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ORIGINAL ARTICLE

A Brief Worry Reappraisal Paradigm (REAP) Increases Coping with Worries

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Abstract

The current study examined a novel computerized cognitive reappraisal paradigm (REAP) for worry management in college-aged adults with a range of PSWQ scores (n = 98). Participants listed three current worries and were randomized to either REAP or a worry condition. For the REAP condition, participants selected positive reappraisal statements of their worries over negative ones. Before and after completing the reappraisal or worry task, participants discussed each worry. Participants rated their worries on coping ability, distress, and probability the worry would materialize. Relative to worry, the REAP group rated an increase in ability to cope with their worries whereas the results failed to provide evidence for a similar increase among the worry group. If similar findings emerge in clinical populations, REAP may eventually serve as a useful tool in augmenting cognitive behavioral therapy protocols.

Keywords Cognitive reappraisal · Computerized reappraisal · Cognitive therapy · Worry · Cognitive behavioral therapy

"The greatest weapon against stress is our ability to choose one thought over another."
—William James.

Pathological worry is a habitual process. And, among those who worry, negative appraisals about the future are theorized to become more automatic over time because of this frequent rehearsal (Hirsch and Mathews 2012; Ruscio et al. 2011). To lessen the impact of worry, a common cognitive strategy involves getting worriers to think differently about

Portions of the data were presented in 2014 as a poster at the 26th annual convention for the Association for Psychological Science.

Study findings have not been previously published or submitted for publication elsewhere, other than as part of a dissertation. The data that support the findings of this study are available from the corresponding author upon reasonable request.The views expressed in this article are those of the authors and not necessarily those of the Department of Veterans Affairs or the Federal Government.

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emotional situations—referred to as 'cognitive reappraisal' (Gross 1998). Engaging in cognitive reappraisal improves subjective and physiological indices of emotion regulation in worriers (Ray et al. 2010; McRae et al. 2012a, b), and long-term reductions in self-reported avoidance (Ayduk and Kross 2009). However, during cognitive behavioral therapy (CBT), many clients spend much less time engaging in positive reappraisal relative to the amount of time they engage in worry. For this reason, providing clients with more low effort and accessible opportunities to engage in positive reappraisals of their worries to offset the frequency of negative appraisals of their worries remains a significant challenge in CBT. One potential method would be the application of automated tools designed to facilitate practice of positive reappraisals. To this end, the current investigation aimed to determine whether a brief, standalone positive reappraisal task administered by computer could lead to measurable improvements in perceptions of worries among young adults reporting a range of worry scores.

Cognitive Reappraisal and Worry

Cognitive restructuring, or 'cognitive reappraisal' in a therapeutic context, commonly includes such strategies as creating emotional distance, taking the perspective of another person, decatastrophizing (Beck and Dozois 2011) and positive reappraisal, or reinterpreting negative information in a more positive light (Jamieson et al. 2012). Cognitive bias modification (CBM) aims to change the underlying cognitive biases that putatively contribute to increased symptoms such as worry (MacLeod and Mathews 2012). In contrast, one of the primary aims of CBT is to change the *response* to negative thinking, including worry, not the underlying information processing biases theorized to have led to the worry in the first place (MacLeod and Mathews 2012). Whereas addressing the information processing biases that contribute to maladaptive thinking such as worry is useful (MacLeod and Mathews 2012), it seems doubtful that bias modification will eliminate all negative thinking. Therefore, cognitive reappraisal training to respond to worries more adaptively might provide a useful complement to bias modification.

Cognitive reappraisal has been implicated as a mechanism leading to therapeutic change in CBT in diverse clinical populations. In adults with subsyndromal social anxiety, one study found that applying cognitive reappraisal during Pavlovian conditioning slowed acquisition and facilitated the extinction of conditioned negative valence for social stimuli (Blechert et al. 2015). Another study of people with social anxiety disorder found that the self-rated self-efficacy of cognitive reappraisal mediated CBT outcome (Goldin et al. 2012). Among individuals with remitted bipolar disorder, cognitive reappraisal was significantly associated with reductions in emotion reactivity (Gruber et al. 2014), However, the efficacy of cognitive reappraisal for individuals with Generalized Anxiety Disorder (GAD) remains unclear. One study provided some support for people with GAD to engage in reappraisal. Specifically, after engaging in reappraisal (instructions included "try to think about a situation differently in order to change your emotions"), participants with GAD showed a reduction in self-reported negative emotion that was comparable to the reduction seen in controls (Aldao and Mennin 2012). Given the paucity of empirical data on this topic, the effect of cognitive reappraisal on constructs central to GAD such as worry warrants further investigation.

Despite CBT's known efficacy for treating Generalized Anxiety Disorder (GAD), a mental health disorder characterized by pathological worry (American Psychiatric Association, 2013), about one in two patients with GAD do not demonstrate clinically significant responses to CBT (Borkovec and Whisman 1996). Given that worry is aversive and repetitive in nature (Watkins 2008; Ruscio et al. 2011) and how negative information is more salient to people and thus encoded and remembered better (Murty et al. 2010; Pratto and John 1991), worry could be conceptualized as a form of rehearsal associated with strong memory traces.

Brewin (2006) posited that CBT doesn't directly change negative memories or representations but works by creating new positive memories to compete with the negative ones. When individuals are asked to reappraise or restructure negative thoughts, such as a worry, they activate the memory trace of the worry they are attempting to challenge. Given how predominant and frequent maladaptive worrisome thoughts are in GAD, it may be difficult for reappraisal to become at least as accessible as worries especially for those who engage in infrequent practice of reappraisal (i.e., cognitive restructuring) in the context of treatment. That is, it is likely that cognitive reappraisal within the context of CBT alone won't fully compete with highly rehearsed worries for at least some patients.

The only guaranteed cognitive reappraisal practice during a course of CBT usually occurs within weekly therapy, which, as others have noted (Resick et al. 2006), is typically 1 out of 168 h in a week. Whereas CBT therapists routinely negotiate practice assignments with the client because practice of CBT skills predicts treatment outcome (Kazantzis et al. 2010; Mausbach et al. 2010), compliance with these outside session exercises often remains low (Burns and Spangler 2000). Moreover, in one study only 63% were able to correctly complete the disputation section of a thought record, a section that requires the individual to generate alternative reappraisals (Rees et al. 2005). Newly learned reappraisal material would need to be practiced many times to compete with the memory trace of the worry. Thus, one avenue to improve treatment outcomes for worry would be to

engage patients in more frequent rehearsal of adaptive reappraisal responses, specifically cognitive reappraisal. Computerized reappraisal might eventually serve as a strategy to address low homework compliance by making practice easier, shorter, and more frequent.

