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Worry Impairs the Problem-Solving Process: Results from an Experimental Study

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Abstract

INTRODUCTION: Many individuals believe that worry helps solve real-life problems. Some researchers also purport that nonpathological worry can aid problem solving. However, this is in contrast to evidence that worry impairs cognitive functioning.

OBJECTIVE: This was the first study to empirically test the effects of a laboratory-based worry induction on problem-solving abilities.

PROCEDURE: Both high (n = 96) and low (n = 89) trait worriers described a current problem in their lives. They were then randomly assigned to contemplate their problem in a worrisome (n = 60) or objective (n = 63) manner or to engage in a diaphragmatic breathing task (n = 62). All participants subsequently generated solutions and then selected their most effective solution. Next, they rated their confidence in the solution's effectiveness, their likelihood to implement the solution, and their current anxiety/worry. Experimenters uninformed of condition also rated solution effectiveness.

RESULTS: The worry induction led to lower reported confidence in solutions for high trait worry participants, and lower experimenter-rated effectiveness of solutions for all participants, relative to objective thinking. Further, state worry predicted less reported intention to implement solutions, while controlling for trait worry. Finally, worrying about the problem led to more elevated worry and anxiety after solving the problem compared to the other two conditions.

CONCLUSIONS: Overall, the worry induction impaired problem solving on multiple levels, and this was true for both high and low trait worriers.

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Keywords

worry; anxiety; problem solving; generalized anxiety disorder

Worry is the defining feature of generalized anxiety disorder (GAD; American Psychiatric Association, 2013), but it is also a common experience for most individuals. Though many report the belief that worry has benefits for coping with potential threats (Borkovec & Roemer, 1995; Hebert, Dugas, Tulloch, & Holowka, 2014), a wide literature documents its negative impact on cognitive, emotional, and behavioral levels. Despite being extensively researched, the effects of worry on some aspects of cognitive functioning and behavioral motivation remain understudied and require further exploration.

Several theories suggest that worry negatively affects cognitive functioning. The Attentional Control Theory (Eysenck, Derakshan, Santos, & Calvo, 2007), posits that worry demands attentional resources that could be allocated to other cognitive capacities and thus creates cognitive impairment. Similarly, Affective Neuroscience theories propose that worry increases cognitive load and interferes with the capacity to ignore task-irrelevant matters (Beaudreau, MacKay-Brandt, & Reynolds, 2013). These theories further posit that because worrisome thoughts are attentionally demanding, additional resources are required to inhibit worry in order to focus attention elsewhere. Thus, worry may interfere with tasks that compete for executive functioning resources.

This perspective has garnered empirical support. High trait worriers performed slower than controls on a number of cognitive and decision-making tasks, in both clinical (LaFreniere & Newman, 2019; Stefanopoulou, Hirsch, Hayes, Adlam, & Coker, 2014) and non-clinical (Tallis, Eysenck, & Mathews, 1991) samples. In a meta-analysis of 94 studies, recurrent negative thinking, including trait worry, was associated with impaired ability to discard irrelevant information from working memory (Zetsche, Bürkner, & Schulze, 2018). Additionally, impaired cognitive functioning, such as difficulty concentrating, slowed learning, and delayed decision-making, has been associated with GAD status in both undergraduate (LaFreniere & Newman, 2019; Pawluk & Koerner, 2013) and community GAD samples (Hallion, Steinman, & Kusmierski, 2018). Similar to trait-level worry, experimentally manipulated state worry has also been found to reduce working memory (Rapee, 1993; Trezise & Reeve, 2016) and attentional control (Hayes, Hirsch, & Mathews, 2008; Stefanopoulou et al., 2014). Further, efforts to inhibit state worry depleted working memory and performance on cognitive tasks (Hallion, Ruscio, & Jha, 2014). Thus, both trait and state worry independently have been associated with cognitive impairment.

Similar to evidence of the association between trait/state worry and impaired cognitive functioning, there have been questions as to whether worry impacts problem-solving abilities. D'Zurilla and Goldfried (1971) suggest that effective problem-solving requires five major components. These include: 1) problem orientation (i.e., confidence in and perceived control over the problem-solving process), 2) problem definition and goal identification, 3) generating solutions, 4) decision making, and 5) implementation/verification. Accordingly, impairment at any one of these levels would hinder one's ability to resolve problems.

On the one hand, many individuals, especially those with GAD symptoms, believe that worry is helpful when solving problems. In fact, such beliefs predicted worry severity levels (Hebert et al., 2014), and were able to distinguish those with GAD from controls (Borkovec & Roemer, 1995). Further, beliefs that worry was helpful in the face of problems, or that persistent thinking was required in order to find the best solution, both predicted trait worry levels (Kelly & Kelly, 2007; Sugiura, 2007). In fact, when tested on their ability to solve hypothetical problems in a laboratory setting, anxious participants performed no differently than controls (Anderson, Goddard, & Powell, 2009), and in an unselected student sample these abilities were uncorrelated with trait worry (Davey, 1994).

On the other hand, however, there is reason to believe that the act of worrying and/or trait worry might be associated with impairment in the real world. Negative effects of worry on problem-solving could happen in several ways. Worrying about a problem could increase cognitive load (Beaudreau, MacKay-Brandt, & Reynolds, 2013), interfering with one's ability to focus on effective solution generation. This could induce lower confidence in one's abilities to generate effective solutions, leading individuals to stall or avoid decision-making (D'Zurilla & Goldfried, 1971) or to prematurely dismiss possible solutions as likely to be ineffective. Additionally, worry could provoke repetitive rehearsal of the problem and/or focus on potential negative outcomes (Mathews, 1990), thereby interfering with effective solution generation and implementation. Trait worry could also have negative effects. These could include difficulty tolerating the uncertainty inherent in the problem-solving process (Dugas, Gagnon, Ladouceur, & Freeston, 1998), which might be linked to the higher "evidence requirements" seen in chronic worriers when making decisions (Tallis et al., 1991). This, in addition to heightened attentional bias toward threat (Goodwin, Yiend and Hirsch, 2017), could serve to prolong indecision in the face of real-life problems while the worrier attempts to gather more information. Finally, the Contrast Avoidance model of GAD (Newman & Llera, 2011) would suggest that for chronic worriers, reluctance to implement solutions could be due to a fear of getting one's hopes up only to be confronted with failure (i.e., emotional contrast). In fact, it is possible that multiple factors could work together to impair problem-solving abilities.

