Acute ostracism-related pain sensitization in the context of accumulated lifetime experiences of ostracism

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Highlights

- First study of acute ostracism effects on pain in context of lifetime ostracism
- Acute ostracism-related hyperalgesia for people with accumulated lifetime exposures
- Lived experiences of ostracism may sensitize individuals to future experiences
- May represent social-environmental conditioning of central sensitization
- Potential social moderator of sensitization and marker of pain burden

Running title: Lifetime ostracism and pain sensitization

Acute ostracism-related pain sensitization in the context of accumulated lifetime experiences of ostracism

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Abstract

Ostracism (i.e., being ignored/ excluded) is a form of social adversity that powerfully impacts health and well-being. While laboratory research indicates that experimentally manipulated experiences of ostracism impact pain, findings have been mixed. Prior investigations have not considered moderating or main effects of individual histories of ostracism, and have been limited in the scope of their pain testing. In this study, participants without current pain reported lifetime experiences of ostracism prior to a laboratory visit where they were randomized to experience either a single episode of ostracism (i.e., acute ostracism) or control condition that was immediately followed by quantitative sensory testing. Results indicate that the experimental effect of a single episode of ostracism on pain ratings, after-sensations, and temporal summation of pain is moderated by lifetime ostracism; no main effects were found. For individuals with histories of more lifetime ostracism, encountering a single episode of ostracism led to greater pain sensitization relative to the control condition, whereas no experimental effect was observed for individuals with little lifetime exposure to ostracism. These findings indicate that acute experiences of ostracism may be accompanied by periods of hyperalgesia for people who are chronically ostracized, implicating ostracism as a potential social moderator of pain

sensitization. People who are stigmatized may therefore experience enhanced pain burden with repeated and accumulating experiences of ostracism.

Perspective: Results suggest that in the context of accumulated lifetime experiences of ostracism, single experiences of ostracism evoke central sensitization. In this way, ostracism may function to trigger central sensitization and shape socially and societally-determined patterns of pain burden and disparity.

Key words: Exclusion, Quantitative Sensory Testing, Chronic Stress, Stigma, Social Modulation of Pain

Introduction

Ostracism – the experience of "being ignored and excluded, often without…explanation or explicit negative attention[67,pg.429]" – is a profoundly negative and emotionally painful experience, yet its effects on health are often insidious.[67] Even brief (acute) episodes of ostracism negatively affect behavior, stress responses, and well-being.[67,75] While less is known about the effect of accumulated ostracism experiences over a lifetime, prolonged and repeated experiences are associated with feelings of alienation, helplessness, meaninglessness, and depressive symptoms,[11,16,17,57] and corresponding effects on physical health have been hypothesized.[57]

Prior research demonstrates that accumulation of other types of adverse social experiences (childhood abuse, racialized discrimination) are associated with enhanced laboratory pain,[22,47,52,66,72] greater clinical pain,[4,20,47] and greater risk for developing chronic pain.[1,6,15,41,60] The emerging literature on the relationship between ostracism and pain has relied upon experimental induction of a single episode of ostracism (exclusion in an online game) and static assessment of pain within a single modality (thermal thresholds and tolerances). Some

studies found no effect of a single episode of ostracism,[8,33,73] while others demonstrated increased[5,53] or decreased[3] sensitivity to experimental pain measures. In adolescents, a single episode of ostracism was linked to increased pain sensitivity two weeks following the experience, but not immediately after.[21] One potential source of these mixed findings may be the limited specificity and sensitivity of static measures of thermal pain to social factors. Prior research on social modulation of pain indicates that experiences of social harm (i.e., racialized discrimination, shifts in relative social standing) are more closely associated with pain facilitation and markers of central sensitization.[26,32,47,55] Another potential contributor to conflicting results is that the context of individual histories and experiences that are likely to moderate experiences of ostracism have been largely unexplored.[9,74] One prior study found chronic stress moderated the effect of a single episode of ostracism on heat pain tolerance (ostracism-related decreases in tolerance were only observed among individuals with high levels of chronic stress)[53] however, the moderating effect of lifetime ostracism on health-related effects of a single episode was not considered.