In summary, cognitive reappraisal is associated with improved subjective and physiological indices of emotion regulation in worriers (Ray et al. 2010; McRae et al. 2012a, b) and positive therapeutic outcomes (Goldin et al. 2012; Gruber et al. 2014). Increased practice of reappraisal may enhance these effects. The current study examines a brief novel computerized cognitive reappraisal paradigm aimed at increasing adaptive or more positive reappraisals of worries.

Aims and Hypotheses

The current study examined whether a computerized cognitive reappraisal training paradigm could improve coping with worry in a sample of undergraduates reporting a range of worry scores. Participants were randomized to either computerized reappraisal training (REAP) or a worry condition in which participants were asked to think about two of their worries for 5 min per worry. Borkovec et al. (1983) demonstrated that focusing on a worry can decrease distracting negative thoughts. This worry condition served to experimentally control for the fact that worry can habituate over time under certain conditions (Borkovec et al. 1983). Both conditions included pre and post assessments that contained worry discussions. In these worry discussions, participants described each of their three worries for 2 min per worry. Worry discussions were coded for reappraisal content. In addition, participants rated the probability of their worry coming true, their distress about the worry, and their ability to cope with the worry if it did materialize.

We expected that coping ratings and distress would be inversely related, probability ratings and distress would be positively correlated (i.e. the more likely an individual rated a worry to come true, the more distressed they would be by the worry), and that coping ratings and probability ratings would be inversely related (i.e. worries deemed high probability may be better articulated and more rehearsed which may, in turn, increase the likelihood of catastrophizing, including the underestimation of ability to cope with the feared negative outcome). There is also evidence of a general ability or propensity to reappraise (Gross and John 2003; McRae et al. 2012a, b); here, reappraisal is defined as thinking about a situation differently to experience less negative or more positive emotions. Consequently, we also expected that the two types of positive reappraisal statements would be positively associated, such that if an individual engaged in probability recalibration statements they'd be more likely to engage in decatastrophizing statements and vice versa.

From baseline to post training, we hypothesized that relative to the worry group, the REAP group would report (a) a greater reduction in distress and probability estimates for worries coming true, (b) a greater increase in ability to cope with worries, and (c) a greater increase in coping and probability recalibration statements about worries included in the two conditions. Further, relative to the worry condition, participants in REAP were expected to extend the skill of reappraisal to another worry not reappraised in the paradigm.

Method

Participants

One hundred and sixteen undergraduates at a Midwestern university participated in the study for course credit in an Introduction to Psychology Course. Due to experimenter error, fifteen participants randomized to the worry group completed a beta version of the worry paradigm that did not include the worry periods and thus could not be included in data analysis. Further, the paradigm malfunctioned for one other worry participant and two participants in the experimental group leaving a final sample of 98 (41 participants in the worry group and 57 participants in the reappraisal group). The full sample did not provide demographic information, thus the sample size for each demographic variable are reported. Fifty-four percent of the sample identified as female ($n = 46/85$ responses) and were an average age of 18.94 years old (min–max 18–23 years old; $n = 86$). Regarding racial and ethnic background, participants identified as Asian/Asian American ($n = 24$), Black/African American/African ($n = 6$), Latinx ($n = 3$), Multiracial ($n = 6$), and White/Caucasian ($n = 43$). Most participants were first years ($n = 59$); the remainder included sophomores ($n = 16$), juniors ($n = 5$), seniors ($n = 4$), and graduate students ($n = 2$).

Measures

Penn State Worry Questionnaire

The Penn State Worry Questionnaire (Meyer et al. 1990) is a 16-item scale measuring pathological worry, the degree to which worry is excessive and uncontrollable. The questionnaire is psychometrically sound in non-clinical samples (Meyer et al. 1990). We administered this measure to be able to check that the worry and experimental group had equivalent worry scores at baseline.

Worry Identification and Ratings

Participants were instructed to identify three different worries, given several published studies indicating that similar

samples can identify readily three to five worries on average (Berenbaum et al. 2007; Dugas et al. 1995). We included two of the worries in the reappraisal learning paradigm and the worry condition. Participants rated each of their three worries in terms of how distressing they found the worry, the probability of the worry actually occurring, and how much they would be able to cope with the feared outcome if it did occur. They rated each worry on a 0 to 9 scale with higher numbers indicating greater distress, perceived coping ability, and increased likelihood of the worry materializing.

Worry Discussions

Participants discussed their worries aloud in response to a prompt that appeared on the computer screen:

> Please talk about whatever comes to mind about this worry. Please talk about everything that comes to mind about the situation you are worried about. No detail is too small. It is okay if you do not finish saying everything you would like to. Everyone is given the same amount of time. You will have 2 minutes for this task. The task will advance automatically after 2 minutes.

The program detected and recorded participants' speech. They had 2 min to discuss each worry from the time they began to speak. Participants' worries appeared in a random order. All participants discussed each worry twice, before and after reappraisal training or, in the worry condition, before and after thinking about each worry. All responses were automatically recorded by the computer via a Logitech microphone and subsequently coded for reappraisal content by a coding team of two undergraduates.

Reappraisal Coding System

Two research assistants were trained to code reappraisal statements using a coding manual with an extensive list of examples of reappraisal content. Two research assistants who were blind to condition and time point independently coded each 2-min worry discussion. Participants' worry discussions were coded for specific reappraisal content presented in the paradigm. Given their brevity, the discussions were not transcribed but coders listened to the audio recording of each worry discussion a minimum of two times. Coders rated two reappraisal categories (Probability Recalibration and Decatastrophizing) on a 0–3 Likert scale ranging from "none" to "quite a bit" of reappraisal. Coding ratings were informed by examples provided for each category. For the Probability Recalibration code, the worry discussion needed to reflect the notion that worries, particularly the person's worst-case scenario, rarely materialize. Example statements included: "This thought has not been true 100% of the time" and "Most of my worries don't actually come true." For the Decatastrophizing/Coping Statements code, the worry discussion needed to reflect the idea that the person can survive the situation or "weather the storm," handle this situation effectively, or even demonstrate "grace under fire." Example statements included "I can think of an action plan to cope with this," "I can develop an effective plan to handle this situation," and "I am more capable of coping than I give myself credit for." Coded reappraisals provided an additional index of reappraisal use that seemed likely to have been less susceptible to demand characteristics than self-report rating.