In support of impairment related to chronic worry, Davey, Hampton, Farrell, and Davidson (1992) identified a link between harboring a negative attitude toward problems, termed *negative problem orientation* (NPO), and high trait worry. Since then, NPO has been linked with anxiety and trait worry in both clinical (Dugas et al., 1998; Fergus, Valentiner, Wu, & McGrath, 2015; Ladouceur, Blais, Freeston, & Dugas, 1998) and non-clinical samples (Anderson et al., 2009; Robichaud & Dugas, 2005). Notably, NPO was more robustly associated with trait worry over other anxiety, mood, and obsessive symptoms in a mixed-clinical sample (Fergus et al., 2015). Additional studies found trait worry to be associated with impairment in other aspects of the problem-solving process, such as skills and/or knowledge base. For example, Borkovec (1985) observed that whereas chronic worriers were very good at defining their problems and identifying possible negative outcomes, they often had difficulty implementing solutions. Further, when assessing real-life problem solving based on daily diary and recall data, a mixed anxious-depressed group demonstrated fewer functional cognitions and behaviors, and less effective solutions, than did controls (Anderson et al., 2009).

Although such research on the nature of chronic worriers tends to converge, the extent to which the act of worrying itself impairs problem solving represents a point of contention within the field. Some researchers have argued that worry interferes with successful problem resolution across the board, whereas others contend that this may only apply to pathological worriers (i.e., those for whom worry is excessive and uncontrollable). Mathews (1990) adopted the first stance, arguing that although worry may begin as attempted problem solving, it predominantly leads to the cognitive rehearsal of danger for everyone. Taking the second stance, Davey and colleagues (Davey, 1994; Davey et al., 1992) proposed that worry may actually enhance problem solving for many individuals, but that this process can become thwarted for those with high levels of trait worry. The latter argument was based in part on evidence that trait worry was associated with some active coping styles (e.g., information seeking) when controlling for trait anxiety in unselected student samples (Davey et al., 1992). Therefore, Davey and colleagues concluded that for some individuals worry might be an adaptive or constructive approach when confronting a problem.

Nonetheless, an abundance of data shows that worry increases state negative affect and arousal for all individuals (see Newman & Llera, 2011; Newman et al., 2019; Ottaviani et al., 2016), which itself may impact the problem-solving process. For instance, a negative mood induction increased perseveration and catastrophizing on a high-responsibility task (Startup & Davey, 2003), which could have negative implications for problem solving. Furthermore, daily diary studies have found that the intensity of state worry was associated with more anticipation of negative outcomes, greater negative evaluation of solutions to problems, more self-blame, and lower rates of solution selection during worry episodes, in samples including both high and low trait worriers (Szabó & Lovibond, 2002, 2006). Additionally, state levels of anxious thinking, including worry, were associated with lower problem-solving effectiveness in a community GAD sample (Pawluk, Koerner, Tallon, & Antony, 2017).

In summary, although there is strong evidence to suggest that worry is associated with impairment in problem solving, none of the studies reviewed above experimentally manipulated worry when testing problem-solving abilities. Therefore, it is impossible to determine the extent to which worry itself causally impacted the problem-solving process, as opposed to other characteristics associated with state or trait worry. Interestingly, depressive rumination (a close conceptual relative to worry) has been shown to impact both mood and the problem-solving process across several studies. For example, experimentally induced rumination (versus distraction) led to lower mood in a non-clinical dysphoric sample, and resulted in generating less effective solutions for hypothetical problems, as well as reduced likelihood of implementing solutions for a personal problem (Lyubomirsky & Nolen-Hoeksema, 1995; Lyubomirsky, Tucker, Caldwell, & Berg, 1999). The absence of similar research on the effect of worry represents a critical gap in our understanding of this phenomenon.

In this study, we sought to address this gap by testing the effects of experimentally manipulated worry on problem solving using a sample of individuals with both high and low trait worry. In this way, we were able to test whether inducing state worry would hinder problem solving for all participants, thereby supporting Matthews' (1990) perspective, or if

it would enhance problem-solving in low trait worriers and only become problematic at high trait levels, thus supporting Davey and colleagues' perspective (Davey, 1994; Davey et al., 1992). We chose to observe the effects of worrying about a real-life problem, as opposed to a hypothetical problem, in order to increase external validity. As a comparison condition, we chose the *problem definition* stage of problem solving as outlined in D'Zurilla and Goldfried (1971). This allowed us to equalize the amount of time spent contemplating the problem, but to channel thinking into styles typical of a worry episode versus thinking in a more objective, emotionally neutral manner. As an additional control condition, a third group engaged in a diaphragmatic breathing task. Immediately afterward, all groups were instructed to brainstorm solutions to their problem and choose the solution they thought would be most successful. We tested a variety of outcomes related to problem solving, including the number of solutions generated, self-reported and experimenter-rated effectiveness of solutions, as well as participant ratings of intention to implement solutions. Further, we assessed state levels of anxiety and worry following the solution-generation phase, to determine the extent to which participants felt calmer once a solution had been identified.

We hypothesized that relative to objective thinking or diaphragmatic breathing instructions, worrying about a problem would lead to 1) generating fewer solutions during brainstorming, 2) generating less effective solutions (based on both participants' and judge's ratings), and 3) lower intention to implement solutions. Further, we hypothesized that 4) worrying would lead to lingering anxiety and worry following solution generation, relative to other conditions. We also hypothesized that these effects would be observed for both high and low trait worriers alike.

Research Design and Method

Overall Design

A 2 (Group: High vs. Low Trait Worry) X 3 (Condition: Worry, Think Objectively, Diaphragmatic Breathing) block design was used to determine the effects of worrying about a problem on various outcomes related to problem-solving.

Participants and Measures

The current study recruited 185 volunteers from psychology courses in a public university. Students received class credit as compensation. Participants were largely young adult (M = 20.06 years, SD = 6.47) females (76.8%), with 57.8% identifying as White, 24.3% African American, 7.6% Asian, 6.2% Hispanic/Latinx, 1% American Indian/Pacific Islander, and 8.6% other (e.g., "mixed race").

Participants were selected based on their scores on the Penn State Worry Questionnaire (PSWQ; Meyer, Miller, Metzger, & Borkovec, 1990), a 16-item self-report measure designed to assess the frequency, intensity, and uncontrollability characteristics of trait worry. The PSWQ demonstrates strong internal consistency (Chronbach's α = .91; Meyer et al., 1990) and retest reliability (.74 – .93; Molina & Borkovec, 1994). Internal consistency for the current sample was high (α = .95). Participants also completed the Generalized

Anxiety Disorder Questionnaire (GAD-Q-IV; Newman et al., 2002) to assess for clinical-level GAD symptoms. The GAD-Q-IV is a 9-item self-report questionnaire based on diagnostic criteria for GAD. It demonstrates strong internal consistency (α = .94) and good retest reliability. A cut-score of 5.7 leads to 83% sensitivity and 89% specificity relative to a structured diagnostic interview (Newman et al., 2002). Internal consistency for the current sample was high (α = .91).

