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Original Report

Pain, Please: An Investigation of Sampling Bias in Pain Research

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Abstract: **Experimental pain research frequently relies on the recruitment of volunteers. However, because experimental pain research often involves unpleasant and painful sensations, it may be especially susceptible to sampling bias. That is, volunteers in experimental pain research might differ from nonvolunteers on several relevant variables that could affect the generalizability and external validity of the research. We conducted 2 studies to investigate potential sampling bias in experimental pain research. In study 1 we assessed participants' (N = 275; age = 17–30 years) perceived likelihood of participating in pain research. Pain catastrophizing, fear of pain, illness and injury sensitivity, depression, anxiety, sensation-seeking, gender identity, body appreciation, and social desirability were also assessed as potential predictors of the likelihood to participate. In study 2, participants (N = 87; Age = 18–31 years) could sign up for 2 nearly identical studies, with only one involving painful sensations. Thirty-six participants signed up for the pain study and 51 participants signed up for the no-pain study. Study 1 showed that lower levels of fear of pain, higher levels of sensation-seeking, and older age predicted the perceived likelihood of participating in pain research. Study 2 showed significantly higher levels of sensation-seeking in participants who signed up for the pain study compared with those who signed up for the no-pain study. The implications of these findings for future research, as well as the clinical conclusions on the basis of experimental pain research, are discussed.**

Perspective: ***Intention to participate in experimental pain research was associated with less fear of pain, higher sensation-seeking, and older age. Actual participation in experimental pain research was associated with higher sensation-seeking. This potential sampling bias in studies involving painful stimuli could limit external validity and generalizability of pain research.***

Key words: *Pain research, sampling bias, volunteer bias, external validity, generalizability.*

A large body of psychological and medical research relies on the recruitment of volunteers, often students, making it susceptible to sampling bias. A review of sampling bias (sometimes referred to as volunteer, recruitment, or self-selection bias), argued that volunteers differ from nonvolunteers and that these differences can directly affect generalizability and external validity.[35] There are several areas of research in which the presence of sampling bias is well documented, such as general laboratory research,[18] sexuality research,[5,39] and body image research.[11] Studies concerned with unusual topics have been thought to attract volunteers who may particularly deviate from the norms of the general population.

Experimental pain research might be especially susceptible to sampling bias,[10] because it commonly involves unpleasant and painful sensations. In fact, volunteers can often choose from a variety of different studies with comparable compensation, most of which do not involve any unpleasant or painful sensations. Paradoxically,

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several traits that are relevant in the development and maintenance of chronic pain, such as pain-related fear,[8,47] pain catastrophizing,[41,42] illness and injury sensitivity,[3] and depression and anxiety[24] might be abnormally low in volunteers participating in pain research. Further, individuals volunteering in research involving unpleasant, often unknown sensations might do so because they seek novel sensations more so than the average volunteer[39] or because of social desirability.[18] Speculatively, gender identity might play a role as well. Individuals with a more masculine (and less feminine) gender identity might also feel more drawn to pain research, for example in an effort to affirm their "toughness" or "bravery."[5] In addition, individuals who avoid participating in research that could cause unnecessary discomfort to their body might be more protective and appreciative of their body, demonstrated by increased body appreciation.[45]

The presence of sampling bias would pose a risk to the generalizability as well as internal and external validity of experimental pain research, especially when clinical populations are compared with "healthy controls."[29] Differences in such studies are often interpreted as symptoms of the disorder, even though they could also be caused by abnormalities in the reference group. Despite these serious implications and its susceptibility for sampling bias, to the best of our knowledge, empirical research investigating sampling bias in pain research has not yet been conducted.

We investigated the presence of sampling bias in experimental pain research in 2 studies. In study 1, the relationship between the perceived likelihood of participating in research involving painful sensations and several pain-specific (eg, fear of pain) and additional (eg, sensation-seeking) outcomes was investigated. In study 2, using a more ecologically valid paradigm, we compared 2 samples of participants who either signed up for a study involving painful stimuli or a study without such stimuli that was otherwise identical. We hypothesized that individuals who are likely to participate in experimental pain research have lower levels of fear of pain, pain catastrophizing, and illness and injury sensitivity. In addition, we also explored possible differences in depression, anxiety, sensation-seeking, gender identity, body appreciation, social desirability, age, and sex.