Consideration of lifetime experiences of ostracism is important, as those with frequent previous experiences with ostracism are also more likely to encounter future repetitive episodes of ostracism – a compounding effect due to systematic ostracism of stigmatized and minoritized conditions or identities.[43,46] Minoritized populations also bear a greater burden of pain; one potential mechanism that might drive inequitable pain burden is differential exposure to ostracism episodes.[7,14,24,29,30,38,45,48,51,54,65]

In this study, we tested the moderation of the effect of a single episode of ostracism on laboratory pain by accumulated lifetime experiences of ostracism. We included static pain measures (cold pain threshold and tolerance) as well as laboratory markers of central

sensitization (cold pain after-sensations and temporal summation of mechanical pain), and prioritized inclusion of individuals from minoritized populations. We aimed to clarify the existing mixed findings on the relationship between an episode of ostracism and pain in several ways. We expected a sample more inclusive of people from racialized backgrounds would enhance generalizability and represent more variability in lifetime ostracism compared to previous investigations. We hypothesized that ostracism-related pain sensitization might be more evident in laboratory pain measures previously associated with social modulation of pain (markers of central sensitization and pain facilitation) than in static measures of pain threshold and tolerance; that accumulated lifetime ostracism would be associated with greater laboratory pain; and that the effect of an episode of ostracism on laboratory pain would be moderated by lifetime ostracism, such that people who experience more frequent ostracism in their everyday lives would show enhanced pain sensitivity after a single episode of ostracism.

Methods

Procedure

This study was approved by the Texas A&M institutional review board. Data were collected between September 2018 and December 2019 in a controlled laboratory environment. All participants provided verbal and written informed consent. Participants were asked to complete the Ostracism Experiences Scale (OES) via an online link at least 48 hours prior to the laboratory visit (though seven completed right before the study and three after the laboratory visit). During the laboratory visit, all procedures (including practice trials of the pain procedures) were first rehearsed to the point of mastery and comfort to support the experimental paradigm. Consistent with standard protocols of laboratory-evoked ostracism, the experimental

manipulation was preceded by demographic questions that make one's visible identity salient, and a distractor task (mental visualization questionnaire). Then, participants either experienced a single episode of ostracism (experimental condition) or the control condition immediately followed by laboratory pain testing. The researcher conducting the pain testing was blind to the experimental condition. After pain testing, participants completed a manipulation check assessing their perceived experience of ostracism, and then completed post-test questionnaires.

Following study completion, participants were debriefed, and the deception involved as part of the ostracism manipulation (i.e., that participants were ostracized or not based on randomization and were not in fact ostracized by real people) was disclosed. At this point, participants either provided written confirmation of consent, or data were not retained.

Participants

Participants were recruited primarily from the university campus community using participant pools, university listservs, posted flyers, and word of mouth, and were compensated with either course credit or $6 for the 30 min study. Eligible participants were at least 18 years of age. Explicit calls for participants from diverse racialized and ethnic backgrounds were used to improve inclusion and representation in this sample. Exclusion criteria were 1) current pain or acute pain causing condition (including muscle soreness, open cuts or wounds, recent bruises, headache, cold/canker sores); 2) history of any chronic pain, recurring pain condition, and/or neuropathic conditions; and 3) use of any analgesic medication (including over-the-counter, prescription, or illicit drugs) in the three days prior to study participation.

One-hundred and six volunteers enrolled, three were subsequently excluded for not meeting eligibility criteria (contrary to responses provided in the eligibility screen), and the data

from two were not retained per the choice of the participants as indicated in the post-debriefing confirmation of consent form. One person was excluded from all analyses due to a technical failure in the experimental program resulting in manipulation failure. This resulted in a total of 100 participants (Table 1) in the analyzed sample. A subset of the participants in this study (i.e., 41 Latinx Americans) were included in a larger, recently reported, secondary analysis.[66]

Measures

Demographics. Prior to the experimental manipulation of ostracism, participants provided demographic information including age (in years, via open text-box), racialized/ethnic identity (*"African-American/Black, American-Indian/Alaskan Native, Asian, Latinx/Hispanic, White (non-Hispanic), Multi-racial (please specify), Other (please specify)"*), and sex (*"Male, Female, Other (please specify)"*). The prompt for the latter erroneously asked "What is your gender?" but then provided options for sex, rather than gender identity. Therefore, we refer to self-identified sex in this paper, but acknowledge this limitation.

