Behaviour Research and Therapy 48 (2010) 840–850

Contents lists available at ScienceDirect

Behaviour Research and Therapy

journal homepage: www.elsevier.com/locate/brat

Efficacy of self-administered treatments for pathological academic worry: A randomized controlled trial

Kate B. Wolitzky-Taylor [a,b], Michael J. Telch [b,*]

[a] University of California, Los Angeles, USA
[b] Laboratory for the Study of Anxiety Disorders, Department of Psychology, University of Texas, Austin, TX 78712, USA

ARTICLE INFO

Article history:
Received 23 January 2010
Received in revised form
23 March 2010
Accepted 24 March 2010

Keywords:
Academic worry
Pathological worry
GAD
Worry exposure
Expressive writing
Audio-photic stimulation
Self-help treatments
Randomized clinical trial
Self-administered treatments
Brief treatments

ABSTRACT

Research on treatments for reducing pathological worry is limited. In particular, academic worry is a common theme in generalized anxiety disorder (GAD) samples as well as non-clinical student samples. Given the high cost of anxiety disorders to society, research is needed to examine the efficacy of self-administered treatments designed to reduce pathological worry. The primary goal of this study was to investigate the benefits of three self-administered interventions for reducing academic worry. College students (N = 113) experiencing clinically significant academic worry were randomized to either: (a) worry exposure (WE); (b) expressive writing (EW); (c) relaxation consisting of pulsed audio-photic stimulation (APS); or (d) waitlist control (WLC). Participants were instructed to practice their interventions three times per week for one month and completed home practice logs online to track treatment adherence. Academic worry, general anxiety, and perceived stress were assessed at baseline and post-treatment. Academic worry and general anxiety were also assessed at a three-month follow-up. Those assigned to the WE and APS conditions showed significant improvement relative to EW and WLC at post-treatment. All treatment conditions showed continued improvement by follow-up, with no between-group differences. Treatment and public health implications are discussed.

Generalized anxiety disorder (GAD) affects approximately 6% of the general US population and is associated with significant impairment in role and social functioning (Kessler, DuPont, Burglund, & Wittchen, 1999; Wittchen, Carter, & Pfister, 2000), high rates of medical and psychiatric comorbidity (McWilliams, Goodwin, & Cox, 1997; Kennedy & Schwab, 1997; Swendsen, Merikangas, & Canino, 1998), and increased rates of health care utilization (Barrett, Barrett, & Oxman, 1988; Wittchen & Hoyer, 2001). GAD ranks as the most common mental disorder seen in primary care settings – two times the prevalence rate in primary care compared to major depression (Wittchen, 2002). Unfortunately, only 28% of GAD patients seen in primary care facilities are correctly diagnosed by their primary care physicians, and these patients are rarely treated with empirically supported treatments for GAD (Wittchen & Hoyer, 2001). These data point to the need for brief cost-effective interventions that could be transported to primary care settings (Telch, Smits, Brown, & Beckner, 2002).

The significance of academic worry

It is estimated that anxiety in response to test taking and other academic concerns affects 25–30% of high-school and college students (McDonald, 2001; Wachelka & Katz, 1999). Not only is academic stress highly prevalent but studies suggest that academic stress contributes to anxiety and depression among college students (Aldwin & Greenberger, 1987; Yadusky-Holahan & Holahan, 1983). Pathological worry about work or school is commonly observed in GAD patient samples (Sanderson & Barlow, 1990) as well as sub-clinical samples (Hazlett-Stevens & Craske, 2003).

Self-administered treatments for pathological worry

One way to make psychological interventions more cost-effective is to utilize brief interventions that lend themselves to self-administration. The American Psychological Association's Task Force on Self-Help Therapies noted several advantages of self-help interventions: (a) they reach a large number of people, (b) they are highly cost-effective, (c) they help maximize autonomy by decreasing reliance on mental health professionals, and (d) they serve educative and preventive functions (Rosen, 1987). The most widely researched self-help interventions for anxiety disorders have been bibliotherapy

* Corresponding author.
E-mail address: telch@austin.utexas.edu (M.J. Telch).

0005-7967/$ – see front matter © 2010 Elsevier Ltd. All rights reserved.
doi:10.1016/j.brat.2010.03.019

(e.g., Febbraro, Clum, Roodman, & Wright, 1999; Lucock et al., 2008; Orbach, Lindsay, & Gray, 2007; Rapee, Abbot, Bailee, & Gaston, 2007; Shoenberger, 2008) and computer/internet-based training programs (Carlbring et al., 2005; Carlbring, Westling, Ljungstrand, & Andersson, 2001; Houghton, 2008; Tillfors et al., 2009). Meta-analytic investigations of these self-help approaches have consistently revealed significant benefits for bibliotherapy interventions relative to controls, with effect sizes equivalent to those observed for therapist-directed interventions (Gould & Clum, 1993; Marrs, 1995; den Boer, Wiersma, & van den Bosch, 2004) especially when participants were provided with self-help media such as audiotapes (Gould & Clum, 1993). Moreover, contrary to the belief that self-help interventions are associated with high rates of attrition, a recent meta-analysis of self-help interventions for anxiety disorders (Hirai & Clum, 2006) reported an overall attrition rate of only 12.3%, which is comparable to that found in studies of therapist-directed treatments for anxiety disorders.

