analgesic. The effect of hearing one's own voice was explored in the context of sleep, shedding light on potential unconscious effects. Here it was found that the principal figure of a participant's dream was more active, assertive, and independent when sleeping was accompanied by his or her own rather than a stranger's voice. Moreover, free associations produced after sleeping contained more active verbs.[5,6] Related to this, a study on awake participants found a reduction in the number of affect words after hearing one's own as compared to another person's voice.[13] Together, the work in sleep and wakefulness suggests that feeling activated, in control, and less emotional after vocal feedback may dampen pain. Additionally, the more general acoustic change that comes with vocalizing could be beneficial. Listening to simple tones or complex pleasant music was shown to reduce somatosensory discrimination[3] and pain perception.[29]

Lastly, we would like to mention the role of higher-order cognitions in vocalizing. Such cognitions may arise fairly automatically because vocalizing was associated with positive consequences in the past. Starting early in development, vocal exclamations like "ow" produce pain-relieving efforts from concerned others. For example, parents typically kiss or blow air across a wound to reduce their child's suffering. Over time, experiences such as these may shape conditioned memories or expectations that become habitually activated when individuals vocalize and that may then function like a placebo. Although such a mechanisms has not yet been identified for vocalizations, it has been discussed in behavior theory[27] and demonstrated for a range of other stimuli experienced in the context of pain (for reviews see[19,25]).

In sum, several lines of evidence point to the possibility that vocalizing is analgesic. However, to date, this possibility has never been tested. Thus, it is still an open question whether other, simpler expressions than swearing can alleviate pain and whether such alleviation results from the motor, sound, and/or higher cognitive aspects of vocalizing. Here we sought to address these issues using a cold pressor paradigm. In 5 conditions, participants were asked to immerse one hand into ice-cold water while 1) saying "ow," 2) listening to a recording of them saying "ow," 3) listening to another person saying "ow," 4) pressing a response button, or 5) doing nothing. The time of hand immersion and pain ratings on a visual analog scale served as direct and self-report measures of pain, respectively. Additionally, participants were surveyed concerning their expected pain in the voice conditions.

Based on existing work, we predicted that the saying "ow" (condition 1) would reduce pain relative to the condition in which participants did the cold pressor without an additional task (condition 5). If this was due to hearing their own voice or sounds in general, then similar effects should emerge for conditions 2 and 3, respectively. Alternatively, if motor aspects were relevant, then button pressing (condition 4) should lower pain. A comparison between emergent effects should reveal the relative contribution of sound and motor processes to vocalizing analgesia. Lastly, a correlation analysis on participant expectations and actual pain measures should inform about the role of higher cognitions linked to vocalizing.

Methods

Participants

Fifty-six participants were recruited for this study. They were Singaporeans who used English as their dominant language. One participant was excluded from data analysis because of a recording failure in one condition. Twenty-nine of the remaining participants were female and on average 21.4 (standard deviation = 2.2) years old. Twenty-six participants were male and on average 22.9 (standard deviation = 2) years old. Twenty-five of the participants enrolled via an introductory psychology module and received course credits for their contribution. The remaining participants were recruited via campus advertisements and received S$10. We contacted potential participants prior to the experiment to confirm that they were using their right hand for writing and that they had no medically diagnosed somatosensory or hearing problems.

Apparatus

The study protocol was reviewed by the institutional review board at the National University of Singapore and found in compliance with international standards for ethics in research. The experiment took place in an enclosed experimental cubicle. Participants were tested individually. The apparatus in the room consisted of the cold pressor task equipment setup to the left of the participant, a video camera pointed at the cold pressor equipment, and a computer screen, 2 loudspeakers, 2 microphones, a button response box, and a computer mouse all immediately in front of the participant (Fig 1).

The cold pressor equipment comprised 2 containers that were filled with cold (4°C) and room-temperature (25°C) water, respectively. The cold water container was 53.5 cm long and 38.5 cm wide and filled to a height of 16 cm. The container with room-temperature water was 30 cm long and 19 cm wide and filled to a height of 10 cm. Water was circulated in each tank using aquarium pumps with a flow rate of 2,000 L/h. Temperature was maintained by thermostats. Depth of hand immersion in the cold water container was controlled by asking participants to rest the nondominant hand palm-side down on a perforated plastic platform attached 6 cm away from the base. Following previous research,[31] a maximum cold water immersion time was set at 4 minutes. Only 1 participant reached this limit. The duration of hand immersion was recorded with a video camera positioned opposite the cold water tank. It was subsequently measured as the time between the participant's hand touching and fully leaving the water.