Lifetime Ostracism. The Ostracism Experiences Scale (OES) is an 8-item self-report survey that measures long-term, lived experiences of ostracism.[9,25] Examples of items include: "*In general, others keep me out-of-the-loop on information that is important to my close relationships"* and *"In general, others do not look at me when I'm in their presence"*. Participants rated the frequency at which they have experienced the item statements on a 6-point Likert scale, ranging from 1 (Hardly Ever) to 7 (Almost Always), such that higher scores indicated more lifetime ostracism. The items were summed to create a total score of lifetime ostracism. The OES demonstrated good reliability in this sample ($\alpha = .92$).

Single Episode of Ostracism. Ostracism was manipulated in the laboratory using Cyberball.[69] Cyberball is a virtual ball-tossing game that has demonstrated reliability and validity [68,69] as a manipulation of ostracism. Participants toss a ball in a virtual environment with two other "participants," who are in fact avatars pre-programmed to interact with the participants in specific ways depending upon the randomized condition. The game was programmed for a total of 30 tosses across conditions. Participants were randomly assigned to the ostracism condition (in which participants received the ball 2/30 times) or the control condition (in which participants received the ball 10/30 times, reflecting equal inclusion amongst the three players).

Manipulation check. Following pain testing, participants rated three items (i.e., "I was ignored", "I was excluded", and "I was ostracized") on a 5-point scale (1 Not at all; 5 Extremely). Scores on these items were highly intercorrelated ($\alpha = .90$) but analyzed individually to confirm the ostracism condition indeed evoked feelings of ostracism. Participants also completed a 22-item measuring negative mood felt during the Cyberball task, as used in previous Cyberball studies (e.g., "I feel bad"; 1 Not at all; 5 Extremely; $\alpha = .92$ [67]). Positively valenced items were reverse scored, and all items were averaged together to create a negative mood score. Participants then estimated the percentage of ball tosses they received during the game to verify the success of the Cyberball manipulation.

Laboratory Pain Testing. Pain testing occurred immediately after the experimental episode of ostracism (or control). Testing followed a standardized set of procedures. Participants received thorough instruction and practice before the start of the experiment to allow for immediate completion of pain testing after the episode of ostracism. To minimize deterioration of experimental effects, instructions were not provided during pain testing. Mechanical

procedures (which involved brief punctate stimuli) preceded cold pain procedures (which involved sustained cold pain to maximal tolerance levels) to minimize carry-over effects.

Mechanical Pain Procedure.

Practice Trial: During the training portion of the study visit, participants completed and practiced the mechanical pain procedure. First, two dots were marked on the participant's middle phalange on the right middle finger to indicate stimuli location. Participants were then asked to close their eyes. A single punctate stimulus was applied to the most proximal dot using a 128 mN weighted probe, and participants responded by rating their evoked pain on a 0 (no pain) to 100 (worst pain imaginable) numerical pain scale. A series of 10 consecutive stimuli applied to the same location was then administered at a rate of one stimulus per second, and participants responded by rating the maximum pain they perceived during the stimulus series using the same 0 to 100 scale.

Experimental Trial: The same procedures were used during the experimental trial. Immediately after the experimental manipulation of ostracism, participants placed their right hands flat on the table, and a single and series of stimuli were administered to the most distal dot on the middle phalange of the middle finger using a 256 mN probe.

Mechanical temporal summation (MTS) was calculated as the difference between pain ratings in response to the single stimulus compared to the series of 10 using the 256 mN probe in the experimental trial.

Cold Pain Procedures.

Practice Trial: Participants practiced the entire cold pain procedure described below during the training portion of the study visit. Instead of submerging their hand in cold water, however, participants placed their hand adjacent to the water bath positioned in the same orientation as would be used in the experimental trial. After initial training, participants rehearsed each step, verbally indicating when they would place their hand in the bath, say "pain," and remove their hand from the bath.