Efficacy studies of self-administered treatments for pathological worry/GAD represent a small subset of the efficacy studies of self-help treatments for anxiety disorders. The self-help treatments investigated have included problem solving (Bowman, Scogin, Floyd, Patton, & Gist, 1997), relaxation training (Jannoun, Oppenheimer, & Gelder, 1982), multi-component CBT interventions consisting of relaxation training, diaphragmatic breathing, and cognitive restructuring (Newman, Consoli, & Taylor, 1999), or PMR, cognitive restructuring, and *in vivo* exposure (White, Keenan, & Brooks, 1992). The treatments were delivered via bibliotherapy (Bowman et al., 1997; White et al., 1992), Palm devices (Newman et al., 1999), or audiotapes with accompanying instructional booklets (Jannoun et al., 1982). The amount of therapist contact ranged from several telephone check-ins (Bowman et al., 1997) to six therapist-led treatment sessions (Jannoun et al., 1982; Newman et al., 1999; White et al., 1992). Not surprisingly, each found greater improvement among those receiving the intervention compared to no-treatment controls. Taken together, the current literature suggests that self-administered treatments may be promising alternatives to therapist-directed treatment for reducing pathological worry, but that more research on self-help treatments is needed particularly with respect to alternatives to CBT packages delivered via bibliotherapy, CD/audiotapes or the internet.

Worry exposure as a self-administered treatment for pathological worry

Worry exposure is a treatment strategy that was developed in line with Borkovec's influential cognitive avoidance model of GAD (Borkovec, 1994). The model proposes that worrying is a verbal process that functions both to distract the worrier from more threatening thoughts and inhibit the autonomic experience of anxiety thus impeding emotional processing (Borkovec, 1994). Empirical support for the cognitive avoidance model of worry comes from findings indicating that worry attenuates physiological arousal during subsequent exposure to a feared situation (Borkovec & Hu, 1990); and, experimental demonstrations that worrying as compared to engaging in relaxation or mental imaging leads to more intrusive thoughts about the stressor on subsequent days (Butler, Wells, & Dewick, 1995).

Worry exposure consists of having patients gradually and repeatedly confront their worry-provoking scenarios via imagery until the distress associated with them habituates. Despite its inclusion in manualized treatments for GAD (e.g., Brown, O'Leary, & Barlow, 2001; Rygh & Sanderson, 2004), worry exposure has not been empirically evaluated as a stand-alone treatment. Cognitive exposure – a variant of this procedure – has the patients imagine the worst possible feared outcomes associated with their worry. Like worry exposure, cognitive exposure has only been tested in the context of its inclusion as one of several components of a 12–16 session therapist-directed cognitive-behavioral treatment for GAD (Dugas et al., 2003; Ladouceur et al., 2000).

Expressive writing as a self-administered treatment for pathological worrying

The use of writing as a variation of exposure therapy comes from the literature on written emotional disclosure, a procedure developed by Pennebaker and Beall (1986). This procedure consists of writing about a stressful experience or past trauma for 15–30 min over several consecutive days. Considerable research has established the benefits of this expressive writing intervention (EW) across a diverse range of populations and problems (see Frattaroli, 2006 and Pennebaker, 1997, for reviews). We expected that expressive writing may be a useful intervention for reducing worry by imposing some controllability over worries in much the same way scheduled worry time (i.e., stimulus control) has been shown to do (see Borkovec, Wilkinson, Folensbee, & Lerman, 1983).

One study reported on the efficacy of expressive writing as an intervention for pathological worrying. Goldman, Dugas, Sexton, and Gervais (2007) randomized non-clinical worriers to an emotional writing intervention or neutral control writing condition. Those assigned to the emotional writing condition were instructed to write about a scenario describing their worst fear coming true. At a two-week follow-up, participants receiving the emotional writing intervention were significantly less likely to meet for GAD relative to the control writing condition. These encouraging findings along with the ease with which emotional writing lends itself to self-administration led to our decision to include it as one of the active intervention arms for the current study.

Pulsed audio-photic stimulation as a potential intervention for pathological worry

The relaxing effects of flickering light have been documented for hundreds of years. Early scientists used the comforting, mesmerizing light of the fires in their fireplaces to draw them into lucid states of mind then commonly referred to as "reverie" (Rocke, 1985). Relaxation strategies such as diaphragmatic breathing and progressive muscle relaxation have demonstrated efficacy in reducing general anxiety and worry and are commonly found in manualized treatments for GAD (e.g., Rygh & Sanderson, 2004). Unfortunately, techniques such as PMR often require a significant amount of time and diligence on the part of the therapist and patient with regard to training and homework compliance in order to achieve optimal benefit. For those who may be unwilling or unable to devote significant time to practicing relaxation skills, alternative relaxation approaches requiring no skill acquisition offers significant advantage for self-administration.

