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Choice and placebo expectation effects in the context of pain analgesia

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Abstract The current experiment examined whether having choice over treatment options facilitates or inhibits the strength of placebo expectations in the context of pain perception. All participants were exposed to an aversive stimulus (i.e., the cold pressor task), and participants in some conditions were given expectations for two pain-relieving treatments (actually the same inert ointment mixture). Critically, participants in these expectation conditions were also given a choice or not about which of the two treatments they preferred to use. Participants in a control condition were not provided with a treatment expectation. Despite receiving the same inert treatment, participants who had a choice over treatments showed increased placebo analgesia as compared to participants not given a choice and participants in the control condition. Moreover, this effect was mediated by changes in anxiety. Explanations and implications for these results are discussed.

Keywords Choice · Placebo effect · Expectations · Pain · Cold-pressor

Introduction

Placebo effects—defined as physiological or psychological responses which can be directly attributed to expectations associated with a substance or procedure but not a result of the inherent power of that substance or procedure—are among the most widely reported and clinically relevant phenomena linking psychology to medicine (Price et al., 2008; Stewart-Williams, 2004; Stewart-Williams & Podd, 2004). Placebo effects have been demonstrated for a range of domains (e.g., pain reduction, depression, motor function), individuals (e.g., patients and non-patients), and types of treatments (e.g., pills, surgeries, therapies; for reviews see Benedetti, 2008; Rief et al., 2008; Stewart-Williams & Podd, 2004). Moreover, despite advances in modern medicine, the success of many treatments still depends upon placebo responding, including for depression (Kirsch & Sapierstein 1998), cardiovascular disease (Bienenfeld et al., 1996), and, importantly for the current research, acute and chronic pain (Laska & Sunshine, 1977; for reviews see Harrington, 1999; Kirsch, 1999; Price et al., 2008). Although considerable research has demonstrated placebo effects and their mechanisms, there has been less research on the social psychological factors that determine when such effects are strongest (Hyland, 2011; Price & Fields, 1997). The current research explored whether having choice (vs. not) over a treatment influences placebo responding in the context of pain analgesia (i.e., pain reduction).

We suggest that the study of choice is quite natural and ecologically meaningful in the context of treatment expectations. For instance, the recent movement toward patient-centered medicine has led to an increase in patient involvement in treatment plans—including choice over treatment options (Stewart et al., 2003). Moreover, this transformation toward patient centeredness has coincided with the advent and proliferation of web-based medical tools, health decision aids, and direct-to-consumer medication advertising that provide increased opportunities for patient involvement in treatment selection. Even for people who forego an official visit to a medical professional, there

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are a variety of self-treatment and over-the-counter options that necessitate making a choice. Importantly, many of these contexts are likely to involve elements of placebo responding or expectations in relation to the treatment. However, despite the fact that choice is quite common in these contexts, studies and clinical trials investigating placebo effects have not considered the potential moderating role of patient choice.

How and why choice might impact placebo responding

The main hypothesis tested in the current work is that having a choice over treatments with placebo elements will lead to stronger expectation effects (e.g., pain analgesia), compared to control conditions and conditions where expectations are provided without the availability of choice. This hypothesis is tenable due to prior research showing that people (1) feel more positive about chosen rather than non-chosen options (Brehm, 1956; Harmon-Jones & Mills, 1999; Sharot et al., 2010), (2) search and appraise information in a manner that confirms rather than disconfirms their prior choices (Hart et al., 2009; Nickerson, 1998; Smith et al., 2008), and (3) feel less anxiety and greater confidence when they are allowed to make choices and exercise personal freedom (Langer, 1975; Langer & Rodin, 1976; Leotti et al., 2010; Presson & Benassi, 1996; Schulz, 1976; Shafir et al., 1993). Each of these diverse literatures supports the possibility that making a choice over treatments could result in greater placebo analgesia. For example, choosing a placebo treatment would be expected to (1) enhance positivity for the chosen treatment, (2) lead people to appraise somatic information as evidence that the chosen treatment was effective (as opposed to ineffective; Geers et al., 2011b), and (3) decrease feelings of anxiety and increase feelings of confidence regarding the treatment and one's ability to cope (for review see Geers & Rose, in press). The potential for treatment choice to reduce anxiety is particularly important, as both prior research and theory points to anxiety reduction as a key cause of placebo effects (Petrovic et al., 2005; Turner et al., 1994).