Experimental Trial: Immediately after rating the maximum pain they felt during the 10 stimuli from the 256 mN probe (mechanical pain procedure, applied to the right hand), participants submerged their left hand, up to the wrist, in a cold (4ºC) water bath. When they first experienced pain from the cold water, they verbally responded by saying "pain" out loud, and then removed their hand when the pain from the cold water became intolerable. Following hand removal, participants verbally reported their current as well as their retrospectively recalled maximum pain using the same 0 to 100 numerical pain scale as indicators of cold pain tolerance intensity. Cold pain threshold was operationalized as the time (in seconds) between hand submersion and verbal notification of first pain. Cold pain tolerance was operationalized as the duration (in seconds) that participants kept their hands submerged in the cold-water bath.

After-sensations (i.e. pain after stimulus removal, thought to be indicative of central amplification [70]) were measured via pain ratings following the cold pain procedure. After removing their hands from the cold-water bath, participants were prompted to report pain ratings using the same 0 to 100 numerical pain rating scale at 15 second intervals for the first 30 seconds then 30 second intervals until an absence of pain (i.e., a rating of "0") was reported. After-sensations were operationalized in two ways – severity and duration. After-sensation severity was operationalized as pain reported at 30, 60 and 90 seconds after hand removal. After-

sensation duration, or lingering pain, was operationalized as the summed duration in seconds that participants reported after-sensation pain greater than 0 when prompted.

Post-test questionnaires. Following pain testing, participants completed additional questionnaires (e.g., surveys of life experiences and open-ended reflections) intended as pilot data for future studies that are outside the scope of the current investigation and therefore not reported here.

Data Analysis

All data analyses were conducted using SPSS, Version 27.[37] Descriptive statistics are reported on sample characteristics and study-related variables.

Data cleaning and transformation. Significant Shapiro-Wilk tests for normality indicated a positive skew for lifetime ostracism (OES) and all dependent (pain) variables. A uniform logarithmic transformation was applied to variables of interest resulting in diminished skew. Transformed data were used for analyses, and raw data are presented in the table and figure to retain the original scales. One extreme outlier was identified (> 3 SD above the mean) in the cold pain threshold measure and was excluded from analyses of this measure.

Manipulation check. Independent samples t-tests were conducted on each manipulation check item (i.e., evoked feelings of being ignored, excluded, and ostracized) to confirm the ostracized group felt more ostracized than the control group after the experimental manipulation. Independent samples t-tests were also conducted on the negative mood measure, and the estimated percentage of ball tosses they received.

Primary analyses. Group differences in pain between participants in the ostracized and control conditions were examined using independent samples t-tests with all pain measures. Partial correlations between the continuous lifetime ostracism scores and all pain measures controlling for experimental condition were also examined. Finally, lifetime ostracism was assessed as a moderator of the effect of experimental condition (ostracized or control) on pain in separate models for each of the pain measures. Lifetime ostracism was manually centered by subtracting the mean from each individual score, which is consistent with the centering conducted by the PROCESS Macro program in SPSS. Moderation analyses were conducted using PROCESS Macro on SPSS (Model 1).[34,37] The Johnson-Neyman technique was used to probe interactions to identify specific ranges of moderator (i.e., lifetime ostracism) values that are interpretable beyond the current sample.[40] Cut points identified using the Johnson-Neyman technique, rather than standard deviations, were used to determine high, medium, and low values depicted in the figure. These represent statistically meaningful ranges of OES scores for which the relationship between experimental condition and pain differs, thus identifying levels of lifetime ostracism that may increase risk for acute-ostracism related pain. In this particular sample, the identified cut points resulted in the low range of lifetime ostracism scores representing the lowest possible detected by the scale (i.e., responding "Hardly ever" to all but a few items) and the high range representing mid-scale responses on the lifetime ostracism scale.

Missing data. All usable data values were used for each analysis. Some individual data values for specific variables are missing or removed as follows. Seven values are missing for cold pain threshold: four due to experimenter error (i.e., stopwatch delay), two due to participant error (i.e. forgetting instructions), and one (as previously described) that was an extreme outlier and therefore removed from analysis. One set of after-sensation, and one set of MTS, values

were missing due to participant error (i.e. not following instructions and participant confusion, respectively). Two lifetime ostracism values are missing due to participants choosing to skip one or more items of the OES. Available sample size for each comparison is noted in Table 1.