Vocalizations were recorded with 2 microphones placed in front of the participant. One microphone was used to record good-quality sounds for later replay. The other microphone served as a voice-key to measure voice onset times. A button response box served to record responses in the button response condition.

Stimuli

The stimulus material was specially prepared for each participant during the first of 2 visits to the lab. It comprised recordings of themselves saying "ow" and of another participant saying "ow." We used "ow" rather than other spontaneous vocalizations for 2 reasons. First, we wanted to ensure that auditory input was largely comparable when hearing one's own voice and the voice of another person. Second, we considered "ow" a typical pain exclamation in our study population. This supposition was confirmed in an online survey conducted several months after the experiment, including a subset of the original participants and naïve individuals (see below).

"Ow" recordings were created as follows. After an initial practice phase, participants were asked to immerse their hand first into room-temperature water and then into cold water (see Procedure). When their hand was in cold water, a fixation cross appeared at rhythmic intervals on the computer screen prompting participants to say "ow." The recorded sequence was later edited to remove nonresponses, other responses (eg, "ouch"), and responses that occurred while participants were removing their hand from the water. The remaining "ow" were then saved in one file for presentation during the second lab visit.

For each participant, we selected "ow" recordings from one other participant. This was done by controlling for participant sex and self-reported pain intensity. Additionally, we tried to match the acoustic character or intensity of the produced "ow" sound.

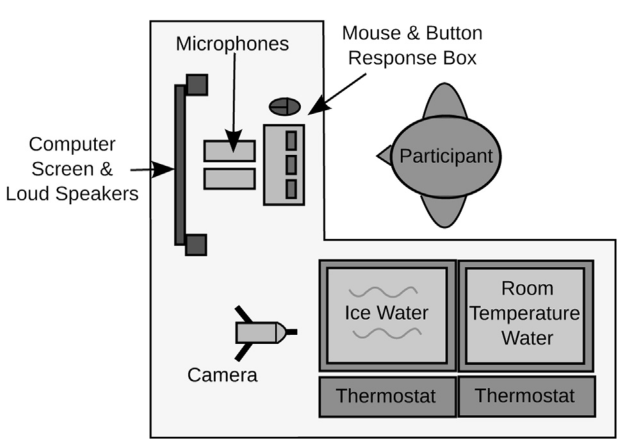

Figure 1. Experimental setup.

Procedure

The experiment consisted of 2 lab visits that were separated by a minimum of 2 and a maximum of 10 days. The cold pressor trials were comparable on both days (Fig 2). In both cases, the participants sat down in the experimental room. The instruction "Submerge your hand in room-temperature water. Keep your eyes on the screen." appeared on the computer screen for the duration of 3 minutes. Then the screen displayed the instruction "Submerge your hand in cold water now. Keep your eyes on the screen." After 3 seconds, the instruction was replaced by a fixation cross in the center of the screen. The cross turned off after 1,200 milliseconds and returned after 250 milliseconds as long as the participants kept their hand in the cold water or until 4 minutes elapsed. Then a visual analog scale appeared and participants used the computer mouse to move the cursor to a point on the scale that best reflected pain intensity on that trial.

On their first visit, participants were informed about the study and provided written consent. They were then given detailed instruction regarding the experimental procedure. They were told that they would complete 2 cold pressor trials during the current visit. On the first trial, they were free to vocalize or not vocalize as they wished. On the second trial, they were asked to say "ow" every time they saw the fixation cross appear on the screen in front of them.

During their second visit, participants were reminded of the cold pressor procedure and asked to complete 5 trials during which they would 1) say "ow" at the onset of each fixation cross, 2) hear their "ow" sequence from the first visit synchronized with the fixation crosses, 3) hear another person's "ow" sequence synchronized