Participants were included in the High Trait Worry group (N = 96) if they scored in the upper range on the PSWQ (≥ 60) during a pre-screen. On the day of testing, the High Trait Worry PSWQ score mean was comparable to that found in GAD patient samples (M = 66.68, SD = 9.47; see Startup & Erickson, 2006). The High Trait Worry mean on the GAD-Q-IV was also well above the clinical cut-score (M = 8.58, SD = 2.35). Participants were included in the Low Trait Worry group (N = 89) if they scored in the mid-low range on the PSWQ (≤ 45). On the day of testing, scores in this group were comparable to those of nonanxious samples from other studies (M = 41.02, SD = 11.93; see Startup & Erickson, 2006). Further, the Low Trait Worry group scored well below the cut-score on the GAD-Q-IV (M = 3.66, SD = 2.82).

Procedure

This study was approved by the university IRB. Participants were each tested alone in a private room equipped with a computer. All instructions and tasks were completed using the Qualtrics survey platform (Qualtrics, Provo, UT). Participants first provided informed consent, and then completed demographic questions along with the PSWQ and GAD-Q-IV. Next, they completed baseline state measures, comprised of 4 items: *worry*, *anxiety*, *relaxation*, and *mood*. They were instructed to rate each item based on how they felt *right now*. The first 3 items were rated on a scale of 0 (*not at all*) to 100 (*extremely*). *Mood* was rated from 0 (*very negative*) to 100 (*very positive*).

Participants were next instructed to identify a current, real-life problem; specifically, one that was affecting them right now, and for which they had some control over the outcome. The latter requirement was to assist in identifying a problem for which there were possible solutions, as opposed to an uncontrollable issue (e.g., a loved one's terminal illness). They were then asked to briefly describe their problem by typing it out on the computer.

Next, participants were randomly assigned to either a Worry (WOR; N = 60) or Think Objectively (T-OBJ; N = 63) task, with the remaining third assigned to a Diaphragmatic Breathing (DB; N = 62) task. The primary distinction between WOR and T-OBJ conditions was that participants either worried or did *not* worry over their problem. To that end, instructions for the WOR task were based on the definition of worry as negatively valanced cognitive activity focused on a threat, along with consideration of potential negative outcomes (i.e., negative emotional and catastrophic thinking; Borkovec, 1985; Borkovec, Robinson, Pruzinsky, & DePree, 1983). Those in the WOR task were therefore instructed to worry about their problem, with an emphasis on their concerns along with possible negative outcomes and implications (see supplement for full instructions). To control for the amount of time spent contemplating the problem, but to do so in a non-emotional, non-catastrophic manner, instructions for the T-OBJ task were based on the problem definition stage of

problem solving (D'Zurilla & Goldfried, 1971). Participants in the T-OBJ task were instructed to attempt to focus on their problem in a more objective, emotionally neutral manner, such as by breaking it down into smaller components and coming up with ultimate goals. If they found themselves focusing on negative thoughts, participants were instructed to refocus their attention back on the problem itself.

After receiving these instructions, participants in the WOR and T-OBJ conditions were asked to think about their problem for 2 minutes in the specified manner. Those in the DB task were given instructions to engage in diaphragmatic breathing for 2 minutes.

Following this task, and to determine whether the manipulations had their intended effects, all participants again completed state measures of *worry*, *anxiety*, *relaxation*, and *mood*. This was to ensure that conditions led to three distinct groups: one that had engaged in emotional/catastrophic thinking (WOR), one that had engaged in non-emotional, non-catastrophic thinking (T-OBJ), and one that had engaged in a relaxation-inducing breathing task (DB). As such, distinctions on state levels of *worry*, *anxiety*, *relaxation*, and *mood* between conditions served as compliance checks for adherence to the manipulations.

Immediately afterward, all participants were asked to generate as many solutions to their problem as they could for 2 minutes, representing the brainstorming stage of problem solving. Solutions were typed out on the computer. Next, they were instructed to reflect on these ideas and choose their "best, most effective" solution, representing the decision-making stage. Once finished, they ranked how confident they felt that this solution would be effective, as well as how likely they were to actually carry it out, on a scale of 0 (*not at all confident/likely*) to 100 (*very confident/likely*). They then provided final ratings of current state *worry* and *anxiety* and were debriefed about the study.

Once data collection was complete, a judge uninformed of condition rated participants' self-identified "best" solutions for their effectiveness on a 7-point scale (1 = *not at all effective*, to 7 = *extremely effective*), identical to that used in similar studies (Lyubomirsky & Nolen-Hoeksema, 1995; Lyubomirsky et al., 1999). To determine this score, they rated the likelihood that participants' solutions would lead to successful resolution of the problem (i.e., maximize positive consequences and minimize negative ones, and not create additional problems; D'Zurilla & Goldfried, 1971). For example, if participants listed a solution that would likely improve or resolve the situation (e.g., behavior that would directly enhance their performance in a class, etc.), that was rated as more effective. If their solution was unlikely to improve or resolve the situation, or could potentially exacerbate the issue (e.g., distraction from or avoidance of the problem, etc.), it would be rated as less effective. A second independent judge who was also uninformed of condition rated a random selection of 25% of responses, with evidence of sufficient interrater reliability (ICC = .7). (See Supplemental Materials for an overview of the process used to ensure reliability of judges' ratings.)

Data Analytic Plan

We first tested whether there were any differences at baseline on measures of state *worry*, *anxiety*, *relaxation*, and *mood*, using a 2 (Group: High/Low Trait Worry) X 3 (Condition:

WOR, T-OBJ, DB) MANOVA. Next, to test that WOR, T-OBJ, and DB tasks had the intended effects, we ran a similar MANOVA but with ratings of state measures of *worry*, *anxiety*, *relaxation*, and *mood* immediately following the induction as manipulation checks.

To test the 4 main hypotheses, we ran a series of factorial ANOVAs, using Group and Condition as predictors. Outcome variables included 1) the number of solutions participants generated during the brainstorming phase, 2) participant and judge's ratings of effectiveness of solutions, and 3) ratings of intention to implement solutions. Finally, to determine the presence of any lingering anxiety and worry after participants chose their best solution (4), we ran a MANOVA with Group and Condition as predictors, and state *worry* and *anxiety* levels after identifying "best" solutions as outcomes.