Study 1

Methods

Participants

Participants were 275 (63 male) undergraduates between 17 and 30 years old (mean age = 20.48 years, SD = 2.18) from Maastricht University (n = 137), the KU Leuven (n = 131), or another university (n = 2), or they were not university students (n = 5). Their body mass index (BMI) was between 16.61 and 38.45 (mean BMI = 21.90, SD = 3.07) and they identified as white (n = 257), Asian (n = 8), black (n = 2), Hispanic (n = 1), or "other" (n = 7). Ethics approval was obtained from the ethics committees of Maastricht University (ERCPN- 16804062016) and the University of Leuven (G201603506).

Measures

Fear of Pain Questionnaire-3. The Fear of Pain Questionnaire-3 (FPQ)[25] assesses pain-related fear and consists of 30 items describing painful experiences (eg, "Being in an automobile accident"). Participants are asked to "look at each item and think about how fearful you are of experiencing the pain associated with each item." If they had never had a particular painful experience, they are told that they should "answer on the basis of how fearful you expect you would be if you had such an experience." Items are rated from 1 = not at all to 5 = extreme. Scores on the 30 items are summed (range = 30–150), with higher scores reflecting greater fear of pain. FPQ total and subscale scores have shown good internal consistency and construct validity in healthy U.S. female and male undergraduates.[25]

Pain Catastrophizing Scale. The Pain Catastrophizing Scale (PCS)[41] is a 13-item scale that assesses catastrophic pain-related cognitions. Participants are asked to reflect on past painful experiences and to indicate the extent (1 = not at all to 4 = all the time) to which they experienced the thoughts and feelings described (eg, "I feel I can't go on"). Scores on these 13 items are summed, with higher scores indicating higher levels of pain catastrophizing (range = 0–52). PCS scores have shown good internal consistency and construct validity in healthy Canadian female and male undergraduates.[41]

Illness-Injury Sensitivity Inventory-Revised. The Illness-Injury Sensitivity Inventory-Revised (IISI-R)[6] comprises 9 items (eg, "I worry about my physical health"), rated from 0 = agree very little to 4 = agree very much. Item scores are summed (range = 0–36), with higher scores reflecting greater fear of illness and injury. IISI-R total and subscale scores have shown good internal consistency and construct validity in U.S. female and male undergraduates.[6]

Patient-Reported Outcomes Measurement Information System Depression and Anxiety Short Forms. The Patient-Reported Outcomes Measurement Information System (PROMIS) Depression (eg, "I felt worthless") and PROMIS Anxiety (eg, "I felt fearful") Short Forms[1] each contain 4 items rated from 1 = never to 5 = always, and concern how participants have felt in the past week. Items were designed to be applicable to clinical as well as general populations. Scores for each short form are averaged (range = 1–5), with higher scores reflecting higher levels of depression and anxiety, respectively. Scores on the items of these subscales have shown adequate psychometric properties in U.S. women and men (see http://www.healthmeasures.net for details).

Brief Sensation Seeking Scale. The Brief Sensation Seeking Scale (BSSS)[20] consists of 8 items (eg, "I like to do frightening things"), rated from 1 = strongly disagree to 5 = strongly agree. Scores on the BSSS items are averaged (range = 1–5), with higher scores indicating higher levels of sensation-seeking. BSSS scores have shown good internal consistency and construct validity in U.S. female and male undergraduates.[20]

Personal Attributes Questionnaire. The Personal Attributes Questionnaire (PAQ)[38] comprises 24 items that are rated on 5-point bipolar scales. These items are divided into Masculinity (8 items; eg, not at all aggressive to very aggressive), Femininity (8 items; eg, not at all emotional to very emotional), and Androgyny (9 items; eg, very home-oriented to very worldly) subscales. For each item, the extreme Masculine, Feminine, or Androgynous response is given a score of 4, the next most extreme response is scored 3, etc. Scores on the items of each subscale are summed (range = 0–24), with higher scores indicating a more masculine, feminine, or androgynous gender identity, respectively. PAQ subscale scores have shown good internal consistency and construct validity.[38] For the purpose of this study, only the items from the Masculine and Feminine subscales were analyzed because they relate to earlier research investigating the importance of gender roles and pain.[13,23]