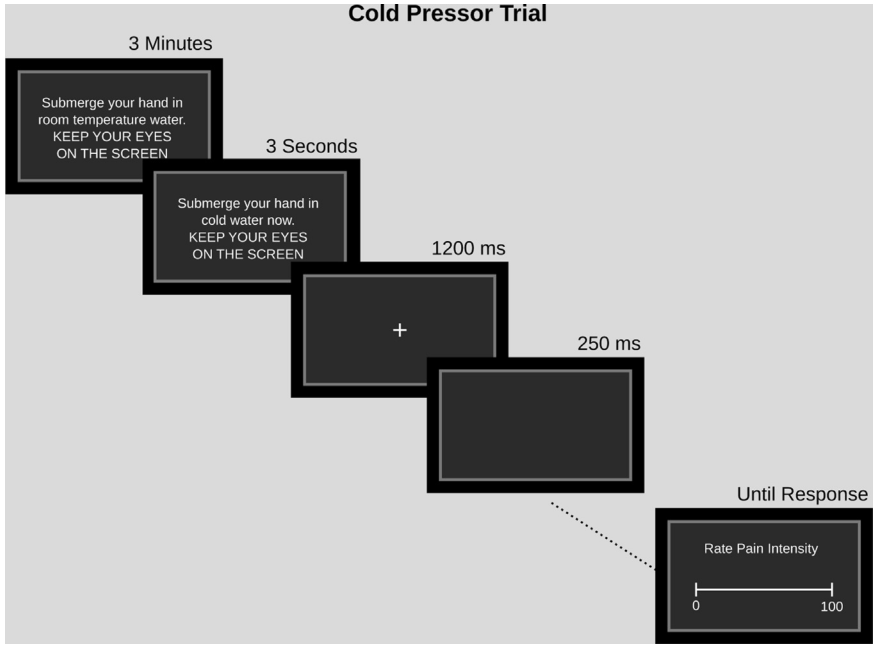

Figure 2. Cold pressor trial.

with the fixation crosses, 4) press a button on a response box at the onset of each fixation cross, and 5) simply watch the fixation cross. Played-back "ow" sequences were looped in case they were shorter than the current trial. Trials were separated by about half a minute and their order was controlled using a Latin-square design such that each condition occurred with the same frequency in the first, second, third, fourth, and fifth places across participants. After completing the 5 trials, participants heard again their own "ow" and the other person's "ow" sequence, indicated which was their own, and rated each sequence on a 5-point scale ranging from −2 for very unpleasant to +2 for very pleasant. Then participants could dry their left hand and were given a questionnaire to complete. On this questionnaire, they indicated whether they thought saying "ow," hearing their own "ow," or hearing another person's "ow" would increase, maintain, or decrease pain relative to doing nothing. Following this, they were debriefed and reimbursed for their participation.

Postexperimental Survey

About 3 months after data collection for this research was completed, an email was sent to all participants and to 90 naïve individuals inviting them to complete a short online survey. The survey was conducted via qualtrics (Qualtrics, Provo, UT; www.qualtrics.com). Participants from the experiment were asked to enter an assigned identification number, their age, and sex. Naïve individuals entered age and sex only. Afterward, everyone answered the question "What do you typically say when you get physically hurt? You may list more than one expression." Once they entered their answer, new instructions prompted them to indicate whether saying "ow" was a very likely, likely, somewhat likely, unlikely, or very unlikely response to pain.

Nineteen (9 female, 10 male, mean age = 22.6 years) of our original participants contributed to this survey alongside 58 naïve individuals (44 female, 14 male, mean age = 23.4 years).

Results

Data were analyzed in R (R Foundation for Statistical Computing, Vienna, Austria). We first explored whether the data were normally distributed. Both the Shapiro-Wilk test and qq-plots suggested a skewed distribution. Log transformation helped normalize the hand immersion data but not the pain rating data. Therefore, we decided to use nontransformed data together with nonparametric statistics. Separate analyses for male and female participants yielded similar results. Therefore, the 2 groups were pooled in the analyses reported below. As a completion of 5 cold pressor trials in a row may lead participants to habituate or sensitize to the pain, we analyzed hand immersion durations and pain ratings as a function of trial order. Because trial order was counterbalanced and because there was only a weak trend for sensitivity to increase from the first to the last trial, we did not include trial order as a factor in the following analyses. All tests were conducted 2-sided.

Hand Immersion Data

The duration with which participants immersed their hand into cold water is illustrated in Fig 3 and Table 1. The data were subjected to a Friedman test, a nonparametric alternative to analysis of variance. The test was conducted with condition as a repeated factor. The factor levels "say," "hear-own," "hear-other," "button," and "baseline" refer to conditions 1 through 5 as described above. The condition effect was significant