Direct evidence in the literature regarding the influence of choice on placebo responding is sparse. However, given that expectations are a component of all health care treatments—even treatments or procedures using active ingredients (Benedetti, 2008)—research on the role of choice-making in the context of active treatments and their outcomes is clearly relevant. Indeed, the possibility that exercising choice and stating preferences can alter treatment outcomes has surfaced across the physical and mental health care literatures under many guises. First, various non-experimental studies show that increased *perceptions* of choice, personal involvement, and maximization of fit between preferences and treatments have all been associated with beneficial outcomes (e.g., quality of life, treatment efficacy and satisfaction) in a number of different contexts (e.g., pain, depression, phobias; Devine & Fernald, 1973; Gattellari et al., 2001; Hack et al., 2006; Moyer & Salovey, 1998; Rokke & al'Absi, 1992; Street & Voigt, 1997; Vogel et al., 2009). Second, permitting patients to choose between identical and different *active* treatments is also associated with beneficial outcomes in a number of diverse contexts (e.g., increased adherence to medication, increased pain tolerance; Chilvers et al., 2001; Fallowfield et al., 1990; Gordon, 1976; Handelzalts & Keinan 2010; Kanfer & Grimm, 1978; Mendonca & Brehm, 1983; Morris & Royle, 1988; Myers & Branthwaite, 1992; Rokke et al., 2004; Rokke, & Lall, 1992; Vandereycken & Vansteenkiste, 2009; Worthington, 1978).

Current experiment

Although the aforementioned results are in agreement with the general hypothesis that choice strengthens placebo expectation effects, each of these studies employed treatments with inherent, active ingredients. Accordingly, there is currently a dearth of well-controlled experimental data in the context of more pure placebo effects—that is, reductions in psychological or physiological symptoms which can be directly attributed to receiving a substance or undergoing a procedure, but is not a result of the inherent power of that substance or procedure (Stewart-Williams & Podd, 2004). Thus, this lack of data in placebo contexts does not permit researchers to disentangle the placebo expectation effect itself from the potential benefits of choice solely on active treatments. The current research is the first to examine the role of choice in facilitating placebo expectation effects.

In the experiment, participants were told they were in a study involving pain perception from submerging their hand into a container of crushed ice and water. Before engaging in this task, participants in some conditions were given expectations for two pain-relieving ointments (actually the same inert ointment mixture). Participants in the *choice condition* were permitted to choose which of the two ointments they would like to use during the task, whereas participants in the *no choice condition* were told by the experimenter which ointment to use. Participants in the *control condition* were not given an expectation or a choice, but did receive the same inert ointment on their hands before the task (described as a hand-cleanser). For the main dependent measures, participants rated their pain during and after the task. The main hypothesis was that participants in the choice condition—relative to the no

choice and control conditions—would be most likely to respond to the aversive stimulus in a manner consistent with treatment expectations (i.e., lower perceived pain). Moreover, based on our theoretical reasoning, we also assessed whether anxiety reduction was a key mediator of the influence of choice on pain perception.

Method

Participants and design

The sample consisted of 41 undergraduate students (25 female) from a large, Midwestern university who participated in the study as part of a psychology course requirement (Note that one participant removed her hand prematurely from the ice water and was omitted). Participants were randomly assigned to the *choice condition,* the *no choice condition*, or the *control condition*.

Procedures, manipulations, and measures

Participants came to the laboratory and were greeted by an experimenter wearing a white lab coat. The laboratory room contained a one-way mirror, had an intercom system for remote communication between the participant and experimenter, and was designed to look sterile and medical. Participants began the study by answering pre-task questions (e.g., demographic items), which included a visual analogue scale (VAS) assessing baseline levels of pain. Specifically, participants responded to a single item asking them to rate their current level of pain by marking a 100-mm line, anchored with *no pain* on the left side and *worst pain possible* on the right side (Geers et al., 2008).[1] After completing the pre-task questions, the primary task was described to participants as involving an evaluation of cold temperature. Participants were told that they would be placing their non-dominant hand into a container of water and crushed ice.