Pulsed audio-photic stimulation (APS) – also referred to as audio-visual entrainment (AVE) – has been used by clinicians since the 1980's to promote relaxation and treat stress-related disorders (e.g., Berg & Siever, 1997). Our group has investigated the use of APS to induce dissociation and relaxation in college students (Horowitz & Telch, 2008; Leonard, Telch, & Harrington, 1999) and as a relaxation control group in several randomized treatment studies of exposure-based treatment for phobic disorders (e.g., Powers, Smits, & Telch, 2004; Smits, Powers, & Telch, 2006; Wolitzky & Telch, 2009). Over the past 10 years, the devices commercially available for administering audio-photic stimulation have become more portable (i.e., about the size of an IPod) and significantly more user-friendly.

The current study

The current study aimed to evaluate the efficacy of three self-administered treatments for pathological academic worry. College students experiencing clinically significant levels of academic worry were randomized to one of four conditions: (a) worry exposure (WE); (b) expressive writing (EW); (c) relaxation consisting of pulsed audio-photic stimulation (APS); or (d) waitlist control (WLC). These three interventions were selected because they each had demonstrated some benefit in reducing stress-related problems; (b) lent themselves well to self-administration; and (c) were conceptually distinct. Adherence to each of the treatments was assessed using a web-based treatment session log. The primary outcomes (see Measures) were assessed weekly during treatment, at post-treatment, and at a 3-month follow-up assessment. Secondary outcomes (see Measures) were collected at pre- and post-treatment. It was expected that all three interventions would outperform WLC and that worry exposure would outperform the other two treatments on specific measures of academic worry. There were no a priori hypotheses concerning differential effects of the three treatments on the secondary outcome measures related to academic performance and health outcomes.

Methods

Experimental design

Participants underwent a pre-treatment screening assessment. Those who were eligible were randomized to one of four conditions: (a) worry exposure (WE); (b) expressive writing (EW); (c) relaxation consisting of pulsed audio-photic stimulation (APS); or (d) waitlist control (WLC). Participants completed an in-laboratory training session and were instructed to practice their respective intervention at home at least three times per week for one month. Participants also completed an online post-treatment assessment at the end of the month and a brief online 3-month follow-up assessment.

Participants

Study participants (N = 113) were recruited from a large Southwestern university through email and verbal announcements made to students in a wide range of academic departments, as well as announcements on our laboratory website and flyers posted at the university counseling center, university-based academic enrichment and mentoring programs, and other academically-oriented organizations. 545 students expressed interest in the study. After receiving further information, 178 students completed the online screening questionnaire, the Academic Worry Questionnaire (AWQ; see "Measures"). Of those completing the online screening, 159 reported at least a moderate level of distress and/or interference due to academic worry on the screening questionnaire and were thus invited to the laboratory for a face-to-face interview.

Participants were included of they: (a) continued to report that academic worry caused a significant amount of distress and/or life interference on the Academic Worry Questionnaire (AWQ; see measures for description); and (b) were currently enrolled in a college or university program. Participants were excluded from participation for any of the following: (a) currently taking psychotropic medication for depression and/or anxiety and were unwilling to stay on the same dose during the course of the study; (b) planning to start or terminate psychotherapy for worry, stress, or anxiety and unwilling to wait until after the post-treatment assessment; or (c) had a history of seizures, due to the slight increased seizure risk associated with receiving photic stimulation. Of those 130 participants who underwent the comprehensive screening assessment, 117 met eligibility criteria. Four declined to participate, leaving 113 participants who were randomized to treatment using a randomization scheme (N_{WE} = 33; N_{EW} = 33; N_{APS} = 29; N_{WLC} = 18). 84 participants were classified as treatment completers as defined by completing at least one-third of the recommended home sessions (N_{WE} = 23; N_{EW} = 20; N_{APS} = 24; N_{WLC} = 17). Of the 29 participants who did not complete the treatment phase of the study, eight were willing to complete a post-treatment assessment. 17 participants assigned to the three self-help treatments who completed the post-treatment assessment (9 completers and 8 dropouts) did not complete the three-month follow-up assessment. Fig. 1 shows the flow of participants through the study (Fig. 2).

The final intent-to-treat sample was primarily female (75.2%) and undergraduate (85%). Majors and areas of study spanned a wide array of fields with 21.2% natural sciences, 18.5% health sciences, 15.7% liberal arts, 13% business, 12% engineering, 6.5% law school, 3.7% public policy, 2.8% social sciences, 2.8% undeclared, and 3.7% double majors. The sample was also ethnically diverse, with 45.1% Caucasian, 24.8% Asian American, 16.8% Hispanic, 3.5% African-American, 8% biracial/multiracial, .9% Native American, and .9% Pacific Islander. Slightly less than one-third of the sample (31.2%) met criteria for a current DSM-IV diagnosis of GAD and 40.4% met for a GAD diagnosis in the past year. Participants also met criteria for a number of other disorders, with 11% meeting criteria for MDD, 1.8% for dysthymia, .9% for bipolar disorder, 18.3% for social anxiety disorder, 11% for specific phobia, 5.5% for panic disorder, 3.7% for obsessive compulsive disorder, .9% for post-traumatic stress disorder, 4.6% for a substance use disorder, and .9% for an eating disorder.