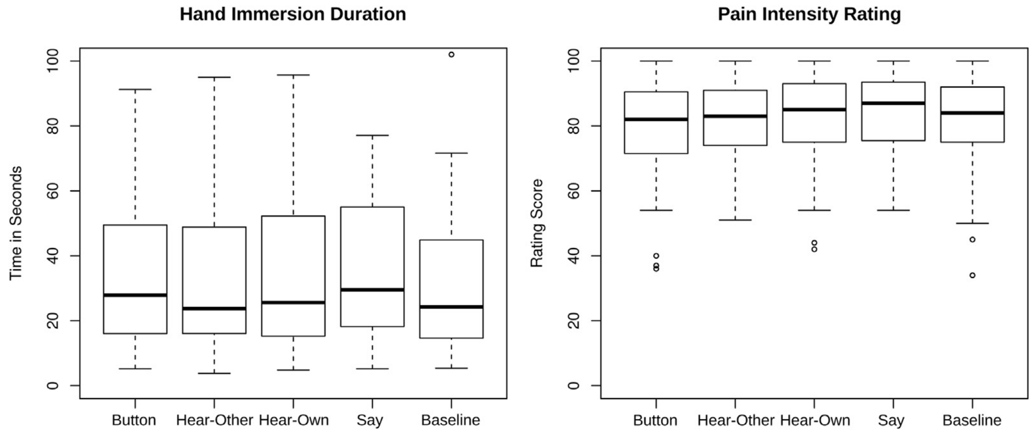

Figure 3. Box plots illustrating condition differences for primary dependent variables.

(χ^2 = 20.6, df = 4, $P < .001$) and pursued with 5 Wilcoxon tests, a nonparametric alternative to the t-test. Testing was limited to our specific hypotheses, and P values were adjusted using the Bonferroni correction (ie, .05/5 = .01) in an effort to control false discovery rate. The results confirmed longer hand immersions in the say condition relative to the baseline condition (V = 1,076, $P < .01$, r = −.39). Additionally, we found that the button condition produced longer hand immersion than the baseline condition (V = 1,092, $P < .01$, r = −.4). However, a similar effect was absent for the hear-own and hear-other conditions (*P*s > .1).

A direct comparison between the say and button conditions was nonsignificant ($P > .1$), suggesting that performance in these 2 conditions could be linked to or driven by a common factor. To explore this possibility, we subjected hand immersion durations from the say and button conditions to a Spearman correlation analysis. The result of this analysis was significant (rho = .38, $P < .01$), pointing to a positive relation.

Because the effect of hearing one's voice may depend on whether one can recognize that voice, we repeated the above analyses while excluding participants who failed in the postexperimental voice recognition test (n = 14, 7 female). The Friedman test was again significant (χ^2 = 20, df = 4, $P < .001$), allowing us to explore individual condition effects. Similar to before, the say (V = 668, $P < .01$, r = −.48) and button (V = 605, $P = .02$, r = −.35) conditions differed significantly and marginally from the baseline condition, respectively. Moreover, the hear-own and hear-other conditions failed to do so (*P*s > .1). Again, hand immersion failed to differ between the say condition and the button condition (V = 565, $P = .04$, r = −.32), and the two were significantly related (rho = .46, $P < .01$).

Table 1. Median and Range of Cold Pressor Data

Condition	Hand Immersion Duration, s (Minimum–Maximum)	Pain Intensity Rating Scores (Minimum–Maximum)
Button	27.9 (5.2–240)	82 (36–100)
Other	23.74 (3.8–240)	83 (51–100)
Own	25.6 (4.79–187.8)	85 (42–100)
Say	29.54 (5.2–255.8)	87 (54–100)
Silent	24.27 (5.36–240)	84 (34–100)

Pain Rating Data

A Friedman test with condition as the independent factor and pain ratings as the dependent factor was nonsignificant both when including all participants and when including only those who had recognized their own voice (*P*s > .1). Therefore, no individual condition comparisons were conducted.

Participant Expectations

The role of participant expectations was explored by coding responses as 1 if pain was expected to increase, as 0 if pain was expected to be stable, and as −1 if pain was expected to decrease. Scores for say, hear-own, and hear-other conditions were subjected to separate Wilcoxon tests to determine whether they differed from 0. This was true for the say condition (V = 216, $P < .0001$, r = −.31) but not for the other conditions (*P*s > .1). For the say condition only, participants expected a reduction in pain (mean = −.41, standard deviation = .85).

To explore whether this expectation could explain the hand immersion results, we conducted a Spearman correlation analysis with the participants' expectation scores and the hand immersion difference between the say condition and the baseline condition. The results were nonsignificant (rho = .17, $P = .37$), indicating that the participants' expected pain reduction failed to positively predict the actual pain reduction they experienced in the say condition relative to the baseline condition.

Postexperimental Survey Results

To the first survey question, participants gave varied answers including "ow," "ouch," "ah," "argh," "ssss," "groan," "swear," "oh gosh," and "remain silent." These answers were counted, converted to percentages, and subjected to a chi-square test with exclamation (9 levels as mentioned before) and group (old participants, new participants) as factors. The test was significant (χ^2 = 22.8, df = 8, $P < .005$), indicating that exclamations differed as a function of group. Moreover, a test including only "ow" responses revealed that they were more frequent in old relative to new participants (χ^2 = 6, df = 1, P < .05), possibly because our study made "ow" more salient in their memory. As can be seen in Fig 4, whereas "ow" was the most frequent response in old participants, it was only the second most frequent response in new participants. The latter reported saying "ouch" most frequently.