Next, participants in the two expectation conditions (the *choice condition* and the *no choice condition*) were told that the study involved "product testing" for novel pain-relieving treatments (actually inert ointments). The two products were described briefly and were subtly distinguished from one another. Specifically, the first product was described as warming a participant's hand and protecting it like a glove, whereas the second product was briefly described as blocking the pain receptors in the hand (the order in which these two products were presented was counterbalanced and did not interact with our condition variable). Participants were then given 2 min to think about these products while the experimenter left the room to ostensibly gather more materials. When the experimenter returned, participants in the *no choice condition* had the product selected for them by the experimenter (participants were randomly assigned to receive either the first product or the second product). Participants in the *choice condition* were asked which of the two products they wanted to try during the cold pressor task. It is important to note that the number of participants in the choice condition who selected the product that "warms like a glove" ($n = 8$) did not differ from the number who selected the product that "blocks pain receptors" ($n = 7$) ($N = 15$; $\chi^2 = .07$, $P > .70$), and the specific product used did not significantly change our main results.

Participants in the *control condition* were presented with a bottle containing the same placebo ointment. However, these participants were told this was an ordinary ointment that would be used to cleanse dirt and oil off of their hands before the cold pressor task. Thus, control participants had the same inert ointment applied to their hands but were not given the placebo expectation.

Next, participants in all conditions followed the same procedures. The experimenter (wearing surgical gloves) opened up the bottle and applied the placebo ointment (a mixture of thyme, food coloring, and lotion; see Geers et al., 2010; Montgomery & Kirsch, 1996, Montgomery & Kirsch 1997). The experimenter then left the room and provided instructions over an intercom from an adjacent observation room. Approximately 1 min after application of the ointment, participants submerged their non-dominant hand (up to their wrist) in a container filled with non-circulating water and crushed ice set at 8°C. Participants were instructed to leave their hand submerged as long as possible, but that they could withdraw at any point if it became unbearable. At four points during the task (15, 30, 45, and 60 s), the experimenter prompted participants to orally indicate their current level of pain on a scale ranging from 0 (*no pain*) to 10 (*worst possible pain*). These will heretofore be referred to as "concurrent pain ratings".

At 75 s, participants were prompted to take their hands out of the ice water, were provided with a towel, and were immediately given a questionnaire packet that included several post-task measures. Critical among these measures were the post-task pain ratings, where participants indicated their current level of pain on two measures using 100 mm visual analogue scales (VAS), with the first anchored with *no pain* on the left side and *worst pain possible* on the right side and the second anchored with *not*

[1] Given that we did not extensively prescreen for chronic pain or other health conditions in this college sample, the inclusion of a baseline pain measure allowed us to control for any pre-existing differences in our analyses. It is notable that mean baseline levels of pain did not differ across conditions (F [2, 38] = .05, $P > .90$) nor did they violate homogeneity of variance assumptions across conditions (*Levene's Statistic* = .032, $P > .90$).

bad at all on the left side and *most unpleasant feeling possible* on the right side ($\alpha = .96$). Also included was an item about feelings of anxiety during the cold pressor task ("How anxious did you feel when your hand was in the ice water?"; 1 = *not at all anxious*; 7 = *very anxious*). Additionally, the questionnaire packet included two manipulation check questions, assessed at the very end so as not to make participants overly sensitive to the manipulations (see also Geers et al., 2006, 2010). First, participants were asked about the extent to which they expected the ointment to influence their pain during the cold pressor task ("When the ointment was put on your hand, did you expect it to reduce the pain from the ice water?"; 1 = *not at all*; 7 = *very much*). Second, participants in the choice and no choice conditions (but not the control condition) were asked about the extent to which they perceived having choice over the two pain relievers used during the task ("To what extent did you have a choice over which of the two ointments you would use during the cold water task?"; 1 = *no choice at all*; 7 = *complete choice*). After completing the packet, participants were debriefed, thanked, and dismissed.