Body Appreciation Scale-2. The Body Appreciation Scale-2 (BAS-2)[44] comprises 10 items (eg, "I respect my body"), rated from 1 = never to 5 = always. Scores on these items are averaged (range = 1–5), with higher scores reflecting higher levels of body appreciation. BAS-2 scores have shown good 21-day test-retest reliability, construct validity, and internal consistency in U.S. female and male undergraduates.[45]

Balanced Inventory of Desirable Responding-6 Impression Management Subscale. The Impression Management Subscale[40] comprises 20 items (eg, "I sometimes tell lies if I have to") that are rated from 1 = not at all true to 6 = very true, of which 10 items are reverse scored. Items rated with a 6 or 7 are given 1 extra point before item scores are summed (range = 20–160). Higher scores indicate a stronger tendency to respond in a socially-desirable manner. Scores on the Impression Management Subscale have shown good internal consistency and construct validity in U.S. female and male undergraduates.[40]

Likelihood of Participating in Pain Research. Participants were told: "At Maastricht University and the KU Leuven, people have the opportunity to participate in different kinds of studies for financial compensation or participation credits. In the following, please indicate how likely it is that you would participate in the following kinds of studies if given the opportunity." Several potential study types were listed in the following order: studies involving brain imaging, computer tasks, painful/unpleasant stimuli, food consumption, physical activity, surveys, and medication. The study type of interest was "studies involving painful/unpleasant stimuli (eg, electrical stimulation)." Participants responded from 1 = extremely unlikely to 6 = extremely likely for each study type. A higher score on the pain-relevant item indicates a greater perceived likelihood of participating in research involving painful stimuli.

To explore the potential reasons behind participants' responses, on the following page they were asked, "You indicated that it is [response inserted here] that you would participate in a study involving painful/unpleasant stimuli (eg, electrical stimulation). Please explain why." To disguise the focus of the study, participants were first asked to explain their response concerning studies involving "consumption of food (eg, chocolate)." The responses to the question concerning participation in pain research were later independently read by the first and second authors. Both authors identified the most common themes among participants' responses. Subsequently, both authors compared their identified themes and agreed on a final set. Last, they categorized participants' responses according to this final set of themes. Note that this qualitative analysis was post hoc and serves mainly informative purposes.

Procedure

Participants were recruited via flyers and the electronic recruitment system at Maastricht University and the KU Leuven for a study about "the characteristics of the current student population." The study was completed online using Qualtrics Research Suite (2016; Qualtrics, Provo, UT). Participants signed an electronic informed consent sheet and then provided demographic information (eg, age). Next, in the following order, they completed the PAQ, BSSS, BAS-2, PCS, FPQ, Balanced Inventory of Desirable Responding-6 Impression Management Subscale, IISI-R, PROMIS Depression and Anxiety Short Forms, and the questions concerning the likelihood of participating in pain research. Last, they were asked to guess the aim of the study, and indicated their desired compensation (research credits or a chance to win a gift voucher). Debriefing occurred at study completion.

Data Preparation and Analyses

Sample size calculations were performed for a linear multiple regression using G*Power,[14] assuming an estimated medium effect size ($f^2 > .15$), 95% power, an α level of .05 (2-sided testing), and 9 predictors, indicated that at least 166 participants were needed. We conducted 3 separate backwards linear multiple regression analyses with the perceived likelihood to participate in pain research as dependent variable: first, we tested the pain-specific variables (fear of pain, pain catastrophizing, and illness and injury sensitivity) as predictors while controlling for age and sex (analysis 1). Second, we tested the remaining variables as predictors (anxiety, depression, sensation-seeking, femininity, masculinity, body appreciation, and social desirability) while controlling for age and sex (analysis 2). Third, we conducted a final backwards linear multiple regression analysis including all final predictors that remained in analysis 1 and 2 (analysis 3). The threshold for deletion was set to $P = .05$. An α level of .05 was also used for all other statistical analyses and they were performed using SPSS version 20 (IBM Corp, Armonk, NY). Assumptions for linear multiple regression analyses were checked; all assumptions were met. All predictors were checked for normality and all variables were normally distributed. Holm-Bonferroni corrections were applied to control for multiple testing.[17]