A chi-square test on group differences in the likelihood of saying "ow" was also significant (χ^2 = 23.4, df = 4, P < .0005). Old participants selected "very likely" less often (χ^2 = 12.9, df = 1, P < .0005) and "somewhat likely" more often (χ^2 = 6.9, df = 1, P < .05) than new participants. There were no differences for other rating options (Ps > .1). Moreover, as can be seen in Fig 4, "very likely," and "likely" were more frequent than other responses in both groups.

Discussion

The goal of this study was to determine whether vocalizing alleviates pain. In line with this notion, we observed higher pain tolerance when participants said "ow" than when they did nothing. Moreover, the size of this effect as reported in the Results section using the r-statistics can be considered medium to large,[8] implying a practical relevance outside the laboratory. In the following, we will discuss this effect and try to characterize its underlying mechanisms.

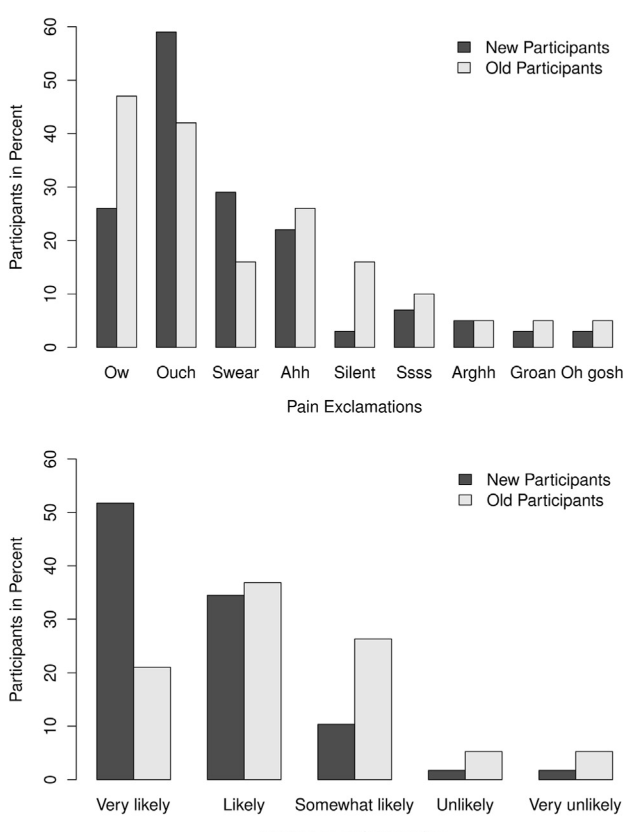

Figure 4. Survey results.

On the Nature of Vocalizing Analgesia

The present study identified and compared the contributions of motor, sound, and higher cognitive processes and found that motor processes produced the dominant effect. Button pressing, but not hearing one's own "ow" or that of another person, increased pain tolerance relative to baseline. Moreover, the button effect matched that of saying "ow" when considering all participants, and both were positively correlated. Lastly, although participants had expectations in line with the present results, these expectations failed to account for actual task performance. Thus, the duration of hand immersion was not simply driven by lay theories about the usefulness of vocalizing during pain.

In addition to using the duration of hand immersion as a direct measure, we employed pain intensity ratings as a self-report measure. Contrary to the direct measure, the self-report measure was comparable across conditions. This dissociation is not unprecedented in the literature[32] and likely speaks to the greater sensitivity of direct relative to self-report measures. Compared to enduring pain, evaluating pain requires more reflection and is perhaps more influenced by implicit norms and the desire to conform. Thus, although it is possible that vocalizing modulates only unconscious aspects of pain that are inaccessible to subjective judgments, a contribution to conscious aspects can and should not be ruled out.

Together the present results add to previous research on the effects of swearing on pain. As mentioned before, swearing was found to increase cold pressor times relative to a neutral vocalizing condition.[31] Moreover, this effect was greater the less frequently participants used swearwords outside the lab.[32] Thus, it has been proposed that the effect of vocalizing negatively relates to how frequently a particular expression is being used and the extent to which one has habituated to its emotional connotation.[32] We extend these findings by demonstrating that vocalizing in and off itself is potentially analgesic. Moreover, despite "ow" being one of the top 2 vocal responses in our study population, it was nevertheless effective, suggesting that besides emotional connotation, other aspects of vocalizing can moderate pain. In the following, we will develop a case for the role of motor aspects.