Measures

Diagnostic assessment

Composite International diagnostic interview (CIDI; World Health Organization, 1997)

Assessment of DSM-IV diagnoses of GAD and other Axis I disorders were conducted using the computerized, interviewer-based version of the CIDI-Auto. The CIDI-Auto has been used in several anxiety disorder clinical trials (e.g., Powers et al., 2004; Roy-Byrne et al., 2005; Wolitzky & Telch, 2009). The anxiety disorder module demonstrates good psychometric properties including good sensitivity (.86; Peters & Andrews, 1995). Although the computerized version was used, trained interviewers administered the CIDI interview to the participants.

Treatment credibility, adherence, and fidelity

Credibility expectancy questionnaire (CEQ; Devilly & Borkovec, 2000)

The CEQ is a widely used scale for assessing the perceived credibility of treatments. The questionnaire asks participants to rate how logical the therapy seems, how much they think it will reduce worry, how confident they would be in recommending it to a friend, and how much improvement they expect to have by the end of treatment. We modified the scale so that all four items were rated on a 0–100 scale. The four CEQ items used in this measure were averaged to create one index of treatment credibility.

Online home practice logs

As a measure of treatment adherence, online home practice logs were created for each of the three treatment conditions. Participants were asked to complete a home practice log after each home practice session in which they answered a few questions about their home session. Several of these treatment-specific questions were used as additional, *in vivo* measures of treatment adherence. For example, participants in the APS condition were asked to rate how relaxed they felt, participants in WE were asked to rate how

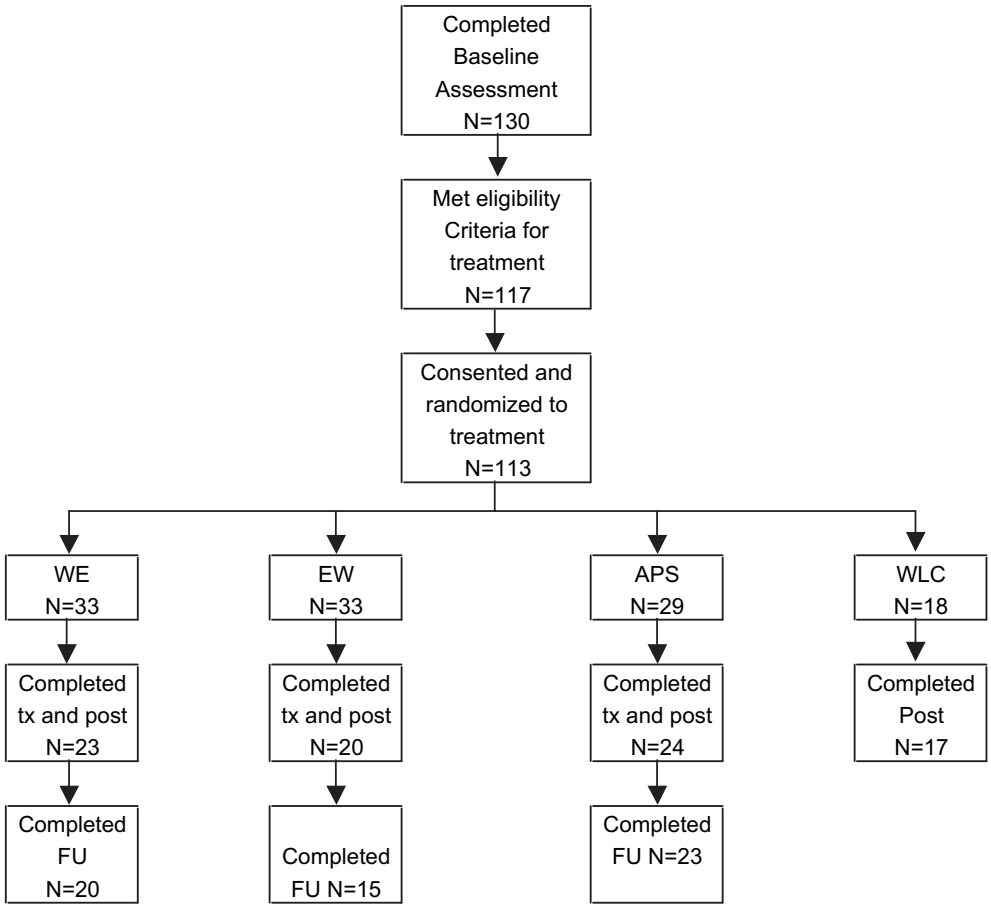

Fig. 1. Flow of participants through the study. Key: WE = worry exposure; EW = expressive writing; APS = audio-photic stimulation; WLC = waitlist control; tx = treatment; post = post-treatment assessment; FU = follow-up assessment.

much they used imagery during self-administration, and participants in EW were asked to rate how much they expressed thoughts and feelings. Participants in the WE condition also completed questions similar to the self-monitoring form proposed by Brown et al. (2001) in their description of worry exposure implementation, such as describing the worst possible outcome and generating alternative outcomes. All online practice log entries were sent directly to a secure server which allowed the investigators to track home practice compliance for each participant.