Table 1. Questionnaire and Likelihood Scores

Questionnaire	Subscale	Mean (SD)	Cronbach α
FPQ		77.98 (18.54)	.928
	Minor Pain	19.97 (6.75)	
	Severe Pain	32.31 (8.13)	
	Medical Pain	25.69 (7.57)	
PCS		18.84 (9.95)	.926
	Rumination	6.83 (3.79)	
	Magnification	4.13 (2.50)	
	Helplessness	7.89 (4.74)	
IISI-R		14.28 (8.27)	.930
	Illness	8.07 (4.85)	
	Injury	6.12 (3.98)	
Anxiety (PROMIS)		8.72 (3.33)	.860
Depression (PROMIS)		8.20 (3.84)	.912
BSSS		3.34 (.71)	.773
PAQ	Femininity	3.00 (.52)	
	Masculinity	2.24 (.53)	
BAS-2		3.59 (.74)	.931
Impression Management (Balanced Inventory of Desirable Responding-6)		84.77 (16.04)	.683
Perceived likelihood of participating in research involving	Painful/ unpleasant sensations	2.87 (1.43)	
	Computer tasks	4.85 (1.10)	
	Brain imaging	4.25 (1.45)	
	Food consumption	4.60 (1.32)	
	Physical activity	3.79 (1.35)	
	Surveys	5.24 (.93)	
	Medication	2.45 (1.45)	

Results

Questionnaire Scores and Internal Consistency

Participants' scores on the questionnaires, and the Cronbach α for each measure, are presented in Table 1. Participant's responses concerning the perceived likelihood of participating in pain research and other types of research are also shown in Table 1. Participants indicated that they would be least likely to participate in studies involving painful/unpleasant sensations (mean = 2.87, SD = 1.43) and studies involving medication (mean = 2.45, SD = 1.45). In fact, the likelihood to participate in pain research was significantly lower than all the other types of research (all *P*s < .001), except research involving medication (*P* > .05).

Analysis 1: Regression Analyses for Pain-Specific Variables

Backward linear multiple regression resulted in a final model in which fear of pain was a significant negative predictor and age was a significant positive predictor for the perceived likelihood of participating in pain research (see Table 2).

Analysis 2: Regression Analyses for Additional Variables

Backward linear multiple regression resulted in a model whereby only age and sensation seeking were significant positive predictors for the perceived likelihood of participating in pain research (see Table 3).

Analysis 3: Regression Analyses With Final Predictors

In the final analysis, incorporating the final predictors from analysis 1 and 2, fear of pain emerged as significant negative predictors of the perceived likelihood of participation in pain research, whereas age and sensation-seeking emerged as significant positive predictors (see Table 4).

Qualitative Responses to Likelihood Estimates

Table 5 provides a summary of the most common reasons that participants reported for why they would or would not participate in pain research. Participants with

Table 2. Summary of Backwards Linear Multiple Regression Analysis 1 for Pain-Specific Variables Predicting the Perceived Likelihood of Participating in Pain Research (N = 275)

	Predictors	R^2	ΔR^2	F (ΔR^2)	B	$SE\ B$	β	P
Model 1		.088	.088	5.175*				
	Age				.084	.039	.128**	.032
	Sex				–.147	.204	–.043	.473
	Pain catastrophizing				–.012	.010	–.085	.231
	Fear of pain				–.011	.005	–.145**	.034
	Illness and injury sensitivity				–.014	.013	–.079	.290
Model 4		.069	–.013	10.141*				
	Age				.091	.039	.139**	.021
	Fear of pain				–.017	.005	–.222*	.006

Abbreviations: R^2, proportion of explained variance; ΔR^2, difference in proportion of variance explained; F (ΔR^2), F value associated with ΔR^2; B, unstandardized regression coefficient; SE, standard error; β, standardized regression coefficient.

*$P < .01$.

**$P < .05$.

Table 3. Summary of Backwards Linear Multiple Regression Analysis 2 for Additional Variables Predicting Perceived Likelihood of Participating in Pain Research (N = 275)

Predictors	R^2	ΔR^2	F (ΔR^2)	B	$SE\ B$	β	P
Model 1	.061	.061	1.921				
Age				.090	.040	.137*	.027
Sex				–.159	.213	–.047	.458
Anxiety				–.013	.038	–.030	.733
Depression				–.014	.034	–.037	.688
Sensation-seeking				.312	.127	.155*	.015
Femininity				–.194	.183	–.070	.258
Masculinity				.075	.183	.028	.680
Body appreciation				–.011	.132	–.005	.937
Impression management				.004	.006	.048	.460
Model 8	.046	–.007	1.936				
Age				.096	.039	.146*	.015
Sensation-seeking				.322	.120	.160**	.007

Abbreviations: R^2, proportion of explained variance; ΔR^2, difference in proportion of variance explained; F (ΔR^2), F value associated with ΔR^2; B, unstandardized regression coefficient; SE, standard error; β, standardized regression coefficient.
*$P < .05$.
**$P < .01$.