Results

Manipulation checks

To examine the effectiveness of our expectation manipulation, we submitted participants' ratings of the extent to which they expected the ointment to affect their pain to an ANOVA with choice condition (choice, no choice, or control) as a between-subjects factor. The overall ANOVA was significant, $F(2, 38) = 8.45$, $P < .01$. Confirming the success of our manipulation, post-hoc tests revealed that participants in the *choice condition* ($M = 3.64$; $SD = 1.69$) and *no choice condition* ($M = 3.29$; $SD = 2.02$) provided significantly higher expectation ratings than participants in the *control condition* ($M = 1.31$; $SD = .63$) ($ps < .01$). Critically, the choice and no choice conditions did not significantly differ from one another ($P > .80$), confirming that participants in these conditions had equivalent expectations about the ointment influencing their pain.[2]

In terms of the choice manipulation, recall that only participants in the choice and no choice conditions (and not the control condition) rated their perceived extent of choice over the placebo ointments. An independent-samples t-test confirmed that participants in the *choice condition* provided higher ratings of perceived choice ($M = 6.62$; $SD = .96$) than did participants in the *no choice condition* ($M = 2.86$; $SD = 2.51$), $t(25) = 5.07$, $P < .01$, indicating that the choice manipulation was successful.

Concurrent pain ratings

Recall that participants rated their pain during the task on 11-point scales (0 = *no pain*; 10 = *worst possible pain*) at four time points during the task (after 15, 30, 45, and 60 s). These concurrent pain ratings (Table 1) were submitted to a 3 (choice condition: choice, no choice, or control) X 4 (time: 15, 30, 45, or 60 s) mixed-model ANCOVA, controlling for participant gender, age, and baseline pain ratings (Geers et al., 2008; Myers et al., 2006; Riley et al., 1998). First, there was a main effect of time, $F(3, 99) = 8.13$, $P < .01$, $\eta_p^2 = .20$, where participants' pain ratings increased the longer their hands were in the water. Second, there was also a significant main effect of choice condition, $F(2, 33) = 4.73$, $P < .05$, $\eta_p^2 = .22$. Follow-up tests showed that overall pain ratings for the *choice condition* ($M = 3.13$; $SD = 1.86$) were significantly lower than for the *no choice condition* ($M = 5.20$; $SD = 1.83$) ($t(25) = 2.46$, $P < .01$, $d = 1.00$) and marginally lower than for the *control condition* ($M = 4.69$; $SD = 1.77$) ($t(24) = 1.54$, $P = .13$, $d = .61$). Also, these main effects were qualified by a significant Time X Choice Condition interaction, $F(6, 99) = 2.98$, $P < .05$, $\eta_p^2 = .15$.

In looking at Fig. 1, pain ratings for the three conditions appeared to be comparable when participants first placed their hands in the cold water (after 15 and 30 s). Indeed, follow-up analyses showed that pain ratings after 15 and 30 s did not significantly differ among the conditions (all $ts < 1.6$, $ps > .10$). However, it appeared that the *choice condition* started to diverge from the other two conditions near the end of the cold water task (after 45 and 60 s). Follow-up analyses showed that pain ratings for the *choice condition* were significantly lower than ratings for the *no choice condition* and the *control condition* after 45 s ($ts > 2.49$, $ps < .05$, $ds > .99$) and even lower after 60 s ($ts > 3.13$, $ps < .01$, $ds > 1.25$).

[2] Some readers may still wonder about potential interpretation problems when measuring expectations *after* the cold pressor task, as opposed to immediately after the manipulation of expectations. First, it should be noted that there is precedence for measuring expectations later in the study to avoid any possible contamination that explicitly thinking about expectations could have on a primary dependent variable (e.g., Geers et al., 2006; Geers et al., 2010). Moreover, although choice and no choice participants reported similar pain expectations on the manipulation-check item, their self-reported pain did differ from one another. This finding suggests that the manipulation-check responses, obtained near the end of the experiment, were not primarily determined by participants' pain experiences and reports regarding the cold pressor task.