Worry Task Manipulation Check

The instructions for the manipulation check in the worry group read: "During the last 5 min, what percentage of the time were you *actually* thinking about your worry on the screen? _____% of the time." The participant then pressed the spacebar to advance to the next worry and were again asked for the percentage of time they were able to focus on the worry.

Procedures

Participants completed the Penn State Worry Questionnaire (PSWQ) as part of mass testing prior to participating in this study. In one study, the mean and standard deviation for patients with GAD was 67.35 and 8.12 (Behar et al. 2003). In another study with a smaller sample size, the mean and standard deviation for patients with GAD was 68.11 and 9.59 (Brown et al. 1992). Consequently, we attempted to recruit participants who score close to GAD mean levels, equal to or greater than 65, on the PSWQ. However, due to an error by the research pool administrator we were unable to secure a sample made up entirely of participants with PSWQ scores equal to or greater than 65; only 15 participants had a PSWQ score equal to or greater than 65 ($M = 51.04$, $SD = 13.89$; IQR = 19.75). We did not retest PSWQ scores before the test session. A period of three to ten weeks elapsed between PSWQ administration and participation in the experiment.

Participants were randomized to one of two conditions: REAP or the worry group. The experiment consisted of one 30-min meeting. The tasks were presented to participants on a computer using DirectRT software (Jarvis 2012). We compared the group that completed REAP with a worry group to examine whether the paradigm produced any change in reappraisal usage and worry ratings relative to the worry group.

Baseline Assessments

Participants completed baseline assessments, including discussing three worries they identified for 2 min per worry. These worries were recorded and later coded by two raters

for evidence of different reappraisal types. Additionally, participants rated all three worries for distress, probability of the worry actually occurring, and their ability to cope with the worry occurring. Participants completed either a worry or reappraisal task.

Worry Task

In lieu of completing the reappraisal task, participants randomized to the worry group were asked to think about two of their worries until the computerized program prompted them to complete the second assessment point. It may be that merely focusing on worries is enough to improve outcomes (Borkovec et al. 1983), the worry period was designed to control for this possibility. That is, this worry condition provides a test of whether any relative improvement in the REAP condition can be entirely explained by habituation resulting from increasing focus on worries. Each worry was presented on the screen with instructions to spend 5 min per worry. The 5-min estimate was based on the amount of time pilot participants had taken to complete the reappraisal task. After 5 min, the screen advanced automatically to the manipulation check.

Reappraisal Paradigm

Before the task began, the experimenter guided the participants through one example trial and then left the room. Then, participants were presented with a series of screens containing one of two worries they identified at the beginning of the experiment or an experimenter-generated foil worry. One of the participants' previously discussed worries was not included in the reappraisal task. During a five second delay, participants were asked to indicate, hitting a "yes" key or a "no" key, whether or not the worry presented was one of their worries. After the 5 s delay, two reappraisals appeared on the same screen: one negative, one positive. One of every four trials was preceded by a foil trial in which an experimenter-generated worry was presented. After the participant responded to the foil worry, one of the participant's worries appeared in the manner described above. Presenting the worry alone for 5 s and the yes/no judgments were meant ensure that participants allocated at least some attention to the presented worry.

In each trial, one of the participant's worries appeared at the top of screen. Underneath that, one of two types of cognitive reappraisals: (a) probability recalibration (e.g., "This thought has not been true 100% of the time.") or (b) coping/decatastrophizing (e.g., "I can find an opportunity to grow from this situation."), appeared alongside a negative reappraisal (e.g. "If this happened, I'd never recover."). Participants were instructed to select the reappraisal that reflected the more useful way of thinking about the given worry. For each correct selection, participants saw a green checkmark over the reappraisal and heard one of two pleasant sounds (one for probability recalibration and one for decatastrophizing) similar to when a contestant gets an answer correct on a game show (see Figs. 1, 2 for further details).

After clicking an incorrect response, participants saw a red circle with a diagonal line through it over the incorrect response and heard a buzzer sound. We expected this aversive noise to facilitate learning. Although negative feedback often serves to increase test anxiety (Ball 1995), an opportunity to revise one's answers and receive positive feedback attenuates and sometimes reverses the impact of negative feedback on anxiety (Attali 2011; Attali and Powers 2010). After an incorrect answer, a new screen appeared, presenting the text "Press the spacebar to try again." The original reappraisal prompt appeared once more and participants could not move on until they chose the correct response. Each correct statement cue was 200–500 ms in duration.

In total, 30 pairs of reappraisals were presented; 15 probability recalibration and 15 decatastrophizing reappraisals appeared in block randomized order (see Fig. 1 for a graphical depiction). Mean total completion time for both worries = 4.39 min, $SD = 1.39$, Range = 2.03–8.85 min.

Post Task Assessments

After completing the reappraisal training task or after worrying for a 10-min period (worry group), participants again discussed the three worries they previously identified for 2 min per worry. These worries were again recorded and later coded by two raters for evidence of different reappraisal types. Additionally, participants re-rated all three worries for distress, probability of the worry actually occurring, and their ability to cope with the worry occurring.

After completing the second set of assessments, participants were then debriefed and had any questions regarding the experiment answered. Participants received one credit for their Introductory Psychology class after completing the experiment.

Analytical Approach

We first conducted several analyses as a methodological check on several components of the study. To ensure randomization did not fail, we tested for worry and reappraisal group equivalency at baseline for PSWQ total scores, worry ratings (reported distress about the worries, probability of the worries materializing, and ability to cope with worries), and reappraisal content in worry discussions. Due to the novelty of the reappraisal task, we also conducted analyses examining the validity of paradigm measures and conducted reliability analyses for the coded probability recalibration