Table 4. Summary of Backwards Linear Multiple Regression Analysis 3 for the Final Variables Predicting Perceived Likelihood of Participating in Pain Research (N = 275)

Predictors	R^2	ΔR^2	F (ΔR^2)	B	$SE\ B$	β	P
Model 1	.087	.087	8.645*				
Age				.094	.038	.143**	.015
Sensation-seeking				.034	.015	.135**	.022
Fear of pain				–.016	.005	–.206*	< .001

Abbreviations: R^2, proportion of explained variance; ΔR^2, difference in proportion of variance explained; F (ΔR^2), F value associated with ΔR^2; B, unstandardized regression coefficient; SE, standard error; β, standardized regression coefficient.
*$P < .01$.
**$P < .05$.

Table 5. Top 5 Self-Reported Reasons Provided for Participation/Nonparticipation in Pain Research

More Likely to Participate (n = 84, 30.5%) Reason (n, %)	*More Unlikely to Participate (n = 191, 69.5%)* Reason (n, %)
1. Good prior experiences (34, 40.5)	1. Avoidance of (unnecessary) harm (118, 61.8)
(eg, "I did it before and it wasn't as bad as I thought")	(eg, "I don't like to have pain")
2. Personal growth/curiosity (19, 22.6)	2. Fear of pain (38, 19.9)
(eg, "I like to challenge my boundaries")	(eg, "I am afraid of pain and afraid that it would damage my body")
3. Financial reward (11, 13.1)	3. Bad previous experiences (13, 6.8)
(eg, "Because the pay tends to be better")	(eg, "I did it before and it was worse than I expected")
4. Indifference (8, 9.5)	4. Low pain tolerance (5, 2.6)
(eg, "I don't mind pain")	(eg, "I have a very low pain tolerance")
5. Unavailability of other research (5, 6)	5. Availability of other research (4, 2.1)
(eg, "If there were no other options, I would do it.")	(eg, "Why choose to be in pain when there are other studies")

NOTE. Groups are created on the basis of likelihood score which could range from 1 to 6. Participants scoring ≥4 are categorized as more likely to participate, whereas participants scoring ≤3 are categorized as more unlikely to participate in pain research.

a score of ≥4 were categorized as more likely to participate, whereas participants with a score of ≤3 were categorized as more unlikely to participate in pain research. First, participants were more than twice as likely to indicate they would likely not participate in pain research (n = 191, 69.5%) than that they would participate (n = 84, 30.5%). The most common reasons reported for not participating in pain research were the avoidance of (unnecessary) harm (n = 118, 61.8%) or being afraid of pain (n = 38, 19.9%). In contrast, the most common reasons provided for actually participating in research involving pain were good previous experiences with pain research (n = 34, 40.5%) and personal growth/curiosity (n = 19, 22.6%).

Study 2

Study 2 aimed to investigate whether the findings from study 1 translate to behavior: do individuals who are given the chance to sign up for research involving painful stimuli differ from those who do not sign up for research involving painful stimuli? To this end, we placed advertisements at 2 university campuses for 2 nearly identical studies, one purportedly involving painful stimuli and the other purportedly involving neutral stimuli. We included the main pain-related outcomes (fear of pain, pain catastrophizing, and illness-injury sensitivity) as well as the additional significant predictors from study 1 (sensation-seeking, age). On the basis of study 1, we predicted that, compared with participants who signed up for the study involving neutral stimuli, those who signed up for the study involving painful stimuli would be older and demonstrate lower levels of fear of pain, and higher levels of sensation-seeking. Last, we explored whether a larger number of participants signing up for the study involving painful stimuli had previously participated in pain research.