Table 1 Pain ratings as a function of choice condition

Measure	Choice condition		No choice condition		Control condition	
	M	*SD*	*M*	*SD*	*M*	*SD*
Concurrent pain						
15 s	2.45	2.10	3.55	2.21	2.58	1.93
30 s	3.37	2.38	4.49	2.33	4.00	1.85
45 s	3.67	2.66	6.00	2.35	5.58	1.67
60 s	3.96	2.93	6.83	2.27	6.56	1.93
VAS post-task pain	29.06	21.61	52.96	20.87	48.59	21.58
Anxiety	2.98	1.56	4.56	2.03	4.54	1.78

Concurrent pain ratings were made on an 11- point scale (0 = *no pain*; 10 = *worst possible pain*) at four time points during the task (after 15, 30, 45, and 60 s). VAS (visual analogue scale) post-task pain ratings were made by marking 100-mm lines, anchored with *no pain/not bad at all* on the left side and *worst pain possible/most unpleasant feeling possible* on the right side. Anxiety ratings were made on a 7-point scale (1 = *not at all anxious*; 7 = *very anxious*). The reported means control for participant age, gender, and baseline pain ratings

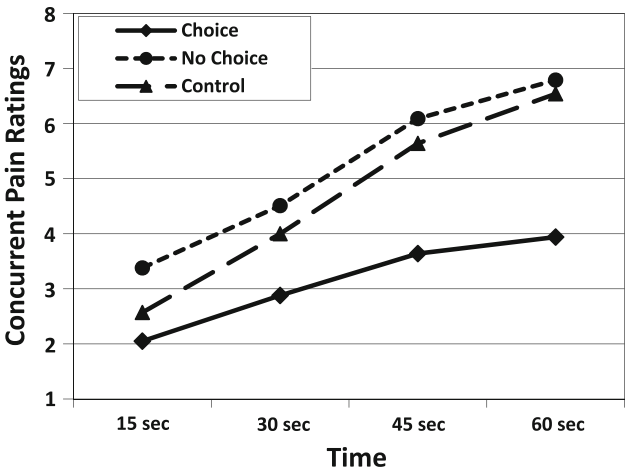

Fig. 1 Concurrent pain ratings as a function of choice condition and time. "Concurrent Pain Ratings" were made on an 11- point scale (0 = *no pain*; 10 = *worst possible pain*) at four time points during the cold pressor task (after 15, 30, 45, and 60 s). Means control for participant age, gender, and baseline pain ratings

Post-task pain ratings

Recall that participants rated their post-task pain using two, 100-mm VAS measures, anchored with *no pain/not bad at all* on the left side and *worst pain possible/most unpleasant feeling possible* on the right side. The aggregated responses ($\alpha = .96$) were submitted to an ANCOVA with choice condition as an independent variable, controlling for participant gender, age, and baseline pain (see Table 1). The ANCOVA revealed a main effect for the choice condition, $F(2, 35) = 4.99$, $P < .02$, $\eta_p^2 = .22$. Specifically, consistent with hypotheses and the concurrent pain ratings, post-task pain was rated as lowest in the *choice condition* ($M = 29.06$; $SD = 21.61$), as compared to both the *no choice condition* ($M = 52.96$; $SD = 20.87$) and the *control condition* ($M = 48.59$; $SD = 21.58$), ts > 2.33, ps $< .05$, ds $> .95$.

Anxiety as a mediator

Recall that participants rated their anxiety during the cold-pressor task on a 7-point scale (1 = *not at all anxious*; 7 = *very anxious*). Table 1 displays the mean anxiety ratings as a function of the choice condition. Of critical interest was to examine whether the influence of choice condition on pain ratings was mediated by anxiety during the task. To answer this question, a series of regression analyses were conducted following the procedures outlined by Kenny et al. (1998). For these analyses, the independent variable was a dummy-coded weighted contrast for the choice condition (*choice condition* = 1; *control* and *no choice conditions* = −.50), the dependent variable was an aggregated Pain Index, and the mediator was the anxiety ratings (note that, consistent with our previous analyses, these regression analyses also controlled for age, gender, and baseline pain). To create the Pain Index, we first aggregated the concurrent pain ratings for all four time points and then standardized these to create a new variable. We then standardized the VAS post-task pain ratings to create a second new variable. These two new variables were then aggregated ($\alpha = .85$) to form a single Pain Index for analysis purposes.