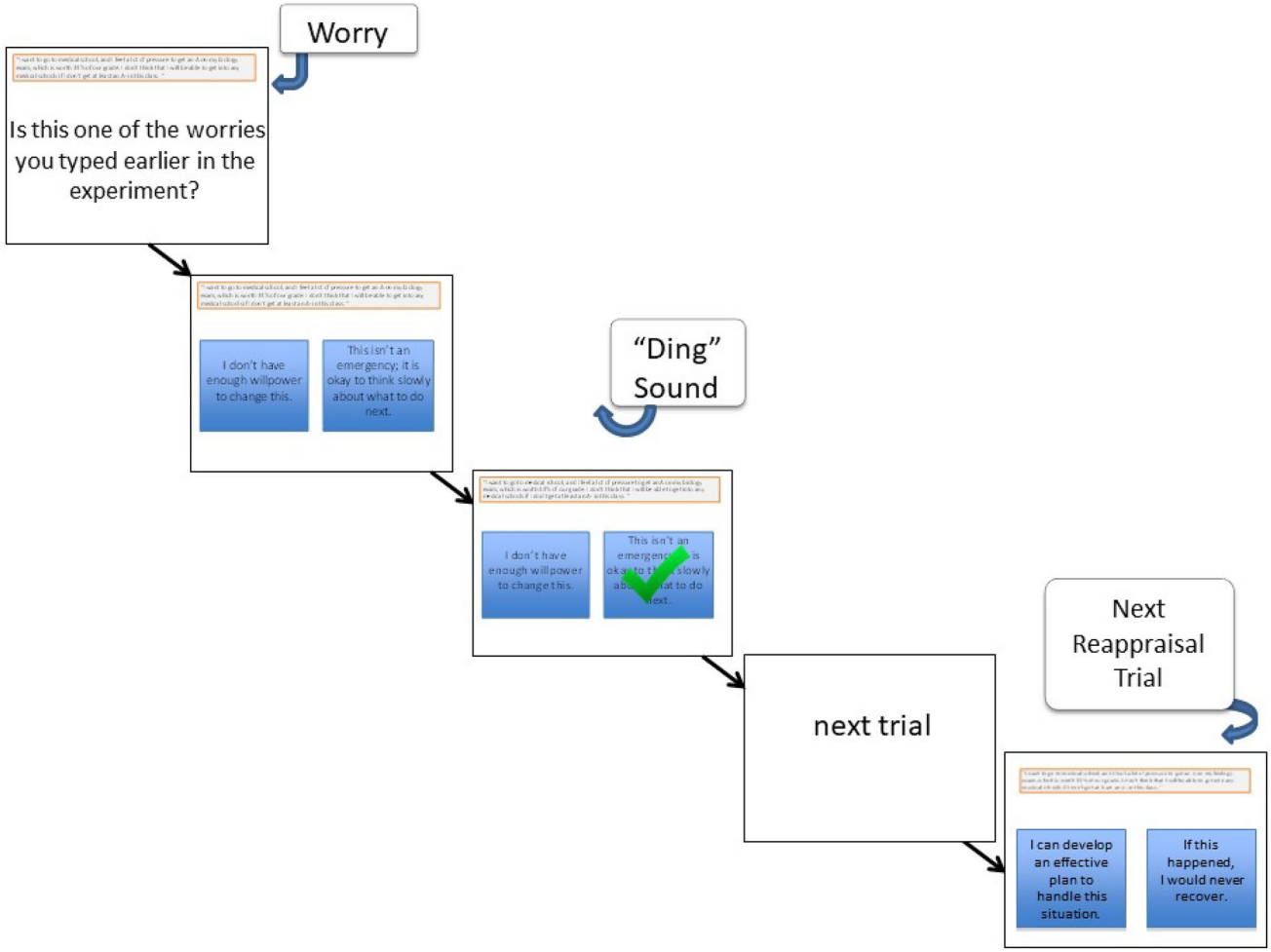

Fig. 1 Schematic of slide progression for a correct selection. The image above is a schematic of the slide progression in the event of a correct answer. First, a worry appeared at the top of the screen. During a five second delay, participants were asked to indicate (yes/no) whether the worry presented was one of the worries they identified. After a five second delay, two reappraisals appeared on the side by side on the same screen: one negative, one positive. After selecting an adaptive reappraisal, participants heard a pleasant "ding" sound and went on to the next trial

and decatastrophizing statements. To determine if there was any difference between worries presented in the reappraisal task (i.e., the first two identified by participants), and the worry that was not presented during the reappraisal task (i.e., the third worry identified by participants), we compared the presented worries and unpresented worry on worry ratings and reappraisal content in worry discussions at baseline Lastly, we examined task length and the time spent focused on worries in the two conditions.

To examine reappraisal task efficacy, we performed a 2 (worry group vs. reappraisal group) × 2 (assessment point: baseline vs. post) analysis of variance (ANOVA) to test the simple Group × Assessment Point interaction for each of the coded and self-report outcome measures. To control Type I error rate, for each of the two types of variables (coded and self-report), we divided the alpha level in each analytic approach by the number of tests conducted in that approach to get a corrected alpha-level. Finally, we performed effect size and power analyses for worry ratings, and for coded decatastrophizing and probability recalibration statements.

Results

Validity of Paradigm Measures

Most of the correlations between outcome measures were small to moderate (see Tables 1 and 2). As expected, the inverse relationships between distress ratings and coping ratings, the positive relationship between probability ratings and distress ratings, and the positive correlation between probability recalibration statements and coping statements