Methods

Participants

Participants were 87 (11 male) undergraduates between 18 and 31 years of age (mean age = 21.10 years, SD = 8.85) from Maastricht University (n = 79, 90.8%), the KU Leuven (n = 6, 6.9%) or another university (n = 2, 2.3%), with a BMI between 14.86 and 34.60 (mean BMI = 21.40, SD = 2.84). They identified as white (n = 78, 89.7%), Hispanic (n = 1, 1.1%), Asian (n = 3, 3.4%) or "other" (n = 5, 5.7%). Ethics approval was obtained from the ethics committees of Maastricht University (ERCPN- 168_04_06_2016) and the KU Leuven (G 2016 03 506).

Measures and Materials

The PCS, FPQ, IISI-R, and BSSS were administered (see the *Measures* section for study 1). Two flyers were created to advertise for a study involving painful stimuli ("Focus") and a study involving neutral stimuli ("Think Fast"; see Figure Supplementary Material 1). The studies were given 2 different names to appear as 2 independent studies to potential participants. The flyer for "Focus" stated, "We are interested in the effect of different distractors (eg, sensory stimuli, colors, shapes) on performance. In this study, you will complete a set of computer tasks and a few questionnaires at the lab. The entire study will take you maximum 1 hour to complete. Some of the distractors used in this study are sensory stimuli which can be perceived as unpleasant/painful." The flyer for "Think Fast" used the same description, except that the example distractors were "colors, shapes, and numbers," and the sentence concerning unpleasant/painful stimuli was removed. Both flyers stated that participants should be university students between 18 and 35 years old and that they would receive research credit or a chance to win a €50 gift voucher. The flyers were created in accordance with studies that had been done previously to maximize ecological validity.

Procedure

Participants were recruited via flyers at Maastricht University and the KU Leuven. Importantly, the flyers for both "studies" (involving painful stimuli or not) were always advertised on the same bulletin boards on campus. However, to avoid suspicion, they were not posted directly side by side. Participants who expressed interest in either of these studies were asked to fill in an online "screening" to determine eligibility. First, they filled in an electronic informed consent sheet. Next, they provided their demographic information, followed by the BSSS, PCS, FPQ, and IISI-R. Last, they indicated whether they had ever participated in a study involving painful stimuli. They were told that they would receive an e-mail within 2 weeks concerning their eligibility. At that time, participants were notified that they were "ineligible" to take part and could choose between research credit and a chance to win a €50 gift voucher. Participants were debriefed after data collection was completed.

Data Preparation and Analysis

Sample size was computed for independent-samples t-tests using G*Power.[14] Because this study was on the basis of study 1 and confirmatory in nature, we assumed a large effect size (d > .80), 95% power, and an α level of .05 (2-tailed) resulting in a required sample size of 84 participants. The 2 resulting data sets were merged and participants were either allocated to the pain group if they had signed up for the study involving painful/unpleasant stimuli (n = 36), or the no-pain group if they had signed up for the study without painful stimuli (n = 51). Five participants (5.05%) signed up for both studies and were counted toward the pain group, because they showed that they were willing to participate in the study involving painful stimuli. Independent samples t-tests were run to investigate differences between the 2 groups with regard to pain catastrophizing, fear of pain, illness and injury sensitivity, sensation-seeking, and age. In addition, χ^2 tests of goodness-of-fit were run to investigate whether sex or previous experience with pain research differed between groups. An α of .05 was used for all analyses and they were performed using SPSS 20 (IBM Corp). Cohen d was calculated to quantify the magnitude of effects.[7] Assumptions of normality were checked for all dependent variables; all assumptions were met.

Results

Group Comparisons on the Main Outcomes

As shown in Table 6, and contrary to our hypothesis, there were no significant differences in pain catastrophizing, fear of pain, illness and injury sensitivity, or age between the pain group and the no-pain group. However, participants in the pain group scored significantly higher on sensation-seeking compared with participants in the no-pain group ($t_{85} = 2.349$, $P = .021$), and the magnitude of this difference was moderate (d = .512 [.350–4.334]).

In addition, we compared whether there was a relationship between sex or previous experience and group.