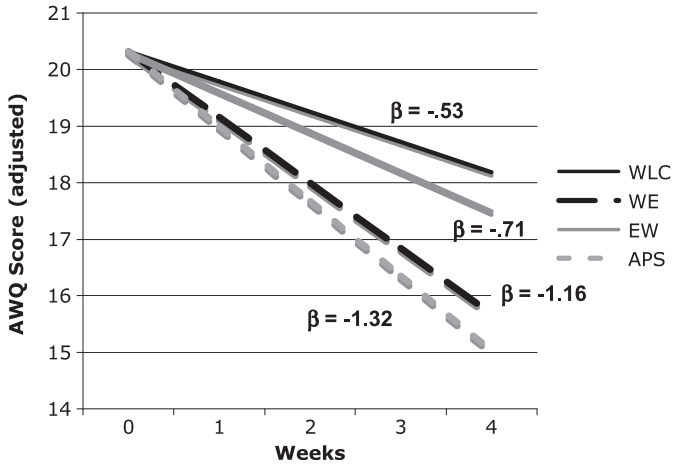

Fig. 2. AWQ decline slopes assessed weekly throughout treatment phase (from pre- through post-treatment) by condition.

Assessment of treatment activities (ATA)

Participants completed a two-part, author-constructed questionnaire measuring treatment fidelity. In Part A, participants answered Yes/No questions about what they did during treatment, such as "I listened to a tape" or "I wrote about my academic worries." Part B asked participants to rate on an 11-point Likert scale how much they agreed with statements about their treatment activities, such as "I expressed my innermost thoughts and feelings about academic worry-related topics" and "I focused on worry-related images during my home practice of my intervention." Participants completed this online measure at post-treatment.

Primary outcome measures

Academic worry questionnaire (AWQ; Wolitzky & Telch, 2005)

This 10-item questionnaire asks participants to rate on a 5-point scale the degree to which they experienced different characteristics of academic worry in the past week. Domains include frequency of worry episodes, overall duration of worry per week, distress associated with worrying, anxiety experienced during worry episodes, negative beliefs about worry, positive beliefs about worry, controllability of worry, impairment due to academic worry, and use of safety behaviors to cope with academic worry (e.g., overpreparing for exams, arriving extremely early for class). This measure demonstrated good internal consistency (Cronbach's α = .87) and

test–retest reliability ($r = .83$) as well as convergent and discriminant validity.

Penn state worry questionnaire (PSWQ; Meyer, Miller, & Metzger, 1990)

The PSWQ is a 16-item scale that measures the tendency to worry excessively and uncontrollably. Examples of items on the PSWQ are "My worries overwhelm me" and "Many situations make me worry." Items are rated on a 5-point Likert scale ranging from 1 (not at all typical of me) to 5 (very typical of me). The PSWQ has high internal consistency, $\alpha = .86–.95$, and good test–retest reliability over 4 weeks, $r = .74–.93$ (Molina & Borkovec, 1994).

Secondary outcome measures

Health care utilization

The number of medical visits obtained from student health center records was used as a measure of health outcome and medical utilization. This information was collected for: (a) the semester prior to participation and (b) the semester of participation.

Semester grades

Overall GPA was obtained from the registrar. This information was collected for: (a) the semester prior to participation and (b) the semester of participation.

Perceived stress scale (PSS; Cohen, Kamarck, & Mermelstein, 1983)

This widely used 10-item instrument for measuring perceived stress uses a 5-point scale. Items measure how unpredictable, uncontrollable, and overloaded people find their lives to be. The scale also includes questions about current levels of experienced stress. The measure demonstrates good internal consistency (Cronbach's $\alpha = .86$) and test–retest reliability ($r = .85$).

Procedures

Screening

Participants who contacted the laboratory were instructed to complete the online AWQ. Those who reported at least moderate distress and/or impairment due to academic worry were invited to the laboratory for further screening. Participants completed a full diagnostic assessment (CIDI) and a battery of online questionnaires including a demographic questionnaire, the AWQ, PSWQ, and PSS. Those who met eligibility criteria (see "Participants") and were interested in participating in treatment signed informed consent to participate in treatment and were randomized to one of the four treatment conditions.

Treatment phase

Participants completed an instructional training session in the laboratory immediately following randomization. Procedures common to all treatment conditions included: (a) experimenter presenting the rationale for treatment; (b) participant completing the CEQ; and (c) after intervention-specific training, participants being provided verbal and written instructions for completing home practice, online home practice logs and online questionnaire batteries. Below is a brief description of each treatment protocol.

Worry exposure (WE)

The WE protocol was adapted from the protocol proposed by Brown et al. (2001), which is also outlined in the treatment manual by Rygh and Sanderson (2004). During the intervention training, participants: (a) received brief imagery training consisting of guided instruction to imagine pleasant scenes; (b) learned the SUDS rating scale; (c) worked collaboratively with the experimenter to construct a hierarchy of five worry-provoking images relating to school; (d) created a loop tape (with coaching from the experimenter) describing each of these scenes (starting with the lowest on the hierarchy) in the present tense with use of sensory detail; (e) were given instructions to listen to one worry image (starting with the first) at a time at home repeatedly until SUDS fell below 30 on the 0–100 scale and then to move onto the next image, spending 20–30 min per home session on worry exposure; and (f) received additional tips such as to expect an increase in anxiety at first; to focus on the images and avoid distraction; and to add other worry-provoking images to the loop tape if they could listen to all of the scenarios with minimal distress before the end of the one-month treatment phase. The intervention training session lasted approximately 35–45 min.