What Links Motor Acts and Pain?

The importance of motor acts in vocalizing analgesia may spring from different sources. First, one may speculate that vocalizing and button pressing were pain relieving because they effectively distracted from the cold pressor task. In contrast, listening to sounds and/or watching a fixation cross appear and disappear may have been less engaging, leaving more resources to the perception of pain. In line with this possibility, some studies found that moving attention away from pain by introducing an unrelated task is analgesic.[16,17,34] However, there is also conflicting evidence, namely, that individuals benefit from attention to the sensory aspects of pain in that it allows them to tolerate a cold pressor stimulation longer.[1] Because of this disagreement,[33] it is uncertain whether and how attentional mechanisms account for the present effects.

A second, perhaps less equivocal, explanation derives from embodiment research demonstrating a relation between bodily and mental states.[23,26] It holds that certain motor acts feel activating and empowering and can push individuals from passivity and avoidance to activity and approach, thereby changing their perspective on pain. Stephens and colleagues interpreted their findings on swearing within this framework.[31,32] Additionally, they provided evidence by engaging participants in a violent or nonviolent video game.[30] Pain tolerance measured after the game was greater in the violent compared to the nonviolent condition, suggesting that approach-related mental states induced through action can dampen pain. Simply vocalizing may work similarly.

Last, one may explain the present results in the context of sensorimotor processes. Motor acts engage both efferent and afferent parts of the peripheral nervous system. Effected muscular changes feed back to the brain via somatosensory pathways and may thus compete with pain-related processes. In support of this, neuroimaging research found overlap in brain regions such as primary and secondary somatosensory cortex during thermal pain, nonpainful tactile stimulation, and finger movement.[11] Additionally, studies comparing pain sensations with and without concurrent tactile stimulation found touch to be analgesic.[18] Such effects were reported when pain and touch affected the same dermatome[12] and also when they affected different dermatomes,[36] allowing for the possibility that somatosensory feedback contributes to vocalizing analgesia.

Are Sounds and Cognitions Irrelevant for Pain?

The failure of the present voice playback conditions to reduce pain may have several reasons. First, auditory stimulation was temporally predictable and nonimperative and as such may have done little to distract from pain. Perhaps, to be analgesic, auditory impressions must attract a certain amount of processing resources. In line with this, past research showed sound-induced analgesia for pleasant music and simple, task-relevant tones—but not for unpleasant music with which participants did not wish to engage[29] (but see[1]).

Additionally, the playback of the participants' own voice differed acoustically from how they would hear themselves vocalize. This was necessarily so because when vocalizing we hear ourselves both through the outer ear and through the transmission of sound waves from within the body. The latter is missing in voice playbacks, making them seem somewhat odd and potentially unfamiliar. In line with this, not all participants in the present study could distinguish their voice playback from the voice of another participant. However, the fact that those who did distinguish their own voice failed to respond differently in the say and the button conditions suggests that a possible contribution of hearing one's voice to vocalizing analgesia may be negligible.

Apart from sounds, we explored whether higher cognitions contribute to vocalizing analgesia. In line with behavior theory,[27] we guessed that participants might expect vocalizing to reduce pain and that it may be this expectation rather than the actual vocalizing itself that is analgesic. Although we could demonstrate the existence of lay theories about the benefits of vocalizing, we found these theories unrelated to pain behavior. Participants who declared that vocalizing is pain relieving were not the ones with the greatest vocalizing effect on pain tolerance. One reason for this may be that lay theories dissociate from implicit and more accurate expectations about pain relief that necessitate measures other than self-report. Another reason could be that the relation between expectations and pain is fairly small and would require a larger sample size. In line with this, an existing meta-analysis on placebo analgesia[35] reports effect sizes as low as .15 Cohen's d.

Limitations and Future Directions

Despite shedding light on vocalizing in pain, the present study is not without limitations. First and foremost among these limitations is the reliance on controlled rather than spontaneous exclamations. In an effort to make auditory input and response characteristics comparable across conditions, we sacrificed the naturalness with which people cry out in pain. As such, the present results may present an incomplete picture of how vocalizing affects pain. One may venture that controlled responses are more measured than spontaneous responses and thus potentially less effective. To tackle this issue, future research should contrast a controlled exclamation with a spontaneous exclamation condition.