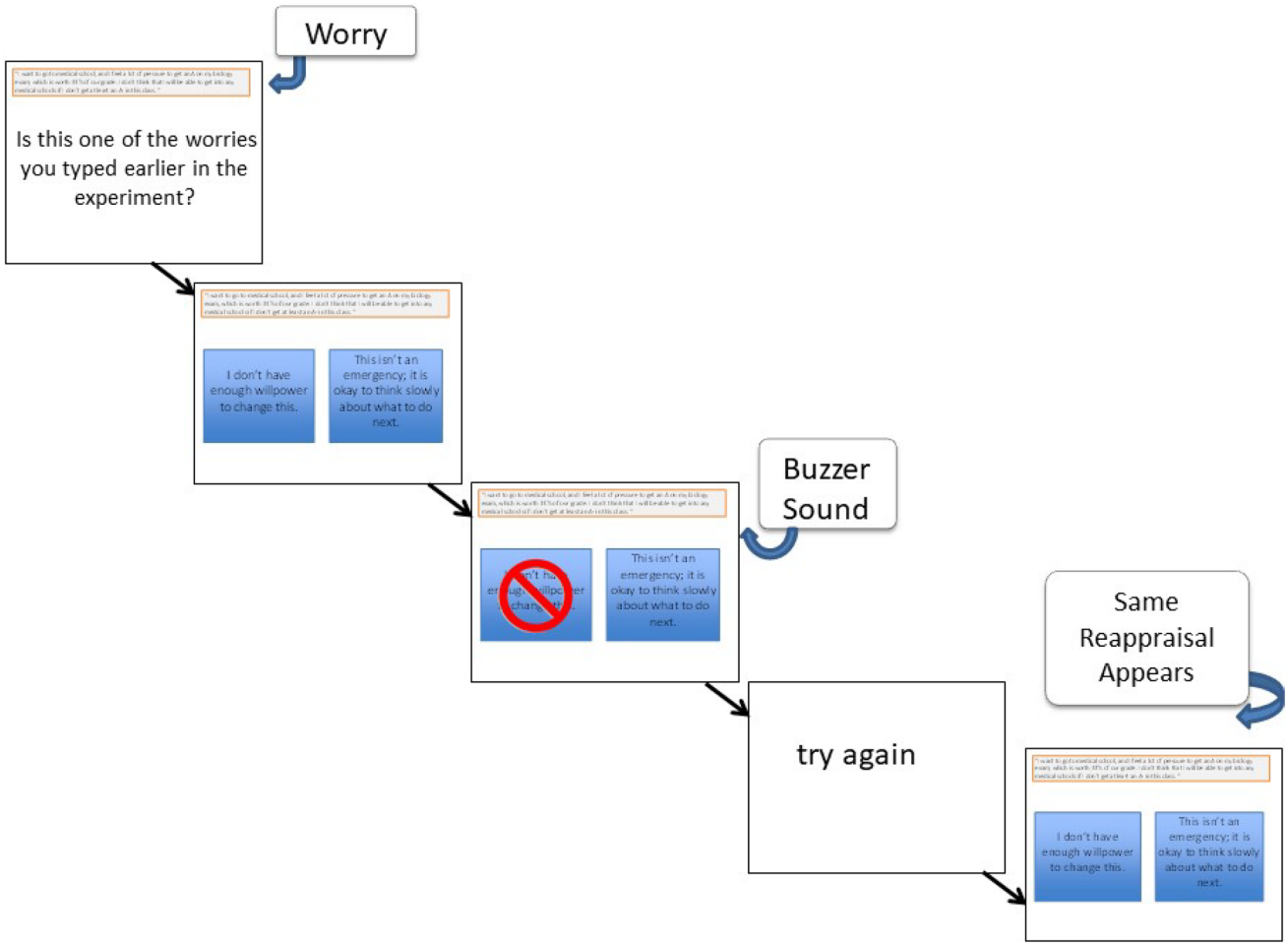

Fig. 2 Schematic of slide progression for an incorrect selection. This image above is a schematic of the slide progression in the event of an incorrect answer. The same sequence occurred, except after selecting an incorrect reappraisal, participants heard a buzzer sound and were presented with the same set of reappraisals until they chose the adaptive reappraisal

were observed at both baseline and post-test (see Table 1). These relationships provide some evidence for the validity of the coding system and self-report ratings. Moreover, variability in these ratings demonstrates that some people use more cognitive reappraisals than others. Several outcome measures were not significantly correlated in the expected ways (see Table 1). Further, a significant positive correlation between coping ratings and probability ratings was observed at baseline (see Table 1); this was in the opposite direction of what we expected. Overall, these findings provide partial support for the validity of the ratings overall.

Reappraisal Coding System Reliability

The two coders demonstrated moderate to good reliability as evidenced by intraclass correlation coefficients (ICCs) of coded coping ratings at pre/post = .86/.90 and coded probability ratings at pre/post = .71/.67 (LeBreton and Senter 2008). A portion of participants worry discussions were not available due to recording failure or very poor audio quality (see Tables 1, 2, and 3 for sample sizes for these measures).

Testing Group Differences at Baseline

Independent samples t-tests were performed comparing the worry and reappraisal groups in terms of mean PSWQ scores and baseline, pre-intervention scores of the outcome measures. The worry group's PSWQ scores at baseline ($M = 50.41$, $SD = 15.46$, N = 41) did not statistically differ from the reappraisal group's scores at baseline ($M = 51.51$, $SD = 12.72$, $N = 55$), $t(94) = -.38$, $p = .71$). The same was true for distress ratings ($t(96) = -1.00$, $p = .32$), coping ratings ($t(96) = -.57$, $p = .57$), probability ratings ($t(96) = -.69$, $p = .49$), coded decatastrophizing statements ($t(72) = -.15$, $p = .88$), and coded probability recalibration ($t(72) = -.90$, $p = .37$) at baseline.

Table 1 Correlations among and descriptive statistics for self-report and coding outcome measures

Measure	1	2	3	4	5
1. Distress SR	–	−.42**	. 26*	−.23*	−.03
2. Coping SR	−.48**	–	.22*	.15	−.04
3. Probability SR	. 21*	−.04	–	.00	.02
4. Coping rating C	−.25*	.22*	.01	–	.28*
5. Probability C	−.11	.08	−.06	.69**	–
Pre *M*	7.13	4.87	4.96	1.35	1.08
Pre *SD*	1.16	1.74	1.40	.59	.44
Post *M*	6.67	5.23	4.63	1.58	1.02
Post *SD*	1.40	1.86	1.62	.83	.52

Intercorrelations at baseline across groups are presented above the diagonal ($n=74$ for coding measures, 98 for self-report measures). Intercorrelations at post across groups are presented below the diagonal ($n=95$ for coding measures, 98 for self-report measures). The means and standard deviations are presented in horizontal rows. For all measures, higher scores indicate more extreme responding

SR self-report, *C* coding

*$p<.05$, **$p<.009$

Table 2 Correlations among and descriptive statistics for baseline self-report and coding outcome measures

Measure	1	2	3	4	5
1. Distress SR	–	−.16	. 43**	−.31*	.05
2. Coping SR	−.59**	–	.17	.05	−.21
3. Probability SR	.13	.26	–	.10	.16
4. Coping rating C	−.19	.24	−.08	–	.41*
5. Probability C	−.09	. 08	−.23	.08	–
M (Worry)	6.99	4.75	4.85	1.34	1.03
SD (Worry)	1.08	1.71	1.46	.64	.45
M (REAP)	7.23	4.95	5.05	1.36	1.12
SD (REAP)	1.21	1.77	1.36	.56	.43

Intercorrelations of outcome measures for the worry condition at baseline are presented above the diagonal ($n=30$ for coding measures, 41 for self-report measures). Intercorrelations of outcome measures for the reappraisal condition at baseline are presented below the diagonal ($n=44$ for coding measures, 57 for self-report measures). The means and standard deviations are presented in horizontal rows. For all measures, higher scores indicate more extreme responding

