Mobile phones and Physical Pain

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ABSTRACT. Mobile phones and their psychological effects have been a point of interest for researchers in recent years. Although research has assessed the effects of active mobile phone use on pain management (e.g., Wiederhold, Gao, Kong, & Wiederhold, 2014), most mobile phone interaction is passive. If personal phones are associated with social support, the mere presence/absence of a mobile phone may influence pain responses. Our study aimed to test this effect. A sample of 100 were randomly assigned to hold a mobile phone or television remote control while a cold pressor task was used to ethically induce acute pain. During the task, pain threshold and tolerance were recorded. Afterward, subjective pain, social support, current emotions, perceived mobile phone attachment, and mobile phone usage were also measured. The mobile phone group reported marginally higher pain thresholds, $F(4, 95) = 0.47, p = .76, R^2 = .02$, and showed marginally greater pain tolerance, $F(4, 95) = 1.98, p = .10, R^2 = .08$, than the remote control group. The effects did not rise to the level of statistical significance. Interestingly, the remote control group scored marginally higher in some negative emotions compared to the mobile phone group. This research lays the groundwork for future research on the effects that increasingly routine interactions with mobile phones have on people, often without their knowledge.

Mobile phones have become a pervasive part of American life over the past 40 years. According to the Pew Research Center’s Mobile Fact Sheet (2017), mobile phone ownership has steadily risen to an overwhelming 95% of Americans. Additionally, smartphone use among Americans has increased from 35% in 2011 to 64% in 2015 (Smith, 2015). Smartphones can be used for everything from text messaging and e-mail, to video and music streaming. Given their useful capabilities combined with their ever-growing accessibility, it is not difficult to understand why mobile phones and the impact of these devices intrigue researchers of all fields, especially psychologists.

Although research on the psychological and social effects of mobile phone usage is limited, the findings have been substantial. Attachment to mobile phones has been found to mirror conventional social attachment (Konok, Pogány, & Miklósi, 2017), and can be impactful enough to cause feelings of social exclusion or inclusion. For example, Smith and Williams (2004) used mobile phone text messages to evoke imagined ostracism in participants to test if it would cause psychological pain. They found that imagined ostracism from the text messages was just as effective as real-life ostracism in causing psychological pain and feelings of social exclusion. Conversely, Barlott, Adams, Diaz, and Molina (2014) found that caregivers who suffered from social exclusion found social comfort in participating in a community text messaging program. Both of these studies involved participants primarily or exclusively receiving text messages, yet even this passive usage of one’s mobile phone was enough to significantly alter levels of social pain or comfort. Extending these results to test physical pain and physical pain relief via mobile phones would be of great use to the field, specifically in the way of pain interventions.

Physiological and psychological connections
can be seen between social and physical pain. The pain overlap theory (Eisenberger & Lieberman, 2004) suggests that there is a shared processing system between physical and social pain due to evolutionary processes, developed in order to prevent social separation that could be detrimental to developing mammals that require a mother’s care for survival. Furthermore, social and physical pain can cause shared psychological consequences of feeling ignored and excluded (ostracism), and increase desire to aggress (Riva, Wirth, & Williams, 2011). In turn, satisfying social needs could increase pain tolerance because some of the negative psychological effects of physical pain would be counteracted (Riva et al., 2011). Due to their built-in social capabilities, mobile phones may pose as a good tool to increase pain tolerance.

Mobile phones have been useful in previous studies to aid in physical pain and stress management via different applications such as virtual reality (Wiederhold, Gao, Kong, & Wiederhold, 2014), mobile-delivered narratives (Grassi, Gaggioli, & Riva, 2011), and smartphone diaries (Garcia-Palacios et al., 2013). However, little research has been conducted to test the effects of the mere presence of mobile phones on physical pain. If mobile phones can elicit the feeling of social inclusion (Barlott et al., 2014), and if social inclusion can offset physical pain (Riva et al., 2011), then the presence of a mobile phone during a physically painful situation could potentially increase pain threshold and tolerance. In our study, we tested whether the presence of a mobile phone would affect pain tolerance and threshold during participation in a cold pressor task. We hypothesized that participants in the presence of their personal mobile phone would show a reduction in the severity of pain experiences, with both higher thresholds of pain onset and tolerance for pain than participants not in the presence of their mobile phone. We also predicted that the presence of mobile phones would decrease self-reported pain intensity and degree of negative emotional experience, relative to their absence. Finally, we predicted that these differences in pain experiences between groups would be mediated by differences in current perceptions of social support.