In the case of nonsignificant findings, we ran exploratory secondary analyses in the form of hierarchical linear regression models to test if reported state worry levels following the WOR/T-OBJ/DB tasks could predict problem-solving outcomes, while controlling for trait worry. The purpose of these analyses was to determine if the extent to which participants reported actually worrying during the induction would be a better predictor than their assigned condition, while also controlling for the possible influence of trait worry on these outcomes. To do so, we entered PSWQ in the first block of the model, followed by state worry levels in the second block. To address any issues of non-normality, bootstrapping using 1000 samples was applied to all ANOVAs and regressions.

Results

Baseline Measures and Manipulation Check

At baseline, there was a main effect of Group, $F(4, 176) = 15.92$, $p < .001$, $\eta^2_p = .27$. As expected, the High Trait Worry group reported more baseline *worry* and *anxiety* than did the Low Trait Worry group. Further, the Low Trait Worry group reported more baseline *relaxation* and better *mood* than did the High Trait Worry group (see Table 1 for means and standard deviations). There was no main effect of Condition; $F(8, 354) = 1.55$, $p = .139$, $\eta^2_p = .03$; and no Group X Condition interaction; $F(8, 354) = 1.07$, $p = .385$, $\eta^2_p = .02$; suggesting no significant baseline differences between conditions.

Following the WOR, T-OBJ, and DB tasks, our manipulation check measures showed a main effect of Group, $F(4, 176) = 15.07$, $p < .001$, $\eta^2_p = .26$. The High Trait Worry group reported significantly more *worry* and *anxiety*, lower *relaxation*, and worse *mood* than the Low Trait Worry group, regardless of their assigned task. More importantly, however, there was a main effect of Condition; $F(8, 354) = 8.75$, $p < .001$, $\eta^2_p = .17$; such that WOR led to significantly higher ratings of *worry* and *anxiety* than T-OBJ and DB, and T-OBJ led to higher ratings than DB. WOR also led to significantly worse *mood* than both T-OBJ and DB, which were not significantly different from one-another. Finally, DB led to significantly higher *relaxation* than both T-OBJ and WOR, and T-OBJ was higher than WOR (see Table 1). There was no significant Group X Condition interaction, $F(8, 354) = .93$, $p = .494$, $\eta^2_p = .02$. As such, data suggest that these tasks operated in the intended way for both High and Low Trait Worry groups.

Main Hypotheses

Number of solutions.—Contrary to predictions, there were no main effects of Group; $F(1, 178) = .67$, $p = .414$, $\eta^2_p = .00$; or Condition; $F(2, 178) = 2.61$, $p = .076$, $\eta^2_p = .03$; and no interaction; $F(2, 178) = .87$, $p = .419$, $\eta^2_p = .01$; on number of solutions generated during the brainstorming period. In a follow-up regression, the first block of the model, consisting of the PSWQ, was not significant; $F(1,181) = .17$, $p = .685$; and accounted for only 0.1% of the total variance. Adding state worry levels to the model did not significantly increase predictive value; $F(1,180) = 1.52$, $p = .221$; and only accounted for an additional 1.6% of the variance.

Effectiveness of solutions.—In terms of participants' own ratings of their confidence in solution effectiveness, there was a main effect of Group; $F(1, 178) = 9.13$, $p = .003$, $\eta^2_p = .05$. Overall, High Trait Worriers reported less confidence in the effectiveness of their solutions (M = 66.73, SD = 22.31) than did Low Trait Worriers (M = 76.25, SD = 23.57), regardless of condition. There was no main effect of Condition; $F(2, 178) = 1.01$, $p = .367$, $\eta^2_p = .01$; but there was a significant Group X Condition interaction; $F(2, 178) = 4.54$, $p = .012$, $\eta^2_p = .05$. When divided by Group, High Trait Worriers in the WOR condition rated confidence in their selected solution as significantly lower (M = 57.77, SD = 29.46) than those in T-OBJ (M = 72.97, SD = 15.0; $p = .017$), and marginally lower than those in DB (M = 68.97, SD = 18.06; $p = .076$), but this did not reach significance. There were no significant differences between T-OBJ and DB ($p = .347$; see Figure 1). Low Trait Worriers did not demonstrate significant differences by condition (all p's > .05).

In terms of judge's ratings, there was a main effect of Condition; $F(2, 177) = 5.08$, $p = .007$, $\eta^2_p = .05$. Those in the T-OBJ condition were judged to have generated significantly more effective solutions (M = 5.77, SD = .93) than those in WOR (M = 5.18, SD = 1.19, $p = .004$) and DB (M = 5.21, SD = 1.38, $p = .009$), which were not significantly different from each other ($p = .938$). Observed differences were modest, but nonetheless significant (see Figure 2). There was neither a main effect of Group; $F(1, 177) = .14$, $p = .711$, $\eta^2_p = .001$; nor an interaction; $F(2, 177) = 1.85$, $p = .161$, $\eta^2_p = .02$.

Intention to implement solutions.—Contrary to predictions, there were no main effects of Group; $F(1, 178) = 3.00$, $p = .085$, $\eta^2_p = .02$; Condition; $F(2, 178) = .21$, $p = .814$, $\eta^2_p = .00$; or an interaction; $F(2, 178) = 2.34$, $p = .10$, $\eta^2_p = .03$; on participants' ratings of intention to implement their solutions. A follow-up regression indicated that trait and state worry together significantly predicted intention, accounting for 5.5% of the total variance. When entered first, the PSWQ was a negative predictor of intention ($\beta = -.158$, $p = .032$), such that higher trait worry predicted less reported intention. Upon adding state worry levels, the model's predictive value significantly increased ($\Delta R^2 = .03$, $p = .017$). Higher state worry also predicted less reported intention to implement solutions ($\beta = -.212$, $p = .020$), but importantly, trait worry was no longer a significant predictor in the full model (see Table 2).