SR self-report, *C* coding

*$p<.05$, **$p<.006$

Testing for Differences Between the Presented Worry and Unpresented Worry at Baseline

Across conditions, there was a significant difference in baseline distress ratings for the worry not presented during the task ($M=6.70$, $SD=1.99$) and baseline distress ratings for the addressed worries ($M=7.34$, $SD=1.18$); $t(97)=-3.12$, $p=.002$). Baseline coping ratings for the worry not presented during the task ($M=5.24$, $SD=2.65$) did not significantly differ from baseline coping ratings for the addressed worries ($M=4.68$, $SD=1.94$); $t(97)=1.95$, $p=.054$. The same was true for baseline probability ratings for the worry not presented during the task ($M=4.92$, $SD=2.03$) and baseline probability ratings for the addressed worries ($M=4.99$, $SD=1.59$; $t(97)=-.34$, $p=.74$). Baseline coping statements did not significantly differ for the worry not presented during the task ($M=1.41$, $SD=.77$) and the addressed worries ($M=1.32$, $SD=.61$; $t(73)=1.05$, $p=.30$). The same was true for baseline probability recalibration statements; they did not significantly differ for the worry not presented during the task ($M=1.12$, $SD=.59$) and the addressed worries ($M=1.06$, $SD=.54$; $t(73)=.66$, $p=.51$). At baseline, participants across conditions rated the worries addressed in the task, the first two they identified, as more distressing than the third worry they identified, the unaddressed worry. Coping and probability ratings and coded statements did not significantly differ at baseline as a function of whether the worry was addressed in the task or not.

Table 3 Correlations among and descriptive statistics for self-report and coded outcome measures at post

Measure	1	2	3	4	5
1. Distress SR	–	−.44**	. 21	−.50**	−.22
2. Coping SR	−.53**	–	−.08	.36*	.21
3. Probability SR	.22	−.02	–	−.01	.06
4. Coping rating C	−.15	.09	.02	–	.73**
5. Probability C	−.05	−. 05	−.01	.69**	–
M (Worry)	6.62	4.72	4.63	1.42	1.03
SD (Worry)	1.14	1.79	1.61	.75	.58
M (REAP)	6.70	5.60	4.62	1.70	1.01
SD (REAP)	1.57	1.85	1.64	.87	.48

Intercorrelations of outcome measures for the worry condition at post are presented above the diagonal ($n=41$ for coding measures, 41 for self−report measures). Intercorrelations of outcome measures for the reappraisal condition at post are presented below the diagonal ($n=54$ for coding measures, 57 for self-report measures). The means and standard deviations are presented in horizontal rows. For all measures, higher scores indicate more extreme responding

SR self-report, *C* coding

*p < .05, **p < .006

Manipulation Check for Worry Group Participants

Worry participants were asked to think about two of their worries for 5 min per worry. They were then asked, "During the last 5 min, what percentage of the time were you actually thinking about your worry on the screen?" Participants in the worry group reported thinking about the worry 40.7% of the time on average ($SD=21.56$) across the two worries demonstrating that worry participants thought

about their worries at least to a considerable degree. Participants reported that the amount of time spent worrying was similar for both the first worry ($M = 39.00$, $SD = 21.72$) and the second worry ($M = 42.40$, $SD = 25.51$). Moreover, given that they focused on their worries approximately 40.7% of the time over a 10-min interval, the worry group spent approximately the same amount of time focused on their worries as the reappraisal group (4.07 min of focusing on worries in the worry condition and 4.39 min in the reappraisal group). The reappraisal portion of the paradigm took less than 10 min to complete.

Reappraisal Efficacy as Measured by Probability Recalibration and Decatastrophizing Statements

A 2 (worry group vs. reappraisal group) × 2 (assessment point: baseline vs. post) analysis of variance (ANOVA) was conducted to test the simple Group × Assessment Point interaction for each of coded variables. The simple Assessment Point × Group interaction was not significant for coded probability recalibration $F(1,71) = 1.71$ $p = .20$; partial $\eta^2 = .02$; the same was true for coded decatastrophizing statements, $F(1,71) = 2.14$ $p = .15$; partial $\eta^2 = .03$.

Reappraisal Efficacy as Measured by Self-Rated Coping, Distress, and Probability

A 2 (worry group vs. reappraisal group) × 2 (assessment point: baseline vs. post) analysis of variance (ANOVA) was conducted to test the simple Group × Assessment Point interaction for each of the self-report measures. We again applied a corrected alpha level to control Type I error rate. With three tests in this set of analyses, the corrected alpha level equaled .05 divided by 3, or .0167. The simple Assessment Point × Group interaction was not significant for self-reported distress about the worries or probability of the worries materializing, $F(1,96) = .40$, $p = .53$, partial $\eta^2 = .00$, and $F(1,96) = 1.08$, $p = .30$, partial $\eta^2 = .01$, respectively. For self-reported ability to cope with worries, however, there was a significant simple Assessment Point X Group interaction, $F(1,96) = 6.67$, $p = .011$, partial $\eta^2 = .07$, that remained significant after applying the corrected alpha level. Follow-up tests of the simple main effects of Assessment Point within the two groups revealed that coping ratings significantly increased from baseline to post for the reappraisal group, $t(56) = -3.46$, $p = .001$, but not the worry group, $t(40) = -.15$, $p = .88$. From baseline to post-intervention, participants in the reappraisal group showed a significant increase in self-reported coping relative to the worry group (see Fig. 3).

Effect Size and Power Analyses

Given unequal sample sizes, the effect sizes were computed for self-reported distress, coping, and probability ratings across all worries by adjusting the calculation of the pooled standard deviation with weights for the sample sizes in the reappraisal and worry group. Effect sizes were computed across all worries based on mean post minus pre change score group differences. The effect sizes for group differences in self-report ratings were as follows: distress, d = .13; ability to cope with the worry materializing, d = .54; and probability of the worry materializing, d = .21. The effect sizes for coded decatastrophizing and probability recalibration statements were d = .35 and d = .31, respectively.

We conducted post hoc power analyses with the program G*Power 3 (Faul et al. 2007).

A power analysis indicated that with $\alpha = .05$ and 98 participants, the sample size for the self-report ratings, power to detect the Group × Assessment Point interaction in ANOVAs equaled .17 for a small effect size ($f = .10$), .69 for a medium effect size of ($f = .25$), and .97 for a large effect size ($f = .40$). Another power analysis indicated that with $\alpha = .05$ and 74 participants, the sample size for the coded variables, power to detect the Group × Assessment Point interaction in ANOVAs equaled .14 for a small effect size ($f = .10$), .56 for a medium effect size of ($f = .25$), and .92 for a large effect size ($f = .40$).