**Method**

**Participants**
The participants in this study were 100 students, 24 men and 76 women at a university in the Southern United States. Nearly all (95%) were between 18–24 years of age, with no participant older than 30 (\(M_{age} = 20.18 \text{ years}, SD = 2.41\)). Participants were told the study assessed the effects of wireless electronic signals on various tasks, and they received course credit and $10 in exchange for their participation in the study. To assure participant safety, individuals who answered “yes” to having a history of cardiovascular disorders, fainting or seizure disorders, Raynaud’s syndrome, or frostbite were not permitted to participate in the study. Similarly, any individuals with injuries such as an open cut, sore, or fracture to their nondominant hand were ineligible to participate. No individuals were excluded due to reported health issues.

**Materials**

**Cold pressor task.** The cold pressor immersion task has been repeatedly used in psychological research as means to produce acute pain in a safe manner (e.g., Mitchell, MacDonald, & Brodie, 2004; Uysal & Lu, 2011). During the task, participants placed their nondominant hand, palm up, in a cold bath of circulating water maintained at a temperature of 5.5°C. The water temperature was controlled by a refrigeration unit (Techne RU-200 Dip Cooler) and a thermo regulator (Techne Model TE10D). Participants were instructed to keep their hand in the water for as long as they could, with a maximum time of 5 minutes. The procedure used to administer the cold pressor task was mirrored after the procedures reported by Uysal and Lu (2011).

**Pain measures.** During the cold pressor task, participants were instructed to indicate when they first felt pain by saying, “now.” They were also instructed to keep their hand in the water as long as they could before removing it. The time between immersion of the participants’ hands and when they said, “now” was recorded as their pain threshold score; time between immersion of the participants’ hands and when they removed their hands was recorded as their pain tolerance score (Uysal & Lu, 2011). After immersion, participants were also asked to rate their overall pain experience during the cold pressor task on a 10-point scale, ranging from 0 (no pain) to 10 (severe pain).

**Social support.** To assess current feelings of social support, participants completed the Multidimensional Scale of Perceived Social Support (Zimet, Dahlem, Zimet, & Farley, 1988). This scale consists of 12 statements such as “My friends really try to help me.” Participants indicated their agreement with each statement on a 7-point scale, ranging from 1 (very strongly disagree) to 7 (very strongly agree). The measure had strong internal reliability,
with an overall Cronbach’s $\alpha = .894$ for the sample.

Current affect. Participants completed the Positive and Negative Affect Schedule (PANAS; Watson, Clark, & Tellegen, 1988) to report on their current feelings. The measure consists of 20 emotion items (e.g., interested, afraid, alert), 10 positive, and 10 negative. Participants chose a number between 1 (very slightly or not at all) to 5 (extremely) that indicated the extent to which they currently felt each emotion. The measure also showed good internal reliability for each subscale, with a Cronbach’s $\alpha = .863$ for positive emotion items and .746 for negative emotion items for the sample.

Mobile phone attachment. Participants responded to five items to measure the amount of attachment they feel toward their mobile phones. This scale includes statements such as, “I would feel lost if I didn’t have a cell phone” (Weller, Dieckmann, Mauro, & Slovic, 2010; Weller, Shackelford, Dieckmann, & Slovic, 2013). Participants were instructed to rate how much they agreed with each statement, ranging from 1 (strongly disagree) to 5 (strongly agree). The measure also showed strong good internal reliability, with a Cronbach’s $\alpha = .808$ for the sample.

Mobile phone usage. Participants were asked to supply information about the make and model of their mobile phone, how long they have owned that mobile phone, and how they typically use their mobile phone (making phone calls, sending text messages, e-mailing, social media, and/or keeping track of their schedule).

Procedure
Experimentation commenced following institutional review board approval (Protocol #16-248). Upon entering the lab, participation eligibility was confirmed. Mobile phone participants were then reminded that the study assessed the effects of wireless electronic signals and that they had been randomly assigned to either hold their mobile phone or a television remote control during the first part of the experiment. Those in the remote control group were instructed to place their mobile phones in an envelope that was moved to an adjoining research room for the duration of the study. The experimenter then provided instructions for the cold pressor task and had the participant restate them in order to make sure that the procedure was clearly understood. During the cold pressor task, the participant placed his/her dominant hand inside of a sheet protector next to the water bath that contained either their personal mobile phone (experimental condition) or a remote control (control condition). The participant was instructed to keep a hand on the assigned device during the entirety of the cold pressor task. Participants then completed the cold pressor task.

After the cold pressor task, participants were given 2 minutes to relax before the questionnaire packet was presented. Participants in the mobile phone condition were instructed to leave their mobile phones in the sleeve next to the water bath for the remainder of the study. After resting, participants first rated their overall pain before completing the measures of social support, current affect, perceived mobile phone attachment, and mobile phone usage. Participants were then asked to provide their sex and age in an open-response format. Participants in the remote control condition were then given back their mobile phones. Finally, all participants were debriefed and paid $10 for their participation.