Worry and anxiety levels after choosing a solution.—There was a main effect of Group; $F(2, 178) = 18.17$, $p < .001$, $\eta^2_p = .17$. On average, High Trait Worriers reported greater *worry* (M = 40.53, SD = 26.04) and *anxiety* (M = 42.80, SD = 25.97) than did Low

Trait Worriers (M = 21.91, SD = 26.59; M = 21.12, SD = 25.11, respectively) after generating their solutions, regardless of condition. Consistent with hypotheses, there was also a main effect of Condition; $F(4, 358) = 4.27$, $p = .002$, $\eta^2_p = .05$. All participants in the WOR condition reported significantly greater *worry* (M = 40.82, SD = 29.68) and *anxiety* (M = 41.90, SD = 29.40) following solution generation compared to those in T-OBJ (M = 31.10, SD = 25.55, $p = .047$; M = 32.11, SD = 27.69, $p = .030$; respectively) and DB (M = 23.11, SD = 25.80, $p = .002$; M = 23.42, SD = 23.01, $p < .001$; respectively). Those in the T-OBJ condition also reported greater *anxiety* than those in DB ($p = .042$), but not greater *worry* ($p = .071$; see Figure 3). There was no Group X Condition interaction; $F(4, 358) = .87$, $p = .484$, $\eta^2_p = .01$.

Discussion

Research has long suggested the possibility of a connection between worry and impaired problem solving; yet no prior study has experimentally manipulated worry to test for a causal link. In this study we tested the effects of a controlled worry manipulation on several factors related to the problem-solving process, using both high and low trait worriers. Ultimately, we found that worrying about a real-life problem, relative to attempting to think about the problem objectively or diaphragmatic breathing, led to interference at multiple levels of problem solving. These findings held true at least in part for both high and low trait worriers alike.

Several findings emerged in terms of the effects of trait or state worry on aspects of the problem solving process. Contrary to our expectations, we found no differences for Group or Condition on the number of solutions participants generated when asked to brainstorm ways to solve their problems. This is not to say that all solutions were of equal quality. For example, some participants listed ideas such as, “ignore it until later”, “get some sushi”, and “do nothing”, alongside more effective ideas (e.g., “join a study group”, “make a budget and stick to it”). Listing as many ideas as possible without judgment while in the brainstorming phase is considered beneficial for problem solving (D’Zurilla & Goldfried, 1971). Our data suggested that both trait worry status and condition type neither significantly helped nor hindered brainstorming performance, and that specific negative effects of worry only emerged later in the problem-solving process.

After choosing the “best” of these solutions, however, high trait worriers reported lower confidence in the effectiveness of their chosen solution compared to low trait worriers, regardless of condition. Also, high trait worriers who worried before generating solutions reported significantly lower confidence in their chosen solution than did those instructed to think about their problems more objectively. They also reported marginally lower confidence than those who engaged in a diaphragmatic breathing exercise, though this did not reach significance. This is consistent with prior findings that chronic worriers reported lower confidence in their ability to solve problems relative to nonanxious controls (e.g., Anderson et al., 2009; Ladouceur et al., 1998); however, this is the first study to demonstrate that in high trait worriers, the specific act of worrying reduced problem-solving confidence. In low trait worriers, on the other hand, worry (vs other conditions) did not lead to a significantly different impact on confidence in their solutions’ effectiveness.

The fact that a prior worry induction only reduced confidence for chronic worriers is more in line with the perspective articulated by Davey and colleagues (Davey, 1994; Davey et al., 1992), who argued that factors such as low problem-solving confidence would impair problem solving, but only for pathological worriers. Notably, high trait worriers who were instructed to think objectively reported mean confidence scores that were significantly higher than those instructed to worry. These results imply that instructing chronic worriers to think about their problems in a more objective manner, and to refrain from negative thinking, may counteract such pessimistic beliefs and enhance confidence levels. However, contrary to Davey's theory, there was no significant benefit of worry on confidence in low trait worriers. Thus, whereas the worry induction impaired confidence in high trait worriers, it neither helped nor hindered confidence in low trait worriers.

As opposed to participants' subjective ratings of confidence in their solutions' effectiveness, ratings made by an independent judge reflected our attempts to objectively rate whether the solution would be effective. In this case, a main effect of condition emerged across all participants. According to these ratings, attempting to think objectively about a problem led to a small but significant advantage in coming up with more effective solutions relative to both worrying and diaphragmatic breathing, which were not significantly different. As such, this finding does not represent a unique impairment effect of worry *per se*, but rather points to the benefits of attempting to contemplate problems in an objective, emotionally-neutral manner. It also indicates that although worrying did not reduce low trait worriers' confidence in their solution effectiveness, such confidence was not matched by an independent judge.

To further unpack this finding, as a non-worry comparison individuals in the T-OBJ condition were instructed to think about their problem in a less emotional, more constructive way (i.e., breaking it down, focusing on their goals), without falling into negative or catastrophic thinking. We cannot rule out that this may have fueled more solution-focused thinking than worrying. In fact, the very act of focusing on a problem (whether it be catastrophically or objectively), likely made it difficult for participants *not* to consider various possible solutions during this manipulation period. If, however, those in the T-OBJ condition tended to naturally spend more time generating better solutions, this still supports the conclusion that worry detracts from problem solving, as it suggests that the negative and catastrophic thinking characteristic of worry interferes with more constructive processes and ultimately detracts from coming up with good solutions. It also suggests this can happen for both high and low trait worriers.

Regarding the lack of differences between WOR and DB on experimenter-rated effectiveness, it is important to note that those randomly assigned to the DB condition were not instructed to contemplate their problem at all prior to brainstorming solutions, but rather were instructed to focus attention on their breathing. That they were then able to generate impromptu solutions rated as not different from solutions of those who had actively worried over their problem beforehand, is a notable finding. This suggests that worrying about a problem offered no greater advantage in this context than did a diaphragmatic breathing exercise. It also contradicts the beliefs of many individuals, and especially those of chronic worriers, that worrying is necessary in order to find the best solution to a problem (e.g.,

Borkovec & Roemer, 1995; Hebert et al., 2014). Taken together, these findings are more consistent with Mathews' (1990) proposition that for all individuals, the act of worrying is not actually helpful in terms of finding adequate solutions to problems.

In terms of participants' reported intention to implement their solutions, there were no significant effects of Group or Condition. A follow-up exploratory regression analysis identified that the extent to which participants worried during their assigned task (irrespective of what that task was) predicted lower reported intention to engage in proactive action. This effect was not simply driven by those with higher trait worry, as state worry predicted ratings of intention when controlling for trait worry, and trait worry was no longer a significant predictor once state worry was entered in the model. This finding provides more clear support for Mathews' (1990) stance on worry thwarting the problem-solving process, regardless of whether it is experienced at chronic levels or not. This also dovetails with the finding that depressive rumination reduced participants' reported likelihood to implement solutions to their problems (Lyubomirsky et al., 1999), suggesting that both forms of repetitive negative thinking may discourage engaging in such proactive behaviors. However, it should be noted that this analysis was simply a secondary, and more correlational, exploration of our data, and as such does not allow for more robust causal interpretations.