Results

Random assignment and experimental group equivalency

Random assignment resulted in experimental groups that did not significantly differ in demographic composition or individual differences in lifetime ostracism (Table 1). While not significantly different, participants in the control condition were slightly younger (0.26 years) in age and reported more lifetime ostracism compared to participants in the ostracism condition. Therefore, the potential confounding of age was considered in primary analyses. Any effects of the non-significant difference in lifetime ostracism were expected to work against experimental effects (as lifetime ostracism was lower in the experimental ostracism group), increasing risk of Type II, but not Type I error. Thus, any observed experimental effects may be underestimated, but were not considered to be confounded by differences lifetime ostracism.

Manipulation check

Individuals in the ostracized condition felt significantly more ignored, excluded, and ostracized (Table 1). Additionally, ostracized participants perceived receiving a smaller percentage of ball tosses and reported more negative mood immediately after the manipulation relative to participants in the control condition. No confidence intervals included zero when assessing these group differences, suggesting the ostracism manipulation was effective.

Ostracism and pain

The main effect of the experimental condition (ostracized vs. control) on pain was not statistically significant (all confidence intervals included zero, Table 1). While ostracized participants reported greater pain sensitivity across pain measures, effect sizes were small ($0.04 < d < 0.32$). Similarly, lifetime ostracism was not significantly associated with pain. Partial correlations between lifetime ostracism and pain, controlling for experimental condition, were not statistically significant ($-0.20 < r < 0.11$; $0.06 < p < 1.0$). The pattern of results was not changed when age was included as a control variable in the analyses.

Across several pain measures, statistically significant moderation revealed that experimental effects emerged for those who had greater frequency of lived ostracism experiences. Specifically, there was statistically significant moderation found for cold pain tolerance intensity (pain ratings), after-sensation severity at 30 seconds, 60 seconds and 90 seconds, mechanical pain rating after repeated stimuli, as well as for mechanical temporal summation. In each case, the direction of the moderation indicated that those with higher frequency of lifetime ostracism experienced greater pain after a single episode of ostracism (Figure 1). The moderation was not significant for cold pain threshold (duration), cold pain tolerance (duration), aftersensation duration, or mechanical pain rating after a single stimulus.

Discussion

The present study is the first to examine the moderating effect of accumulated lifetime experiences of ostracism on acute effects of an episode of ostracism on laboratory pain. Consistent with our hypothesis, findings indicate that a single event of ostracism enhances pain sensitivity for those with greater accumulation of lifetime ostracism experiences. We also found support for our hypothesis that ostracism-related pain sensitization is more strongly related to

markers of central sensitization and pain facilitation (i.e., after-sensation severity and mechanical temporal summation).[13,28,59] Moderation was not observed for most static measures of pain. Taken together, current theory and present results indicate that lifetime ostracism may not only sensitize individuals to future experiences of ostracism – resulting in more profound and harmful effects – but also may be associated with a physiological sensitization to physical pain inputs. This extends the current and emerging literature investigating different social modulators of pain, such as experiences of discrimination and childhood adversity, where greater experiences of adversity predicts greater incidence of chronic pain and worse pain outcomes.[4,20,47,56,63,66,71]

In the present study, the effects of ostracism on pain emerged as an interaction between lived experience and an acute episode of ostracism. Contrary to our hypothesis, the simple (main) effects of lifetime ostracism or acute ostracism alone did not significantly predict pain outcomes across participants. However, this finding has some parallels to the previous mixed findings among studies using a single episode of ostracism and cold pain.[18,58,73] The results of the present study suggest there may be important differences in the experience and impact of an acute incident of ostracism on pain depending on the accumulated lived experiences of ostracism. Additionally, theories of learning would suggest that sensitization may occur with repeated experiences of ostracism such that individuals who experience more frequent episodes of ostracism may experience enhanced and prolonged pain responses following a single episode of ostracism.[9,19] Prior studies examining the effects of a single episode of ostracism on pain may have been unable to detect clear relationships because they did not account for lifetime experiences of ostracism, resulting in mixed findings potentially attributable to the inherent differences between samples. On the other hand, individuals with greater or more extreme experiences of lifetime ostracism are harder to access, less likely to be sampled, and less likely to

participate in research, limiting abilities to detect effects of lifetime ostracism experiences on pain.[74]