Expressive writing (EW)

Participants were instructed to write in as much detail as possible about their academic worry for 20 min per session. This dose is consistent with the original work using this paradigm (see Pennebaker & Chung, 2007). Participants were encouraged to explore their deepest thoughts and feelings regarding their academic worries, concerns, pressures, and demands. Because EW was conceptualized as repeated exposure to worry scenarios, participants were instructed to stay focused on the topic of academic worry. However, in order to maintain the integrity of the original paradigm, participants were encouraged to explore this in any way that was relevant to them. In order to control for time spent in the laboratory, participants completed a writing session in the laboratory. As an additional adherence check, after a writing session was submitted, the date and content of each writing session was sent directly to a secure server that was viewed by the first author.

Audio-photic stimulation (APS)

Audio-photic stimulation was administered using the commercially available DAVID-PAL device (Mind Alive Inc, Alberta, Canada). This device consists of an iPod-sized control board which connects into headphones that emit programmable pulsing sounds similar to that of a beating heart and sun-glasses that emit programmable bursts of orange flickering light. The 35-min APS session was programmed to optimally target worry reduction by David Siever, President of Mind Alive Corporation – the creators of the device. The session protocol was divided into two phases. During the first 15 min of the session (Phase 1), the frequency of both auditory and photic stimulation was set at 10 Hz in both the right and left channels. During the next 20 min, the right channel frequency was increased to 20 Hz while the left channel was kept at 10 HZ. This setting had been used by our group in several prior published studies (Powers et al., 2004; Smits et al., 2006; Wolitzky & Telch, 2009). Participants learned how to operate the device and completed a session to control for time spent in the laboratory. In addition to the use of online home practice logs as a treatment adherence check, the APS device was programmed to automatically record each training session and thus served as an unobtrusive measure of treatment adherence.

Before they underwent their intervention training, participants were provided with the rationale that the audio-photic stimulation (APS) would relax them through a procedure called brainwave entrainment (BWE). It was explained that the special frequencies of the pulsed lights and tones would induce alpha brain wave activity, which are associated with deep states of relaxation and meditation. Participants were instructed to keep their eyes closed and to focus only on the lights and sounds, keeping their minds free of any

thoughts, and to focus their attention back to the pulsing tones should their minds wander.

Waitlist control (WLC)

Participants randomized to the WLC group were informed of their group assignment and it was explained that they would not be receiving an intervention until after the one-month acute treatment phase. Participants were provided with written and verbal instructions for completing the weekly online questionnaire (AWQ) and the post-treatment online questionnaire battery at the end of the month. Participants were encouraged to make an appointment after the one-month treatment phase, in which they would be provided with the tools they would need to self-administer one of the active interventions (i.e., worry exposure). Participants were also assured that the researchers would be available for phone and email consultations if necessary. Participants in the WLC group who made an appointment for an intervention training after their post-treatment assessment completed a laboratory session in which they were trained to self-administer worry exposure. This training was identical to the worry exposure training outlined above, and included the creation of a loop tape for participants to take home for worry exposure practice.

Statistical analysis

To maximize power, fewer participants were randomized to the WLC condition because it was expected that sample size requirements for detecting differences between intervention conditions would be greater than the sample size required to detect differences between active interventions vs. WLC. Separate outcome analyses were conducted with the completer sample and the intent-to-treat sample (ITT; all randomized participants). Missing data for dropouts were estimated using the SPSS expectation-maximization (EM) platform for data imputation. The EM method estimates missing values using an iterative process. More specifically, each iteration calculates (a) expected values of parameters ("E step"); and (b) maximum likelihood estimates ("M step"). ITT analyses are reported throughout. Completers analyses are reported only when they differed from the findings with the ITT sample.

One-way ANOVAs (for sessions completed) and chi-square tests (for dropout/completer status) were used to assess whether completion of treatment and attrition differed between groups. Logistic regression was used to examine predictors of attrition, including demographic, diagnostic, and pre-treatment severity variables.

Both continuous and categorical outcome analyses were conducted on the primary outcome – AWQ total scores. First, the ITT sample was used to examine the potential differential decline slopes of AWQ scores between conditions, taken across five time points from the beginning to the end of treatment: baseline, week 1, week 2, week 3, and post-treatment (i.e., week 4). A 2-level HLM was conducted with AWQ score as the outcome variable, assessment period as the level-1 predictor, and three dummy-coded variables to represent the four conditions (with WLC as the reference category) as the level-2 predictors. This omnibus test was followed-up with post hoc comparisons between two groups using the same basic model. Because one of the benefits of HLM is its ability to handle missing data, data collected on all randomized participants were included in the analysis. Next, percentage of participants achieving statistically reliable change on the AWQ and was determined using Jacobsen and Truax's (1991) reliable change index (RCI).