Finally, we found that for both high and low trait worriers, worrying about one's problem led to significantly higher reported worry and anxiety levels even after having identified a solution, as compared to thinking objectively about the problem or relaxing. This is consistent with research showing that the negative effects of worry linger over time (e.g., Newman et al., 2019; Pieper, Brosschot, van der Leeden, & Thayer, 2010), and appears to hold true even after making a decision about the best course of action to ameliorate a problem. Thus, rather than feel a sense of resolution about the issue, with corresponding decreases in worry and anxiety, worrying before choosing a solution may instead lead to lingering feelings of doubt.

Overall, these results provide evidence that engaging in worry is detrimental to problem solving on multiple levels, which apart from reducing confidence in the process, appears to affect both high and low trait worriers alike. One explanation for these findings may be that, consistent with Attentional Control Theory (Eysenck et al., 2007), worrying about a personal problem focused participants' attention on threatening aspects of the situation (e.g., potential negative outcomes). As such, shifting from worrying into generating and evaluating solutions to the problem, (i.e., threat-related versus goal-directed attention) demanded additional cognitive resources. Attempting to think about the problem objectively, however, is more consistent with goal-directed attention and thus would not have required inhibition. In this way, attempting to think objectively may have allowed for greater access to cognitive resources while problem solving, and possibly more time spent contemplating solutions, relative to worrying. However, we did not measure these effects directly, other than to show that objective thinking facilitated generating more highly rated solution effectiveness than either worry or a breathing exercise.

Another explanation may be that the worry induction both increased cognitive load, and led to greater anxiety and worse mood, and these factors interacted to undermine the problem-solving process. According to Gray's (1990) neuropsychology theory of emotions, anxiety triggers the behavioral inhibition system, promoting harm-avoidance over approach strategies in the face of a problem. This dovetails with the *affect-as-information* perspective, which states that affect influences judgment and decision-making (Clore & Huntsinger, 2007). As such, in the context of problem solving, a negative mood may focus attention on potential obstacles to goals or unwanted outcomes, thus leading to pessimistic appraisals of one's performance (see Schwarz & Skurnik, 2003). Our data support this trajectory based on the fact that worry 1) created greater negative affect in the moment, 2) led to sustained worry and anxiety levels even after participants had chosen a solution, 3) decreased confidence in effectiveness of solutions for the high worry group, 4) led to lower judge's ratings of effectiveness, and 5) predicted less intention to implement solutions for all participants, while controlling for trait worry (though this latter finding was more correlational than causal). In sum, this suggests that worry led to negative cognitive and emotional effects, impairing problem solving at several stages of the process.

Overall, although the worry induction reduced problem-solving confidence only for high trait worriers, it led to a number of additional negative outcomes for all participants. As such, these data provide initial evidence that *state* worry hinders proactive problem solving across high and low trait worry levels. Moreover, despite the fact that low trait worriers reported a non-significant impact of worry on their confidence in solutions, it still predicted lower judge's ratings of the solution effectiveness and less willingness to enact them. Therefore, results of this study provide more robust support for Mathews' (1990) theory, suggesting that worry is a problematic strategy for all persons interested in resolving their problems.

This study has some notable limitations. Because high trait worry participants were not treatment-seeking, this limits our ability to generalize findings to clinically worried individuals. However, previous studies have identified impairment associated with worry in unselected samples (e.g., Hallion et al., 2014), as well as in samples of participants diagnosed with GAD (e.g., Pawluk et al., 2017). Furthermore, we hypothesized that the worry induction would impair problem solving even at low levels of trait worry, thus it was important to demonstrate that findings were not exclusive to a sample with clinically high levels of trait worry. Future studies should seek to replicate findings in clinical populations before such generalizations can be made. Moreover, because our study population consisted of college students, we cannot generalize findings to non-college student samples. As such these findings merit replication in other samples. On the other hand, our college student sample included adequate representation of racial diversity, with about 42% reflecting non-white groups.

Finally, because we asked participants to think about problems in their own lives, this may have led to some lack of uniformity in the complexity or severity level of problems participants were attempting to solve. For example, pathological worriers may be more likely than nonworriers to worry about even minor things. For this reason, we ensured that there was an equal balance of high and low trait worriers randomly assigned across

conditions. Our procedure also directed participants to choose a problem for which they had some control over the outcome (i.e., we directed them to avoid problems for which there were no solutions). This may have also helped to prevent one group from selecting more intractable problems than another. Nonetheless, we cannot rule out the possibility that problem severity varied systematically across conditions leading to the effects we found. Considering that studies of problem solving in real-life settings have been better able to detect worry-related impairment (e.g., Szabó & Lovibond, 2006) relative to those using hypothetical problems in an laboratory setting (e.g., Davey, 1994), we strove to create a task that was both externally valid and experimentally rigorous. However, future studies may wish to increase uniformity of this variable, while attempting to maintain external validity (such as by balancing participants by the types of problems they report or by ratings of problem severity).

In sum, this was the first study to experimentally manipulate worry immediately prior to problem solving in a controlled laboratory setting, and provides initial evidence that the worry process is detrimental to problem solving in this context. Although many individuals are prone to worry in the face of problems, believe that this is a helpful approach to confronting problems, and often conflate worry with active problem solving (e.g., Kelly & Kelly, 2007; Sugiura, 2013; Szabó & Lovibond, 2002), our findings suggest otherwise. We argue that worry is distinct from adaptive problem solving. Whereas it does direct attention to potential threats, worrying about a problem inhibits the ability to proactively address threats in an optimal way, and instead may repeatedly cycle people through their worst-case scenario fears. Data from this study argue that attempting to take a more objective stance when evaluating a problem, and refraining from catastrophic thinking, represent the most effective problem-solving strategies for both high and low trait worry individuals alike.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Highlights

- Worrying about a personal problem lowered confidence in solutions for high trait worriers.
- Thinking objectively about a problem led to more effective solutions than worrying or focused breathing.
- State worry predicted less intention to implement solutions, while controlling for trait worry.
- Worrying beforehand led to elevated worry and anxiety after solving a personal problem.