Results
Descriptive statistics for all dependent measures—both overall and by mobile phone condition—are presented in Table 1. We hypothesized that individuals with their mobile phone present would have higher pain threshold and pain tolerance scores, and lower overall pain ratings, than individuals without their mobile phone present. We used three multiple regression models to test these hypotheses, controlling for mobile phone, sex, age (mean centered), and level of mobile phone attachment (mean centered)\(^1\). The overall models did not explain a significant amount of variance in pain threshold scores, $F(4, 95) = 0.47$, $p = .76$, $R^2 = .02$, pain tolerance scores, $F(4, 95) = 1.98$, $p = .10$, $R^2 = .08$, or self-reported pain, $F(4, 91) = 0.27$, $p = .90$, $R^2 = .01$. The full results of each model are presented in Table 2. Across all models, the only significant effect to emerge was a main effect of sex on pain tolerance scores, such that men showed a greater tolerance for pain than women, $b = -47.32$, $SE = 21.52$, $p = .03$.

Importantly, mobile phone condition did not significantly predict any of the three focal dependent measures: threshold, $b = 10.67$, $SE = 8.48$, $p = .21$; tolerance, $b = 16.9$, $SE = 18.2$, $p = .36$; self-reported pain, $b = -.15$, $SE = 0.32$, $p = .65$. Independent-samples $t$ tests were also used to test the simple relationships between mobile phone condition and our three focal dependent measures, but no significant differences emerged...
between groups: threshold, \( t(98) = -1.23, p = .22 \);
tolerance, \( t(98) = -1.12, p = .27 \); self-reported pain, 
\[ t(94) = 0.51, p = .61 \]

A model was also tested that predicted perceived social support from mobile phone condition, mobile phone attachment, sex, and age. Again, the overall model did not explain a significant amount of variance in perceived social support scores, \( R^2 = .04 \), with no significant main effect of mobile phone condition (\( p = .76 \)).
The full results from this analysis are also presented in Table 2. Because no significant relationships emerged between the independent variable and any pain measure, tests for mediation by social support were not conducted.

For exploratory purposes, independent-samples \( t \) tests were conducted to compare feelings of negative emotions and positive emotions across mobile phone conditions. The two conditions did not significantly differ on overall levels of negative emotions, \( t(97) = 1.47, p = .15, d = 0.29, 95\% CI = [-0.04, 0.26] \), or positive emotions, \( t(98) = -0.43, p = .67, d = 0.09, 95\% CI = [-0.41, 0.26] \). Mean overall levels of negative and positive emotions are presented in Table 1.

Additional mobile phone exploratory analyses were also conducted on individual PANAS items, which revealed marginal mobile phone group differences on four individual negative emotion items. The mobile phone absent group reported feeling marginally more scared (\( M = 1.28, SD = 0.54 \)) than the mobile phone present group (\( M = 1.12, SD = 0.33 \)), \( t(98) = 1.80, p = .08, d = 0.36, 95\% CI = [-0.02, 0.34] \); marginally more hostile (\( M = 1.28, SD = 0.61 \)) than the mobile phone present group (\( M = 1.10, SD = 0.36 \)), \( t(98) = 1.80, p = .08, d = 0.36, 95\% CI = [-0.02, 0.38] \); marginally more ashamed (\( M = 1.20, SD = 0.50 \)) than the mobile phone present group (\( M = 1.06, SD = 0.24 \)), \( t(98) = 1.80, p = .08, d = 0.36, 95\% CI = [-0.01, 0.29] \); and marginally more afraid (\( M = 1.26, SD = 0.49 \)) than the mobile phone present group (\( M = 1.10, SD = 0.36 \)), \( t(98) = 1.86, p = .07, d = 0.37, 95\% CI = [-0.01, 0.33] \). No other individual PANAS items differed significantly across groups.

Discussion
The primary purpose of this study was to test the effects of mobile phone presence and absence on the intensity of physical pain experiences. Additionally, we examined the perceived social support and current emotions experienced by participants during the trial. Our hypothesis that individuals with mobile phones present would have higher pain threshold and pain tolerance scores than individuals without their mobile phone present was not supported by the data. However, the condition means consistently differed in the predicted directions, with the mobile phone present condition displaying higher pain threshold and tolerance scores and lower overall pain scores than the mobile phone absent condition. These trends, however, were combined with a large amount of variability in both pain threshold and pain tolerance scores, suggesting that individual differences in pain experiences need to be better accounted for in future work.