The first step of establishing mediation was to show that the independent variable predicted the dependent variable. Indeed, as already demonstrated above, choice condition was a significant predictor of the "Pain Index" ($\beta = -.33$, $t = -2.49$, $P < .05$), indicating that participants in the *choice condition* had lower pain ratings overall relative to the combined *control* and *no choice* conditions. The second step of establishing mediation was to show that the independent variable predicted the mediator. When regressed onto anxiety, choice condition was a significant predictor ($\beta = -.40$, $t = -2.59$, $P < .05$), indicating that participants in the *choice condition* had lower anxiety relative to the combined

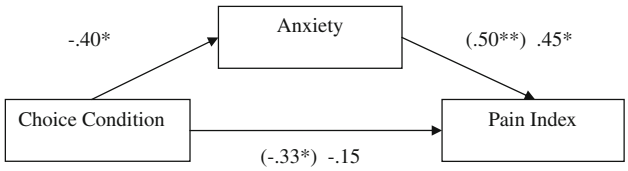

Fig. 2 Mediational analysis involving choice condition (IV), anxiety (mediator), and the pain index (DV). The values in the model are standardized betas from regression analyses (**$P < .01$; *$P < .05$). Coefficients not in parentheses represent results from the model involving both predictors

control and *no choice* conditions. Finally, the third step of establishing mediation was to show that the mediator accounts for the relationship between the independent variable and the dependent variable. To demonstrate this final step, a regression analysis was conducted where choice condition (IV) and anxiety (mediator) were simultaneously entered as predictors of the "Pain Index" (DV). This analysis revealed that anxiety significantly predicted pain ($\beta = .45$, $t = 3.30, P < .01$), but that choice condition was no longer a significant predictor ($\beta = -.15$, $t = -1.17$, $P > .25$). Further establishing full mediation, the Sobel (1982) test confirmed that the strength of the path from choice condition to pain ratings was significantly reduced when anxiety was added to the model ($z = -2.02$, $P < .05$). Taken together, these analyses indicate that having choice reduced anxiety which, in turn, reduced pain ratings (See Fig. 2).

Discussion

The results of the current experiment reveal for the first time that choice plays an important role in shaping placebo expectation effects. In particular, participants having a choice over which of two placebo treatments they would use in response to an aversive stimulus reported lower acute pain than participants not having a choice and participants in a control condition. Moreover, this finding occurred for concurrent ratings of pain during the task, persisted several minutes after the task, and appeared to be mediated by changes in anxiety. Interestingly, for participants not given choice (but still given an expectation), there was no evidence of a placebo effect at all; instead, participants not given choice looked comparable to participants in the control condition.

Explanations for the results

The present results provide preliminary evidence that treatment choice alters placebo analgesia by reducing anxiety. Specifically, consistent with research on choice and anxiety, our mediational data revealed that the act of making choices decreased anxiety (Langer, 1975; Langer & Rodin, 1976; Leotti et al., 2010; Presson & Benassi, 1996; Schulz, 1976; Shafir et al., 1993). Further, this anxiety reduction, in turn, strengthened pain relief of the participants in the choice condition. These results are consistent with prior research and theory implicating anxiety reduction in placebo analgesia (see Petrovic et al., 2005; Turner et al., 1994).

It should be noted, however, that other yet to be examined variables may also serve to mediate the influence of choice on placebo analgesia. Although speculative, we propose two additional potential mediators worthy of investigation (for review see Geers & Rose, in press). First, if choosing one item over another leads to increased positivity (and decreased negativity) for the chosen item (Brehm, 1956; Harmon-Jones & Mills, 1999; Sharot et al., 2010), then participants choosing a particular treatment may feel more positive about that treatment or about the efficacy of the treatment to influence pain—hence leading to strong placebo expectation effects. Second, if making a choice triggers search processes to bolster or confirm the selected item (Hart et al., 2009; Nickerson, 1998; Smith et al., 2008), then participants given treatment choice may be inclined toward searching for evidence that the selected treatment was effective—hence leading to the interpretation of ambiguous symptoms as evidence of pain analgesia (Geers et al., 2011b). Of course, other mechanisms are feasible and it will be important for future research to provide evidence regarding these or other possible mediators.