Table 6. Group Differences on the Main Outcomes Between the Pain and No-Pain Group

	Overall (N = 87)		Pain (n = 36)		No-Pain (n = 51)		P	d†
Outcome	Mean	SD	Mean	SD	Mean	SD		
Age	21.10	8.85	20.58	2.80	21.47	11.35	.648	.108
Fear of pain	80.76	15.93	82.81	16.09	79.31	15.82	.317	.219
Pain catastrophizing	19.05	9.45	20.14	8.17	18.27	10.27	.368	.202
Illness and injury sensitivity	13.45	6.29	14.42	5.90	12.76	6.52	.230	.267
Sensation-seeking	3.33	.59	3.5	.53	3.21	.60	.021*	.512

*$P < .05$.
†Effect size estimates on the basis of Cohen d.

However, neither sex, χ^2 (1, n = 87) = .086, $P = .769$, nor previous experience, χ^2 (1, n = 87) = 1.519, $P = .218$, differed between the 2 groups. However, it should be noted that most of the sample was female (87.36%), so conclusions regarding the influence of sex are tentative.

Discussion

This study investigated sampling bias in studies involving painful and unpleasant stimuli. As expected, study 1 showed that fear of pain was associated with reduced perceived likelihood to participate in pain research. However, fear of pain was not associated with actual participation in study 2. Fear of pain[9,47,48,51] has been implicated in the development and maintenance of chronic pain and several studies have shown that patients exhibit higher levels of fear of pain than pain-free controls. Specifically, fear of pain has been implicated in the avoidance of pain,[22,28,46] so it is unsurprising that individuals with high levels of fear of pain are also likelier to report avoiding pain research. Note that fear of pain scores in our sample were comparable with a similar sample of Dutch healthy undergraduates. In contrast, pain catastrophizing did not seem to predict the likelihood to participate in pain research. Interestingly, most participants indicated that it is unlikely that they would participate in pain research, demonstrating that it seems to be the rule—rather than the exception—to avoid research involving painful or unpleasant sensations. Specifically, the 2 most frequent reasons provided to avoid pain research were avoidance of harm and being afraid of pain.[34] Older individuals also indicated being likelier to participate in pain research. This effect was possibly driven by positive previous experiences with pain research, which we did not assess in study 1 but was one of the main reasons given by participants who said they would consider participating in pain research.

Importantly, sensation-seeking was associated with participation in pain research in study 1 as well as in study 2. Many participants are unfamiliar with painful stimulation in research and might seek out this novel experience because of curiosity. When participants were asked why they would participate in pain research, personal growth and curiosity was indeed one of the most frequent reasons given. Interestingly, this difference in sensation-seeking was not related to sex or gender identity. Previous research has shown that sensation- and risk-seeking are related to hypermasculinity and that men are more likely to participate in sexuality research.[5,33] Concerning pain, even though a masculine gender identity is associated with "toughness,"[23] it was not associated with the likelihood of participating in pain research in this study.

There is currently limited research on the relationship between sensation-seeking and pain. However, the extant research suggests that sensation-seeking is associated with reduced pain sensitivity,[4,31,52] better coping with pain,[27] and increased placebo responding.[19] This might have implications for the generalizability of pain research involving volunteers. For instance, sensation-seeking could be antithetical to the avoidance of pain, because it is explicitly concerned with seeking out novel and arousing situations or stimuli (including pain). If this goal is salient in participants in pain research, it would substantially differ from patients with acute and chronic pain who are primarily concerned with the avoidance and minimization of pain.[49,50] In fact, this level of sensation-seeking might even differ from the general population and represent an especially resilient subset of individuals who actively seek out novel and sometimes unpleasant stimuli. These notions should be tested in future research.

When examining behavior rather than intention in study 2, differences in fear of pain were not replicated. There are several reasons that this might be. First, the intention assessed in study 1 might not translate into behavior. Research into the "intention-behavior gap" shows that intentions are only translated into actions approximately 50% of the time.[36] One factor that might also play a role concerns goals and motivations.[50] Participants might want to avoid pain research, but other goals, such as financial reward or the need for course credits or curiosity, might overrule the aversiveness of pain research. Further, there was a subtle difference in how painful studies were described in studies 1 and 2. In study 1, the study was explicitly described in terms of involving painful/unpleasant stimuli, whereas in study 2 "sensory stimuli" that "might" feel unpleasant/painful were mentioned as one of several distractors. Therefore, the pain element might have been less salient in study 2 than in study 1. Considering that study 2 resembled a frequently-used recruitment strategy, this might be good news: including

information about painful sensations in the study description but not making it too salient might help to counteract sampling bias. Relatedly, results from study 2 suggest that any differences between volunteers and nonvolunteers may be modest.