For all other outcome measures, continuous outcomes were obtained by conducting a series of a series of 2 (assessment time) × 4 (condition) repeated measures ANOVAs to assess the effect of time and time × condition. Follow-up simple effects tests were conducted to determine which conditions showed pre-post change. Simple effects tests were conducted for any significant or marginally significant time × condition effects for the repeated measures analyses using a univariate ANCOVA controlling for pre-treatment scores. Pairwise comparisons using Tukey's tests were used to evaluate intergroup differences at post-treatment. In addition to these continuous analyses on the secondary outcome measures, percentage of participants achieving reliable change on the PSWQ was also determined using Jacobsen and Truax's (1991) RCI.

Maintenance of treatment gains at the three-month follow-up assessment was examined through continuous (repeated measures ANOVAs) and categorical (reliable change) analyses on the AWQ and PSWQ.

Results

Baseline equivalence

Despite random assignment, some variables differed between groups at baseline. A significant difference was observed for gender, $\chi^2(3) = 8.22$, $p < .05$, with more males assigned to EW than APS [$\chi^2(1) = 6.14$, $p < .01$] and WE $\chi^2(1) = 4.59$, $p < .05$]. No other baseline differences emerged for any demographic or clinical diagnosis variables. Means and SDs of the baseline clinical measures for all randomized participants are provided in Table 2. Unfortunately, baseline differences were observed on two outcome measures: the AWQ [$F(3, 109) = 3.19$, $p < .05$], and the PSWQ [$F(3, 109) = 2.72$, $p < .05$]. Post hoc tests revealed that those assigned to WE reported significantly higher academic worry (AWQ) and general worry (PSWQ) than those assigned to APS (all $ps < .05$). Consequently, pre-treatment scores were statistically controlled when analyzing between-group differences at post-treatment through the use of ANCOVAs.

Treatment completion, adherence, and attrition

Table 1a reports treatment completion, adherence, and attrition data. Between-group differences in number of home sessions completed approached significance, $F(2,92) = 2.59$, $p = .08$, with those in APS tending to complete more sessions than those assigned to EW ($p < .07$). However, no differences were observed on the dichotomous completer/dropout variable ($p = .16$). Only two variables were associated with dropout/completer status. Female gender was associated with greater likelihood of completion (OR = 6.34, 95% CI = 1.39–28.91, Wald = 5.69, $p < .05$) and being randomized during the second half of the semester was associated with increased likelihood of dropout (OR = 9.09, 95% CI = 1.81–45.34, Wald = 7.21, $p < .01$). When considering only those who completed treatment, the mean number of home sessions completed for each condition was as follows: $M_{WE} = 8.83$ (SD = 2.48), $M_{EW} = 8.55$ (SD = 2.82), and $M_{APS} = 9.33$ (SD = 1.95).

Table 1a
Treatment adherence, credibility, and attrition for all randomized participants.

	WE	EW	APS	WLC
# home sessions completed				–
M	6.36	5.55	7.93[a]	
SD	(4.36)	(4.40)	(3.62)	
Treatment Credibility (CEQ)				
M	64.44	59.83	58.54	–
SD	(19.54)	(17.46)	(20.30)	
% dropout at the Post-treatment Assessment				
N	10	13	5	1
%	30	39	17	6

[a] PS outperforms EW, $p < .07$.

Treatment fidelity

As shown in Table 1b, findings from the treatment fidelity measure indicated that each intervention was appropriately differentiated. All omnibus tests were significant on Part A of the ATA (all $ps < .001$). Planned comparisons revealed that those in the APS condition did wear a headset and goggles more than those assigned to WE or EW, $\chi^2\,(1) = 29.00$, $p < .001$; those assigned to EW reported writing about worries, $\chi^2\,(1) = 21.36$, $p < .001$, and expressing worries through words, $\chi^2\,(1) = 13.98$, $p < .001$, more than those assigned to the other two interventions; and those assigned to WE listened to a tape, $\chi^2\,(1) = 4.27$, $p < .05$, and formed images of worry scenes $\chi^2\,(1) = 5.73$, $p < .05$, more than those assigned to the other two conditions.

Between-group differences emerged for all questions on Part B ($ps < .001$) with one exception: those assigned to APS did not report feeling significantly more relaxed than those assigned to the other two conditions ($p > .10$). See Table 1b for details.

Treatment credibility

As shown in Table 1a, no significant differences were observed on the CEQ ($p = .50$), indicating participants across the three interventions viewed their treatments as equally credible. The mean CEQ score was $M = 61.00$ (SD = 18.98), suggesting that participants found their treatments to be at least moderately credible.

Treatment outcome on the primary outcome measure (AWQ)

Table 2 presents the descriptive information for the outcome measures across assessment periods (i.e., pre-treatment, post-treatment, and 3-month follow-up) for the intent-to-treat sample.

Table 1b
Data pertaining to treatment fidelity.