It is also important to note that we found no difference between the no choice condition and the control condition without the inclusion of treatment choice. This finding demonstrates the importance of considering treatment choice in placebo research. That is, without the addition of this variable we would have concluded that there was no beneficial response following the inert treatment. Placebo studies (and meta-analyses of placebo studies) often result in weak to non-significant expectation effects (e.g., Hammersley et al., 1998; Hróbjartsson, & Gotzsche, 2001, 2004; Shelke et al., 2008; Voudouris et al., 1990; Walach et al., 2002)—thus supplying one of the chief impetuses for investigations into moderators of placebo responding (Geers et al., 2006). Our finding suggests that a number of these failures in the literature were not really failures, but merely lacked the benefit of the ecologically-valid contextual variable of treatment choice. That said, the fact that the expectation alone did not produce a strong placebo effect in this study raises the possibility that treatment choice only strengthens placebo responding in weaker placebo contexts, and that the use of a stronger placebo context may change our results. Finally, the expectation manipulation check data did indicate that our expectation manipulation was successful—with participants in the

choice and the no choice conditions *expecting* to experience less pain than those in the control condition. As such, it appears that participants in the choice and no choice conditions began with the same belief in impending pain relief but that those in the choice condition were in a better position to confirm this expectation.

Limitations and future directions

As with any study, there are limitations that need to be acknowledged. First, and perhaps the most important limitation is that we only examined healthy college student participants. As this type of sample differs in numerous ways from clinical samples, one must be cautious in extrapolating from these findings to clinical settings.

Second, as our main dependent measures were self-report in nature, we cannot rule out response bias as at least a partial explanation for our results. For example, perhaps participants in the choice condition only *reported* feeling less pain because this was consistent with their lay beliefs about how choice might affect analgesia. However, we suspect that self-report biases are not solely responsible for our results. For example, recent work from our laboratory suggests that people's lay beliefs about the role of choice in treatment outcomes is inconsistent with our pattern of results observed here (Geers et al., 2011a). In this research, student participants read scenarios where they imagined being a participant in one of the three conditions described in this manuscript. When asked to indicate what their pain experience would be like, there were no significant differences between participants' imagined pain in the control, choice-expectation, or no choice-expectation groups—suggesting that response biases or demand characteristics may be limited in accounting for our results. Nevertheless, it will be critical for future research to use physiological and/or brain imaging techniques to verify that the present findings are not limited to self-reported pain.

Third, our experiment does not distinguish between "no choice" situations where a person is explicitly denied choice (e.g., a doctor presents different treatment options but then withdrawals the opportunity to use one treatment and/or prescribes the other) versus situations where a person is not aware that choice was an option (e.g., a doctor presents one treatment option for use without mention of alternatives). Most traditional placebo studies fall into the latter category, where participants are provided with a placebo treatment but are not explicitly aware of other potential treatments that could have been selected or used instead. Future research should determine whether choice removal has a different impact on treatment effectiveness than more traditional placebo study methodologies.

Fourth, although our results suggest that choice is beneficial for placebo effects in the current context, there may be situations in which choice is not beneficial. First, for instance, choice may be less desirable and influential when an outcome is very serious (e.g., cancer) and/or chronic (e.g., migraines). For example, treatment choice in such situations could make people concerned about making the wrong decision (Burger, 1989) and the resultant negative affect may overwhelm the benefits of choice (see also Vohs et al., 2008). Second, if there are too many options (Iyengar & Lepper, 2000) or if a person is dispositionally indecisive, this could result in choice inhibiting (rather than amplifying) the placebo effect. Third, it is unclear what role choice would have on *nocebo* expectation effects (e.g., side effects from a medication). For example, perhaps people do not value choice if it means selecting between options that could have negative consequences (Kahneman & Tversky 1984). As these possibilities suggest, greater exploration of the influence of choice on placebo responding is warranted.

Conclusions

In sum, we suggest that there are a host of everyday situations in which choice may facilitate the impact of placebo expectations on treatment outcomes. Moreover, these findings may be considered especially important in light of recent emphases on "patient-centered" medicine (Stewart et al., 2003), the advent of web-based medical tools, and the plethora of over-the-counter treatment options available to consumers. Our findings highlight that one positive consequence of this enhanced involvement is greater placebo responding to treatments. Importantly, this suggests that choice may be an ecologically-valid means for bolstering the impact of treatment expectations on pain relief.

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