The current study aimed to be more inclusive and represent greater diversity of racialized and ethnic groups. These findings have important implications for marginalized communities who are systematically ostracized within our society and social institutions (i.e., education, healthcare, government etc.), as well as experience an unequal burden of pain.[2,14,38,42,48,61,62,65] Despite suffering the greater burden of pain, marginalized communities receive unequal and inadequate care for their pain.[10,12,35,49,50] Within the healthcare system, policies and practices that inhibit access to care and contribute to poorer provider communication and interaction with patients systematically ostracize individuals belonging to marginalized groups. These experiences of ostracism accumulate – and based on the current study findings – may enhance existing pain or sensitivity to acute painful events that is already disproportionately experienced by marginalized communities, particularly following subsequent events of ostracism. Within the context of the current study, our sample was primarily composed of students from racialized backgrounds who are more likely to experience institutional and interpersonal ostracism in university settings.[64] Persistent feelings of ostracism on campus, in addition to ostracism by other social institutions, can accumulate and may heighten a student's sensitivity to pain experiences after a brief event of ostracism. Thus, the current findings provide supportive evidence for the moderating effects of accumulative experiences of lifetime ostracism on pain response following acute ostracism, and may also suggest that accumulation of ostracism experiences could potentially contribute to the unequal burden of pain faced by marginalized communities.

There were some limitations to the current study that should be considered when evaluating the findings. Although the range of lifetime ostracism scores in our sample was wide,

the higher end of lifetime ostracism experiences was not well represented. This is typical of the majority of studies focusing on lifetime ostracism experiences where general, non-clinical populations (including undergraduate student samples) often have truncated scores[9,39] while extreme experiences of ostracism – such as homeless populations – remain under- represented in the literature.[23,36,44] However, despite the restricted range of lifetime ostracism scores in our sample, those with higher lifetime ostracism scores tended to display greater pain sensitivity across pain measures after a single episode of ostracism. We also did not assess attributions of ostracism in this study. While this is beyond the scope of the current research, we acknowledge this as a limitation, as prior research indicates that ostracism during Cyberball may be enhanced if attributed to racialized discrimination.[27] As such, future research could extend our work by examining these attributions in the context of interacting lifetime and acute ostracism experiences. Finally, non-probability sampling was used in favor of oversampling to increase inclusion and representation relative to typical convenience and true probability sampling methods.

In summary, the current findings elucidate an interaction between lifetime exposures and acute episodes of ostracism on pain that help reconcile previous mixed findings in the experimental literature – highlighting the necessary consideration of accumulated ostracism. Ostracism experiences are not randomly distributed across populations. People with minoritized or stigmatized identities are systematically more likely to experience ostracism, and therefore accumulate more of these experiences over a lifetime.[31,43] Our results indicate that these individuals will experience enhanced pain during episodes of ostracism – periods often not sampled in the clinic or in research, but very relevant to the pain experience and well-being of the individual. The present results also expand understanding of potential pain mechanisms

underlying ostracism-related pain via inclusion of multiple types of pain tests within the QST battery. Specifically, our findings indicate that acute experiences of ostracism may be accompanied by periods of hyperalgesia for people who are chronically ostracized, implicating ostracism as a potential social moderator of pain sensitization. We propose that this may represent a case of social-environmental conditioning that may evoke central sensitization among individuals with accumulated exposures.[56,70] Although future research is needed, chronic ostracism may represent a useful clinical marker of pain experience and burden that has received little attention.

Figure Legend

Figure 1. Moderation of pain-sensitizing effects of a single episode of ostracism by accumulation of lifetime ostracism experiences. Graphs depict raw scores (not transformed values). Moderator ranges were determined using the Johnson-Neyman technique, and are reported as ranges of OES scores. In this sample, Low lifetime ostracism represents responses that are nearly the lowest possible detected by the scale (i.e., responding "Hardly ever" to all but a few items). High scores in this case represent mid-scale responses on the lifetime ostracism scale. a) cold pain threshold (duration), b) cold pain tolerance (duration), c) current (at the time of tolerance) cold pain tolerance intensity (pain rating), d) maximum cold pain intensity (retrospective pain rating), e) after-sensation severity (pain rating), f) after-sensation duration, g) mechanical pain rating after single stimulus (pain rating), h) mechanical pain rating after repeated stimulus (pain rating), and i) mechanical temporal summation (change score). After-Sensations at 60 and 90 seconds reflected similar patterns as 30 seconds.