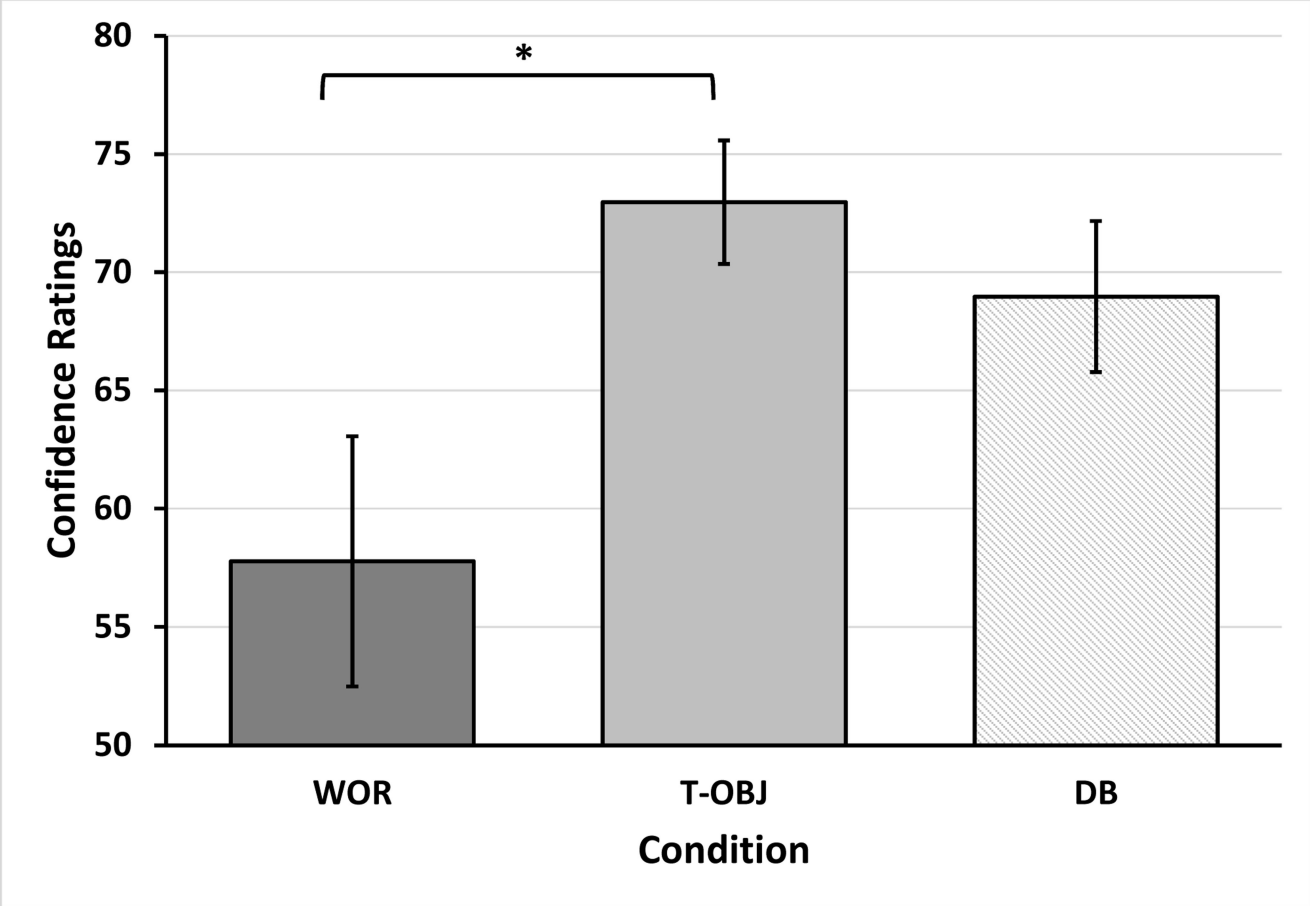

Figure 1.
Participant Ratings of Confidence in Effectiveness of Solutions for the High Trait Worry Group
Note. WOR = worry task, T-OBJ = think objectively task, DB = diaphragmatic breathing task, * $p < .05$.