Another open issue concerns the processes underpinning vocalizing analgesia. Although we could point to a role of motor acts, the actual mechanisms require further specification. Toward this end, it may be useful to compare vocalizing to more tailored control conditions such as whispering. Additionally, one may use techniques that isolate the contribution of brain areas involved in motor, motivation, or somatosensory processing. For example, it would be useful to explore vocalizing analgesia in patients for whom somatosensory feedback from the vocal apparatus is disrupted. Alternatively, one might examine healthy individuals undergoing transcranial magnetic stimulation to the part of the somatosensory cortex representing the vocal apparatus.

A further issue worth mentioning concerns potential differences in the role of vocalizing when a painful stimulus has just occurred as compared to when that stimulus has had an extended presence. Using the cold pressor paradigm in healthy individuals enabled insights into the former situation only. A future step should be to examine the latter situation and to determine whether the present findings extend to patients suffering from chronic pain. If true, then vocalizing could be used not only in clinical settings that induce transient discomfort (eg, injections) but also in the therapy of chronic pain (eg, nerve injury). In the latter context, the act of talking or singing may be beneficial.[15]

Lastly, we would like to raise the potential role of individual variables such as gender and culture in the present effects. Previous research found greater pain sensitivity in women than in men and could demonstrate a role of gender identity and gender role expectations.[2,9,10] Additionally, there is evidence for cultural differences.[9,28] For example, North Americans were found to tolerate pain stimulation longer than first- but not second-generation Asian immigrants.[7] To our knowledge, the intersection of gender and culture has not yet been explored. Moreover, given the absence of gender differences for the present effects, this appears to be a relevant issue. Gender and cultural norms concerning the acceptability of expressing pain might be expected to modulate vocalizing benefits and thus present an interesting target for future research.

Conclusions

To summarize, we found that a simple vocal act such as saying "ow" helps individuals cope with pain. Participants tolerated a noxious stimulus longer when vocalizing than when being silent. Whereas there was little evidence for a role of auditory feedback and pain-relieving expectations, motor acts emerged as instrumental. Like vocalizing, button pressing increased pain tolerance, and both effects were correlated across participants. The functionality of motor acts in the context of pain may arise through associated changes in attention, motivation, and/or somatosensory processing that are shared between vocal and nonvocal acts and that make pain relief from vocalizing vocalizing-unspecific. Nevertheless, there are nonanalgesic vocalizing-specific benefits. Vocalizations serve to attract help or ward off an attacker. Additionally, they are likely preserved when other behaviors are obstructed due to injury or restraint. Together, these features promote vocalizing responses as a first line of defense when individuals get hurt.

References

1. Ahles TA, Blanchard EB, Leventhal H: Cognitive control of pain: Attention to the sensory aspects of the cold pressor stimulus. Cogn Ther Res 7:159-177, 1983

2. Alabas OA, Tashani OA, Johnson MI: Gender role expectations of pain mediate sex differences in cold pain responses in healthy Libyans. Eur J Pain Lond Engl 16:300-311, 2012

3. Bresciani J-P, Ernst MO, Drewing K, Bouyer G, Maury V, Kheddar A: Feeling what you hear: Auditory signals can modulate tactile tap perception. Exp Brain Res 162: 172-180, 2005

4. Brodie EE, Kane FMA, Gijsbers K, Niven CA: Contralateral limb movement modulates cold pressor pain. Acute Pain 11: 121-128, 2009

5. Castaldo V, Holzman PS: The effects of hearing one's own voice on sleep mentation. J Nerv Ment Dis 144:2-13, 1967

6. Castaldo V, Holzman PS: The effects of hearing one's own voice on dream content: A replication. J Nerv Ment Dis 148: 74-82, 1969

7. Chan MYP, Hamamura T, Janschewitz K: Ethnic differences in physical pain sensitivity: Role of acculturation. Pain 154:119-123, 2013

8. Cohen J: Statistical Power Analysis for the Behavioral Sciences, 2nd ed. Hillsdale, NJ, Routledge, 1988

9. Forsythe LP, Thorn B, Day M, Shelby G: Race and sex differences in primary appraisals, catastrophizing, and experimental pain outcomes. J Pain Off J Am Pain Soc 12: 563-572, 2011

10. Fowler SL, Rasinski HM, Geers AL, Helfer SG, France CR: Concept priming and pain: An experimental approach to understanding gender roles in sex-related pain differences. J Behav Med 34:139-147, 2011

11. Gelnar PA, Krauss BR, Sheehe PR, Szeverenyi NM, Apkarian AV: A comparative fMRI study of cortical representations for thermal painful, vibrotactile, and motor performance tasks. NeuroImage 10:460-482, 1999