*, significant moderation.

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	Whole Sample				Experimental Groups						Group Comparisons				
					Control Group			Ostracized Group					Effect size estimates		
	n	*range*	*m*	*SD*	*n*	*m*	*SD*	*n*	*m*	*SD*	*t/X²*	*df*	*Cohen's d/ Cramer's V*	*95% CI*	*p*
Demographics															
Age	100	18-23	18.91	1.13	50	18.78	1.04	50	19.04	1.21			0.23	-0.707, 0.187	
Sex											0	1	0		
Female	68				34			34							
Male	32				16			16							
Racialized Identity											7.57	6	0.28		
African-American/Black	10				6			4							
American Indian/ Alaskan Native	3				3			3							
Asian	23				11			12							

Hispanic/Latinx	41				17			24							
White	12				5			7							
Multi-Racial	10				7			0							
Middle-Eastern	1				1			0							
Ostracism															
Lifetime Ostracism (OES)	98	8 - 49	16.95	8.66	48	17.83	9.35	50	16.1	7.94	-0.99	96	-0.20	-1.74, 5.21	.324
Post-Manipulation Ostracism (Manipulation check)															
Ignored					50	2.76	1.26	50	3.96	1.20	4.90	98	0.98	-1.69, -.71	<.001
Excluded					50	2.54	1.28	50	4.06	1.08	6.42	98	1.28	-1.99, -1.05	<.001
Ostracized					50	2.08	0.99	50	3.06	1.19	4.49	98	0.90	-1.41, -.55	<.001
Negative mood					50	2.77	0.76	50	3.39	0.74	4.14	98	0.83	-0.92, -0.32	<.001
Perceived % of ball tosses					50	22.96	7.60	50	11.74	7.04	7.66	98	1.52	8.31, 14.13	<.001
Post-Manipulation Laboratory Pain															
Mechanical Pain															
Pain Rating, single	100	0 - 42	6.29	7.52	50	5.16	6.22	50	7.42	8.55	1.51	98	0.32	-5.23,	.134

stimulus														0.71	
Pain Rating, 10 stimuli	99	0 - 68	15.95	15.03	50	13.64	13.38	49	18.31	16.35	1.56	97	0.31	-10.62, 1.29	.123
Temporal Summation	99	-2 - 40	9.6	9.68	50	8.48	8.77	49	10.73	10.49	1.16	97	0.23	-6.11, 1.60	.249
Cold Pain															
Pain Threshold (seconds)	93	0-56.69	9.55	9.16	46	11.01	10.21	47	8.13	7.84	1.53	91	0.32	-0.86, 6.63	.129
Pain Tolerance (seconds)	100	4.09 - 225.82	31.56	36.5	50	34.16	39.97	50	28.97	32.87	0.71	98	0.14	-9.33, 19.71	.480
Cold Pain Tolerance Intensity (current)	100	2 - 90	35.51	22.05	50	33.70	20.93	50	37.32	23.18	0.82	98	0.16	-12.38, 5.14	.414
Cold Pain Tolerance Intensity (maximum)	100	2 - 90	41.06	23.96	50	38.70	22.94	50	43.42	24.94	0.99	98	0.20	-14.23, 4.79	.327
Pain Rating, after sensation 30s	99	0-82	19.58	18.5	50	17.76	15.26	49	21.43	21.31	0.99	97	0.20	-11.05, 3.71	.326
Pain Rating, after sensation 60s	99	0-50	10.77	13.37	50	9.70	11.55	49	11.86	15.05	0.80	97	0.16	-7.50, 3.19	.425
Pain Rating, after sensation 90s	99	0-50	6.08	9.53	50	4.94	7.07	49	7.25	11.48	1.21	97	0.24	-6.11, 1.48	.230
Lingering Pain (seconds)	99	15 - 570	124.55	112.38	50	119.10	106.39	49	130.10	119.03	0.49	97	0.10	-56.01, 34.01	.629

Table 1. Descriptive and Inferential Statistics. Raw (untransformed) values are reported in the table. Cohen's d was calculated with the Included (control) group as the reference, such that positive values reflect greater perceptions of ostracism and more pain in the experimentally ostracized group relative to the control group.