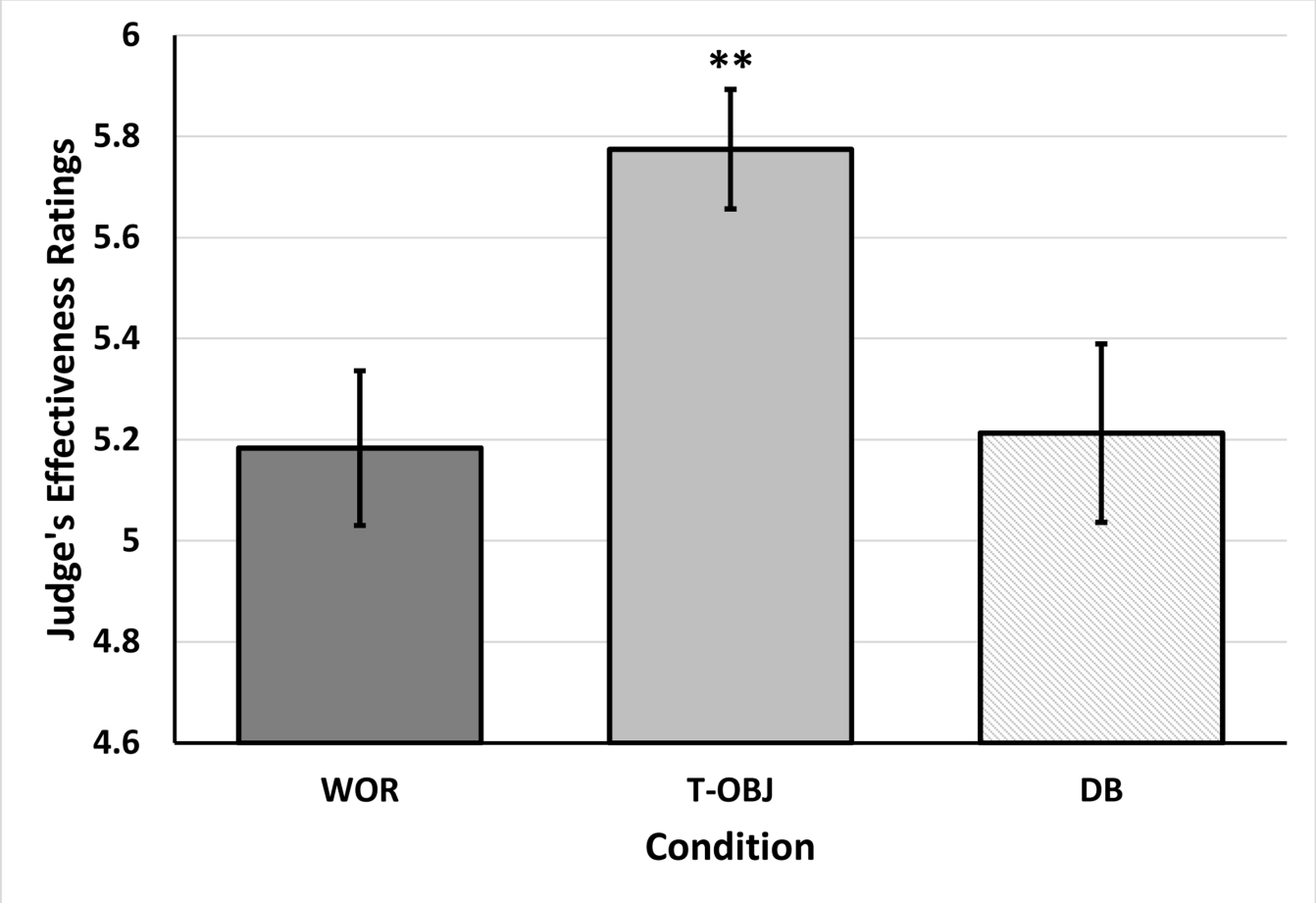

Figure 2.
Judge's Ratings of Effectiveness of Solutions across High and Low Trait Worry Groups
Note. WOR = worry task, T-OBJ = think objectively task, DB = diaphragmatic breathing task, ** $p < .01$.

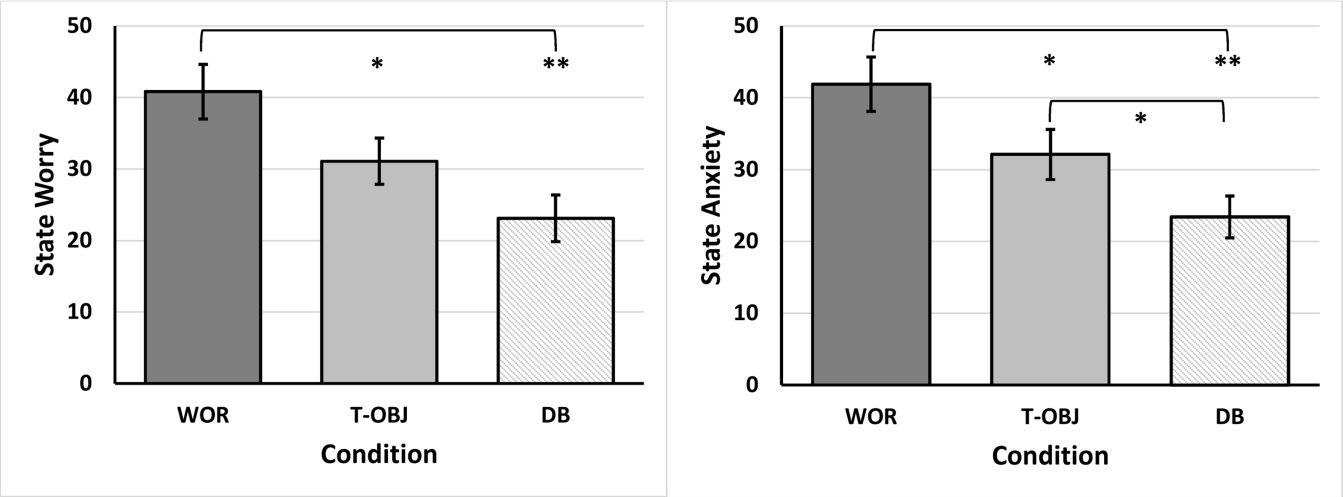

Figure 3.
Post-Solution Generation State Levels
Note. WOR = worry task, T-OBJ = think objectively task, DB = diaphragmatic breathing task, * $p < .05$, ** $p < .01$

Table 1

State Measures at Baseline and Post Problem-Thinking Task

Period	Measure	Group		*p*-value	η^2_p	Condition			*p*-value			η^2_p
		High Worry	Control			WOR	T-OBJ	DB	W vs. O	W vs. DB	O vs. DB	
Baseline	*Worry*	42.07(30.04)	19.62(24.81)	< .001	.145	32.63(29.38)	34.81(31.01)	26.35(28.68)	*ns*	*ns*	*ns*	.017
	Anxiety	44.72(29.47)	17.85(22.42)	< .001	.216	36.90(30.84)	33.43(30.51)	25.19(26.19)	*ns*	*ns*	*ns*	.035
	Relaxation	39.44(28.40)	68.39(26.25)	< .001	.223	53.07(32.28)	53.33(29.62)	53.69(31.38)	*ns*	*ns*	*ns*	.000
	Mood	58.27(20.35)	73.38(21.42)	< .001	.119	67.53(22.94)	65.13(20.10)	64.03(23.52)	*ns*	*ns*	*ns*	.005
Post-Task	*Worry*	47.47(29.98)	23.20(26.75)	< .001	.199	53.82(30.96)	35.60(28.09)	18.55(22.96)	< .001	< .001	< .001	.255
	Anxiety	45.34(29.41)	23.90(27.11)	< .001	.160	51.25(29.68)	35.95(30.45)	18.39(20.48)	.003	< .001	< .001	.225
	Relaxation	38.25(28.62)	64.57(30.26)	< .001	.219	32.62(29.09)	50.38(30.15)	69.16(26.66)	< .001	< .001	< .001	.258
	Mood	52.47(22.42)	70.54(24.08)	< .001	.154	49.65(26.32)	63.86(21.16)	69.56(23.06)	< .001	< .001	*ns*	.129

Note. Reported raw means with standard deviations in parentheses. WOR/W = worry task, T-OBJ/O = think objectively task, DB = diaphragmatic breathing task, *ns* = non-significant.

Table 2

Trait and State Worry Predicting Intention to Implement Solutions

Predictor	R^2	*F*	B	95% CI	*SE B*	β	*p*
Block 1	2.5%	4.66*					
Constant			80.39	(67.06, 92.90)	6.71		.001
PSWQ			−0.26	(−0.48, 0.02)	0.12	−.158	.033
Block 2	5.5%	5.27**					
Constant			76.42	(62.54, 89.48)	6.79		.001
PSWQ			−0.06	(−0.34, 0.23)	0.14	−.038	.666
State Worry			**−0.19**	(−0.35, −0.02)	0.08	**−.212**	**.020**

Note. Confidence intervals and standard errors are based on 1000 bootstrapped samples. PSWQ = Penn State Worry Questionnaire, *Worry* = self-reported state worry levels post problem-thinking task,

* $p < .05$,

** $p < .01$.