Discussion

This investigation demonstrated the potential for brief computerized reappraisal of worry, relative to a worry condition, to successfully change perceptions of worry in young adults with a range of worry scores. Specifically, the reappraisal group (REAP) reported a significantly increased ability to cope with their worries relative to those randomized to a worry condition in which participants were instructed to think about their worries. However, for coping statements, groups did not significantly differ in their pre to post change. Effect sizes ranged from small for coded coping/decatastrophizing to moderate for self-reported coping.

Findings did not support an effect of the reappraisal task on increased probability recalibration reappraisals, or how probable the worry is (e.g., "This thought has not been true 100% of the time."). Perhaps decatastrophizing is a more compelling short-term intervention than probability recalibration, particularly if it is easier to consider the concrete prospect of how one will cope with a worry materializing versus considering the more abstract realistic odds of it occurring. Future studies are needed to determine if probability calibration can be manipulated in the long-term with a computerized reappraisal task.

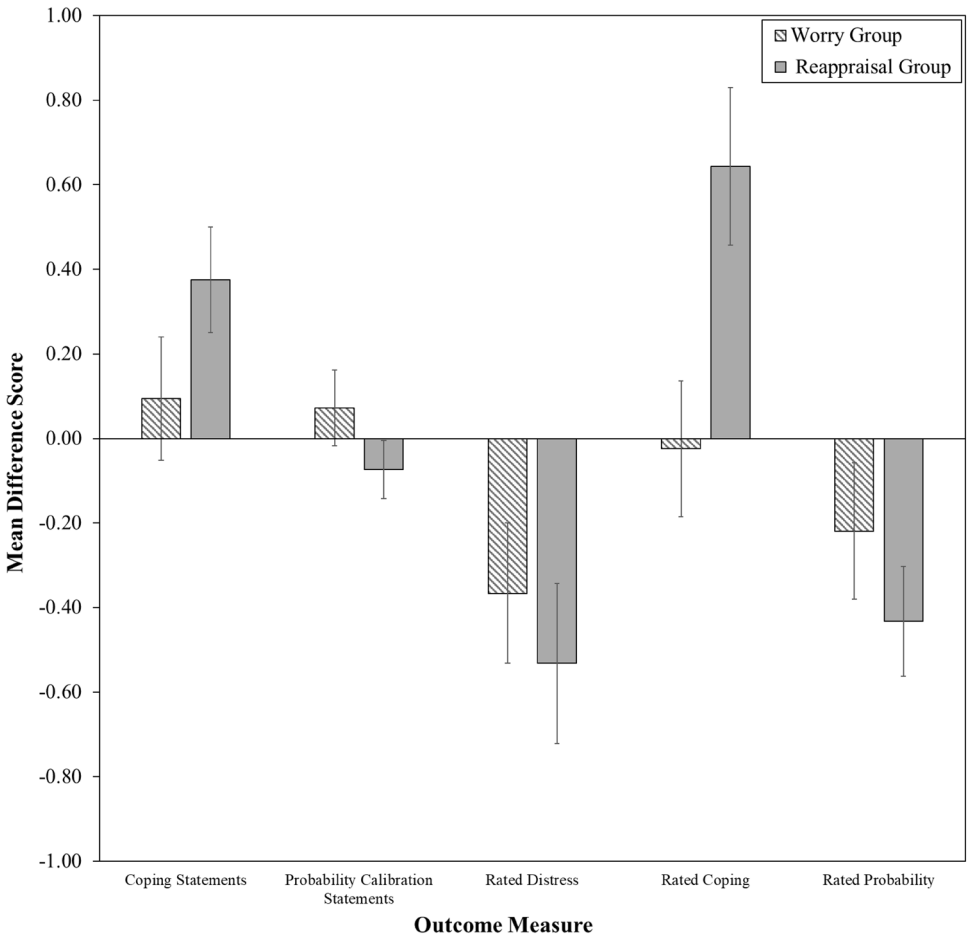

Fig. 3 Mean differences scores for outcome measures. In the reappraisal group, coping statements but not probability calibration statements, increased significantly from baseline to post. Relative to the worry group, participants in the reappraisal group showed a significant baseline-post increase in self-rated coping. The error bars represent standard error

Much of the extant emotion regulation literature on reappraisal has relied heavily on self-report measures (Lewis et al. 2010). The current study benefits from using experimental methods to interrogate the efficacy of cognitive reappraisal, in addition to traditional self-report measures. Future studies could utilize paradigms like the one herein to better mirror the cognitive restructuring delivered within CBT in samples scoring in the clinical range for worry.

Future studies should also consider using a different comparison group that would serve as a better control condition. For example, one potential control condition could closely mirror the reappraisal paradigm in every respect but instead of choosing between positive and negative reappraisals, participants could choose between negative and neutral reappraisals. Such a control condition could potentially be less aversive than one in which participants actively worry. However, even a neutral reappraisal would likely serve as a form of decatastrophizing in a sample with worry scores in a clinical range.

The reappraisal task could also be tested on other digital platforms, such as smartphone applications. This may more easily allow for collection of sample sizes large enough to detect the small to moderate effect sizes demonstrated in this experiment and the small mean effect size demonstrated in CBM for anxiety paradigms (Cristea et al. 2015). Other reappraisal strategies such as acceptance, could also be tested. REAP was designed to mirror the process of cognitive reappraisal in therapy. The format of REAP is less time-consuming and more game-like than the thought record worksheets typically used to facilitate practice of cognitive reappraisal strategies. Moreover, if Brewin's (2006) "retrieval competition account" of CBT is correct, increased practice of adaptive reappraisals may enhance cognitive reappraisal in therapy.

Limitations

The current study had a number limitations. As a result, the results presented herein should be considered preliminary. First, although the mean PSWQ score was elevated, only a small percentage were in the clinical range. Moreover, given that PSWQ scores were not measured immediately before the experiment, participants' worry scores at the time of testing and how these scores may have changed in the interval between PSWQ administration and the experiment is

unknown. Although PSWQ scores have demonstrated good test-test reliability over a two to 10-week period (Molina and Borkovec 1994; Meyer et al. 1990; Stöber 1998), this is problematic in that it is unclear how state worry impacted the experiment's outcome. Future studies should access worry scores immediately before the reappraisal or a control condition. Second, the worry condition took longer than the training condition; this might make the two conditions less directly comparable than if they had taken the same length of time. Yet, when taking into account the ratings by participants in the worry group regarding the percentage of time they actually thought about their worries, the worry group spent approximately the same amount of time focused on their worries as in the reappraisal group. Considering that we had no a priori hypothesis regarding the proportion of time participants in both conditions would spend focused on their worries and that it is unclear if the proportion of time spent worrying would be replicated, future studies may wish to reduce the length of whatever comparison condition is employed to have the task length be more comparable to the reappraisal condition.