The study also produced interesting findings on the emotion measures that could lead to useful insight. Participants in the mobile phone absent group scored marginally higher in the negative emotions scared (a state of fear), afraid (the feeling of fear), hostile, and ashamed compared to the mobile phone present group. These emotions could have been due to the fact that participants felt exposed and anxious without their mobile phones (Cheever, Rosen, Carrier, & Chavez, 2014). Similarly, Hoffner and Lee (2015) found that mobile phone use could lead to alleviation of
negative emotions; stripping people of their mobile phones could, in turn, evoke those negative emotions. It could also be argued that having a mobile phone present could serve as a safeguard against such negative emotions. In order to test this in future studies, a control group that performs a neutral, nonpain inducing task with phones removed could be added to the two original pain conditions. Such a condition could help isolate and identify the independent effect of phone removal on negative emotions.

Another interesting, but secondary, finding involved the relationship between pain tolerance and sex. Consistent with previous research on pain tolerance (Schmitz, Vierhaus, & Lohaus, 2012; Snyder et al., 2005), men were found to be more tolerant to pain. This provides additional support for sex differences on physical pain measures and reinforces the need to statistically control for this difference in future research.

A possible reason why the results did not come out as predicted is that the participants’ mobile phones remained in the plastic sleeve during the questionnaire portion of the experiment. This could have influenced questionnaire results due to the phones not being as easily accessible as they were during the cold pressor task. The lack of accessibility could have affected how participants responded to the questionnaire because any social comfort provided by physical contact with the phone during the cold pressor task was removed while the measures were completed. However, this would not account for the lack of group differences on the two initial pain measures, which were assessed before participants withdrew their hands from the sleeve containing either the phone or the remote. In the future, it may be beneficial to conduct a similar study wherein the participants’ phones remain accessible throughout the entire study, provided they are in the cell phone present group.

Another possible limitation is that, due to an equipment issue, the water temperature used was 5.5 degrees Celsius, instead of the originally intended 5 degrees Celsius (as was used by Uysal & Lu, 2011). Prior protocols (e.g., Mitchell et al., 2004) have used temperatures as low as 1 degree Celsius for similar cold pressor tasks. Using a lower temperature might have produced more physical discomfort, reduced variability in tolerance, and increased the likelihood of a significant difference between conditions. A lower water temperature should be utilized in possible replication studies.

In addition to addressing these methodological concerns, future research should also measure anxiety in regard to mobile phone presence and absence. We made an assumption that anxiety played a role in the negative behaviors displayed by participants in the mobile phone absent condition, but a specific measure for anxiety would be needed to support this claim. There is potential for mobile phones to serve as a mild anxiolytic if these findings are supportive of our prediction. Future research could also move in the direction of testing the relationship between mobile phones and chronic pain. Our study and many others

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*Note: Condition was coded as 0 = mobile phone absent and 1 = mobile phone present. Attachment refers to level of attachment to one’s mobile phone. Sex was coded as 0 = men and 1 = women. Both attachment and age were mean centered.

Because a cell phone manipulation may differentially impact individuals based on level of cell phone attachment, models were also tested that included the interaction term between cell phone condition and cell phone attachment. However, inclusion of this term did not significantly improve any models (all changes in \( R^2 < .015 \); all \( ps > .21 \)). Therefore, cell phone attachment was only included as a covariate in the presented models.

Dropping outliers present for pain threshold and pain tolerance did not change the pattern of findings presented in this paragraph.
measured acute pain, and although knowledge about acute pain is valuable, according to the 2012 National Health Interview Survey, around 25.3 million Americans suffer from chronic pain (National Institutes of Health National Center for Complementary and Integrative Health, 2015). Studying how mobile phones affect chronic pain, whether positively or negatively, could potentially benefit these millions of Americans. For future tests of these specific relationships, efforts to increase sample size (particularly of men) and adequately control for individual differences in pain responses could reveal statistically significant effects related to mobile phones. Having a larger sample of men would allow for between- and within-sex comparisons, and a pretest of initial pain tolerance could help control for individual differences in pain sensitivity. Additionally, race/ethnicity of participants was not measured, leaving open the possibility of meaningful racial or ethnicity differences. Future research should also measure and assess this demographic factor. Moreover, due to the fact that this information is not widely studied yet, effect size and power are difficult to calculate. If the effect size is small to moderate the study may be underpowered and this poses another limitation.

In a world that is becoming increasingly reliant on mobile phone technologies, this study is a stepping-stone in understanding more about how mobile devices are affecting the general population, sometimes even without people’s knowledge. This research adds to the ever-growing literature of coping mechanisms underlying mobile phone use. This study shows that mobile phones can yield psychological consequences when taken away (i.e., fear, hostility, etc.), but future research should further explore their potential psychological benefits. With their vast capabilities and universal nature, mobile phones could be an extremely useful tool in the pursuit of a collective well-being.

References

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