Nevertheless, the present findings suggest that there are at least some relevant differences between volunteers and nonvolunteers in pain research that are worth considering. If replicated in future investigations, this knowledge will spark important discussions concerning the validity of using volunteers in pain research. For example, especially in translational pain research, pain-free volunteers are frequently compared with pain patients and differences are interpreted as symptoms or etiologic factors in the development of chronic pain. Yet, to interpret these differences as symptoms is to assume that the pain-free individuals in these studies indeed represent the general population. This assumption is implicit in many studies comparing pain patients with pain-free individuals, and in studies assessing "normal" responses to pain in pain-free individuals in areas such as neuroimaging,[2,32] learning differences,[15,29] and affective processing.[43] The risk of making this assumption prematurely is that differences between pain-free individuals and pain patients might be misinterpreted (eg, pain-free individuals are characterized by increased differential learning abilities rather than a deficit in pain patients), exaggerated (eg, the difference between a resilient subset of the population and pain patients is likely larger than between the general population and pain patients), or underestimated (ie, correlations on the basis of a restricted range of scores will be smaller than that on the basis of a normative sample).[37] Sampling bias in pain research might also distort estimates of frequency and prevalence, the relationship between different variables, or the observed natural development of acute and chronic pain conditions.[10,30] These possibilities underscore the importance of future experimental research into sampling bias in pain research.

The following limitations to study 1 and 2 must be mentioned. First, one could argue that the sample from which participants were drawn was already biased because it consisted of younger, predominantly white and female, highly educated students, mainly studying psychology. In fact, several authors have identified the problem of sampling bias in the social sciences in general, with the average participant being younger and more highly educated than the general population,[26] and different from the average chronic pain patient. Henrich et al[16] stated that most participants in behavioral sciences research are WEIRD: Western, Educated, Industrialized, Rich and Democratic, and that "members of WEIRD societies, including young children, are among the least representative populations one could find for generalizing about humans."[16 pp 61] There is no reason to believe that pain research is any different. However, we were interested in sampling bias specific to pain research beyond this broader sampling bias problem. Consequently, we mimicked an ecologically valid recruitment approach as much as possible, which included recruiting from a student population, as is common in pain research. Second, we investigated several pain-specific and general constructs that might be associated with participation in pain research, but there are numerous other variables (eg, extraversion,[12] negative affect[21]) that could also play a role and that should be included in future research. For instance, we did not evaluate current or past pain experiences during recruitment and these might also affect the likelihood to participate in pain research.

Considering these limitations and the need for future research on sampling bias in pain research, it would be premature to fundamentally question sampling practices in pain research at this point. However, there are some precautions that researchers could already take to help counteract or prevent sampling bias. First, recruitment could be diversified to not only target university students but explicitly target other populations as well (concerning age, culture, education level, etc). The findings of studies using different populations could then be compared and researchers could be incentivized to address the generalizability of their findings.[16] Second, to avoid selecting individuals low in fear of pain or high in sensation-seeking, researchers could put even more emphasis on the information regarding the harmlessness of different pain induction methods. Yet, the tradeoff might be that such information could threaten the validity of the pain stimulus itself. That is, to make valid conclusions regarding pain on the basis of laboratory research, the pain induction needs to be perceived as sufficiently threatening. Third, another strategy might be to specifically select and match participants on certain influential characteristics (eg, gender, age, fear of pain).

Conclusions

Our studies might provide initial evidence for the presence of sampling bias in experimental pain research. We hope that this research sparks future empirical investigations of the factors that influence individuals' decision to participate in pain research, the possible implications for the validity and generalizability of pain research, and what can be done about it. Selection needs to be more widely addressed, including sample characteristics and motivations for participation in pain research, and the generalizability of studies should be discussed in more detail with this in mind. Overall, a better understanding of sampling bias and participant characteristics in pain research is a prerequisite to a valid and meaningful examination of pain in humans, which is fundamental for scientists investigating pain in the laboratory, as well as clinicians who rely on the findings of this rigorous empirical research.

Supplementary Data

Supplementary data related to this article can be found at https://doi:10.1016/j.jpain.2018.02.011.

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