The worry discussions in which participants discussed each worry for 2 min in response to a non-directive prompt were potentially susceptible to demand cues to be a "good subject" (Orne 1962). Given the transparency of the reappraisal task's goal (i.e. increasing reappraisal selection), participants in the reappraisal condition may have felt compelled to reappraise their worries during the worry discussions that occurred after the reappraisal task. Although no statistically significant between group difference was found for the coded probability recalibration and decatastrophizing statements, the worry discussions potential susceptibility to demand characteristics may be of concern for future, more-well powered studies. The study also had no follow-up assessment to test whether the effects were maintained beyond the immediate post reappraisal period.

Overall, the correlations between outcome measures as baseline provide mixed support for their validity. As expected, the inverse relationships between distress ratings and coping ratings, the positive relationship between probability ratings and distress ratings, and the positive correlation between probability recalibration statements and coping statements were observed at both baseline and post-test. In addition, the variability in reappraisal-related ratings demonstrate that some people use more cognitive reappraisals than others. However, several outcome measures were not significantly correlated in the expected ways; the lack of significant correlations between probability ratings and probability recalibration statements and coping ratings and coping statements was unexpected. Further, a significant positive correlation between coping ratings and probability ratings was observed at baseline (see Table 1); this was in the opposite direction of what we expected. Thus, there was mixed evidence for the validity of the outcome measures. Future studies could examine the possibility that the more individuals believe a threat will materialize, the more they consider how they might cope with it, and this additional processing increases their perceived sense of their ability to cope with the threat.

Although for worry discussions, worries were in random order (without replacement), the paradigm presented the first two worries provided by participants. One implication of this is that the worries included in the REAP and worry conditions may have been more prominent than the worry that was not addressed in these conditions. Indeed, at baseline, participants across conditions rated the worries addressed in the task, the first two they identified, as more distressing than the third worry they identified, the unaddressed worry. Coping and probability ratings and coded statements did not significantly differ at baseline as a function of whether the worry was addressed in the task or not. Nonetheless, future iterations of the paradigm would benefit from presenting worries in random order for both the worry discussions and the task.

Participants in the worry group were asked to think about two of their worries. This worry condition was chosen because of findings reported by Borkovec et al. (1983) showing that focusing on worries can produce habituation. Alternatively, the worry condition could have increased negative affect (McLaughlin et al. 2007). However, self-reported distress about worries did not increase in either the worry or reappraisal condition. Distress and negative affect are not one in the same. Therefore, future studies should include a measure of negative affect. The manipulation check for participants in the worry condition was likely susceptible to demand characteristics. Given that in the worry condition were asked to think about two of their worries, participants may have inferred that if they did not respond with a high percentage when asked, "During the last 5 min, what percentage of the time were you actually thinking about your worry on the screen," they would not have followed instructions. However, given that the mean response was just over 40%, it is unlikely that all participants responses reflect demand pressures but this possibility cannot be entirely eliminated with the current design.

As other researchers have noted (e.g. Ehring et al. 2010; Urry 2009; Aldao et al. 2010), a concern about self-report measures in reappraisal paradigms is that they may be especially susceptible to demand cues. Although the worry discussions are at least somewhat less vulnerable to demand than self-report, REAP itself is susceptible to demand characteristics insofar as the aims of the intervention are fully transparent to participants, just as cognitive restructuring is in CBT. Participants in the reappraisal condition were instructed to select the reappraisal that reflected the more useful way of thinking about the given

worry. This may have contributed to increased coping ratings demonstrated by participants in the reappraisal group.

Further research would be required to determine if the transparency of the paradigm is particularly problematic. If REAP produced symptom change that was maintained over time, the paradigm would still be considered useful despite demand characteristics. Future research could also consider other outcome measures that are less susceptible to demand characteristics and more ecologically valid or clinically relevant. Longitudinal ecological momentary assessment of worries and appraisals of worries could provide another metric of whether any changes produced in REAP translate to everyday life. Longitudinal assessment of any actions to cope with worries addressed within the paradigm, such as asking close others for help, could also serve as a behavioral metric of REAP's impact. Moreover, the REAP task may reduce negative affect via positive feedback (i.e. the green check mark and sound typically associated with correct responses in game shows appeared after the selection of a positive reappraisal). This could have influenced ratings. Including a measure of state negative and positive affect in future iterations of the protocol could help address this concern.

A more well-powered test of REAP with the changes suggested above in a sample of high worriers could begin to answer the question of REAP's efficacy in a sample that would more closely mirror a clinical sample. The dose–response relationship of the paradigm would need calibration in future studies particularly to determine the optimal frequency and spacing of practice. Given the brief nature of the protocol, we did not examine symptom reduction. The study also did not measure the frequency, perceived controllability, or intensity of the worries themselves. Future studies that examine the paradigm's use over time could survey whether the paradigm leads to meaningful and enduring symptom reduction.

Conclusion

In summary, a brief computerized reappraisal training paradigm (REAP) had a demonstrable effect on coping reappraisals in young adults with a range of worry scores. These preliminary data indicate that this brief computerized reappraisal paradigm had a positive impact on how individuals judged their ability to cope with their worries. Given the brevity and straightforward nature of the reappraisal task, this paradigm may show promise for further testing and development via well-powered experimental follow-up studies.

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Compliance with Ethical Standards

Conflict of Interest Nehjla M. Mashal, Sherry A. Beaudreau, Michael A. Hernandez, Rachel Cackler Duller, Holly Romaniak, Ki Eun Shin, Ken A. Paller, and Richard E. Zinbarg declare that they have no conflict of interest.

Ethical Approval All procedures performed involving human participants in this study were in accordance with the ethical standards of the institutional Review Board (IRB) at Northwestern University, Evanston Campus and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Animal Rights This article does not contain any studies with animals performed by any of the authors.

Informed Consent Informed consent was obtained from all individual participants included in the study.

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