12. Higgens JD, Tursky B, Schwartz GE: Shock-elicited pain and its reduction by concurrent tactile stimulation. Science 172:866-867, 1971

13. Holzman PS, Rousey C, Snyder C: On listening to one's own voice: Effects on psychophysiological responses and free associations. J Pers Soc Psychol 4:432-441, 1966

14. Jay T, Janschewitz K: The pragmatics of swearing. J Politeness Res Lang Behav Cult 4:267-288, 2008

15. Kenny DT, Faunce G: The impact of group singing on mood, coping, and perceived pain in chronic pain patients attending a multidisciplinary pain clinic. J Music Ther 41: 241-258, 2004

16. Legrain V, Guérit J-M, Bruyer R, Plaghki L: Attentional modulation of the nociceptive processing into the human brain: Selective spatial attention, probability of stimulus occurrence, and target detection effects on laser evoked potentials. Pain 99:21-39, 2002

17. Legrain V, Crombez G, Verhoeven K, Mouraux A: The role of working memory in the attentional control of pain. Pain 152:453-459, 2011

18. Mancini F, Nash T, Iannetti GD, Haggard P: Pain relief by touch: A quantitative approach. Pain 155:635-642, 2014

19. Miguez G, Laborda MA, Miller RR: Classical conditioning and pain: Conditioned analgesia and hyperalgesia. Acta Psychol 145:10-20, 2014

20. Moseley GL: Graded motor imagery is effective for long-standing complex regional pain syndrome: A randomised controlled trial. Pain 108:192-198, 2004

21. Nakata H, Inui K, Wasaka T, Tamura Y, Tran TD, Qiu Y, Wang X, Nguyen TB, Kakigi R: Movements modulate cortical activities evoked by noxious stimulation. Pain 107:91-98, 2004

22. Nguyen J-P, Lefaucheur J-P, Decq P, Uchiyama T, Carpentier A, Fontaine D, Brugières P, Pollin B, Fève A, Rostaing S, Cesaro P, Keravel Y: Chronic motor cortex stimulation in the treatment of central and neuropathic pain. Correlations between clinical, electrophysiological and anatomical data. Pain 82:245-251, 1999

23. Niedenthal PM: Embodying Emotion. Science 316:1002-1005, 2007

24. Peretz B, Gluck GM: Assessing an active distracting technique for local anesthetic injection in pediatric dental patients: Repeated deep breathing and blowing out air. J Clin Pediatr Dent 24:5-8, 1999

25. Price TF, Harmon-Jones E: Approach motivational body postures lean toward left frontal brain activity. Psychophysiology 48:718-722, 2011

26. Price DD, Finniss DG, Benedetti F: A comprehensive review of the placebo effect: Recent advances and current thought. Annu Rev Psychol 59:565-590, 2008

27. Rachlin H: Pain and behavior. Behav Brain Sci 8:43-53, 1985

28. Rahim-Williams FB, Riley JL, Herrera D, Campbell CM, Hastie BA, Fillingim RB: Ethnic identity predicts experimental pain sensitivity in African Americans and Hispanics. Pain 129:177-184, 2007

29. Silvestrini N, Piguet V, Cedraschi C, Zentner MR: Music and auditory distraction reduce pain emotional or attentional effects? Music Med 3:264-270, 2011

30. Stephens R, Allsop C: Effect of manipulated state aggression on pain tolerance. Psychol Rep 111:311-321, 2012

31. Stephens R, Atkins J, Kingston A: Swearing as a response to pain. Neuroreport 20:1056-1060, 2009

32. Stephens R, Umland C: Swearing as a response to pain—Effect of daily swearing frequency. J Pain 12:1274-1281, 2011

33. Van Damme S, Legrain V, Vogt J, Crombez G: Keeping pain in mind: A motivational account of attention to pain. Neurosci Biobehav Rev 34:204-213, 2010

34. Van Ryckeghem DML, Crombez G, Eccleston C, Legrain V, Van Damme S: Keeping pain out of your mind: The role of attentional set in pain. Eur J Pain 17:402-411, 2013

35. Vase L, Riley JL, Price DD: A comparison of placebo effects in clinical analgesic trials versus studies of placebo analgesia. Pain 99:443-452, 2002

36. Yarnitsky D, Kunin M, Brik R, Sprecher E: Vibration reduces thermal pain in adjacent dermatomes. Pain 69:75-77, 1997

37. Zautra AJ, Fasman R, Davis MC, Craig AD: The effects of slow breathing on affective responses to pain stimuli: An experimental study. Pain 149:12-18, 2010