Treatment fidelity items	Treatment condition		
	WE	EW	APS
Wore APS headset and goggles (%)	0	0	100
Wrote about worries (%)	15	100	0
Expressed worries through words (%)	38	100	0
Listened to a worry tape (%)	100	0	14
Formed images of worry scenes	54	22	0
Relaxed			
M	4.95	6.05	6.44
SD	(2.67)	(2.39)	(2.83)
Distracted from worries			
M	3.30	4.00	6.63[ab]
SD	(2.47)	(2.92)	(2.13)
Expressed thoughts and feelings			
M	7.70[c]	8.89[c]	4.38
SD	(2.32)	(1.33)	(2.53)
Focused on worry content			
M	7.55[c]	8.47[c]	3.69
SD	(2.01)	(1.26)	(2.33)
Conjured up worry images of school			
M	7.50[b,c]	5.26[c]	1.94
SD	(1.57)	(3.18)	(1.98)
Focused on worry-related images			
M	7.20[c]	5.74[c]	2.19
SD	(1.64)	(3.60)	(2.37)

Note: Dropouts = completed fewer than 1/3 of the prescribed 12 home sessions; WE = worry exposure; EW = expressive writing; APS = pulsed audio-photic stimulation; WLC = waitlist control; a = significantly different from WE, $p < .001$; b = significantly different from EW, $p < .01$; c = significantly different from APS, $p < .001$.

Change in academic worry over the course of treatment

Those receiving WE [$\beta = -1.39$, $t\,(419) = -6.37$, $p < .001$], EW [$\beta = -.83$, $t\,(419) = -3.53$, $p < .001$], and APS [$\beta = -1.34$, $t\,(419) = -4.89$, $p < .001$] all showed significant improvement in AWQ scores over time. In contrast, those in the WLC group showed no significant improvement, $\beta = -.52$, $t\,(419) = -1.61$, $p = .11$. Analyses of between-group effects revealed significantly steeper decline slopes relative to WLC for those assigned to WE [$t\,(419) = -2.21$, $p < .05$] and APS [$t\,(419) = -1.93$, $p = .05$]. In contrast, EW did not differ significantly from WLC with respect to change over time, $t\,(419) = -.77$, $p = .44$. No significant differences emerged between WE and APS with respect to AWQ decline slopes, $t\,(240) = -.14$, $p = .89$. WE-treated participants showed marginally significantly steeper AWQ decline slopes than those assigned to EW, $t\,(224) = -1.74$ $p = .08$. Although APS-treated participants also showed steeper AWQ decline slopes than those assigned to EW, this difference did not attain statistical significance, $t\,(226) = -1.43$, $p = .16$. A similar pattern of findings emerged when conducting these analyses using the completer sample.

Reliable change

Percentages of participants achieving reliable change on the AWQ at post-treatment were 58% for WE, 33% for EW, 59% for APS, and 28% for WLC. An omnibus chi-square test indicated that between-group differences were statistically significant, $\chi^2\,(3, 113) = 8.18$, $p < .05$. Planned comparisons revealed that higher percentages of those in both the WE and APS conditions achieved reliable change compared to EW and WLC (all $ps < .05$) No other significant inter-group differences were observed.

Secondary outcome measures

General worry (PSWQ)

Treatment outcome: reliable change. Percentages of participants achieving reliable change were lower on the PSWQ at post-treatment than the AWQ, with 36% for WE, 18% for EW, 21% for APS, and 0% for WLC. An omnibus chi-square test indicated between-group differences were statistically significant, $\chi^2\,(3, 113) = 9.56$, $p < .05$. Planned comparisons revealed that all three interventions outperformed WLC ($p < .01$ for WE, $p < .05$ for APS, and $p = .05$ for EW). In addition, those assigned to WE showed a non-significant trend for greater improvement relative to EW ($p < .10$). No other significant differences emerged.

Treatment outcome: continuous analyses. A significant effect of time from pre- to post-treatment was observed across conditions, $F\,(1, 109) = 34.96$, $p < .001$, $\eta = .24$, power = 1.00. Those assigned to WE, EW, and APS showed significant improvement ($ps < .001$ for WE and EW, $p < .05$ for APS), while those assigned to WLC showed no significant change across time ($p = .71$). A significant time × condition effect was also observed, $F\,(3, 109) = 4.89$, $p < .01$, $\eta = .12$, power = .90. Simple effects tests at post-treatment revealed a significant condition effect, $F\,(3, 108) = 3.94$, $p < .01$, $\eta = .10$, power = .82, with those in WE outperforming those in WLC ($p < .001$) and EW (approaching significance, $p = .07$) and those in APS also outperforming WLC ($p < .05$). In addition, those assigned to EW marginally outperformed WLC ($p < .07$). However, no differences were observed between EW and WLC for the completer sample.

Health center visits

Contrary to hypothesis, no time or time × condition effects were observed for the number of visits to the health center (all $ps > .80$).

Table 2
Means and SDs by condition across assessment periods for outcome measures.

	WE			EW			APS			WLC	
	Pre	Post	FU	Pre	Post	FU	Pre	Post	FU	Pre	Post
AWQ											
M	21.18	15.65[d]	13.18	20.70	17.11	13.43	18.34	13.33[ce]	11.14	19.44	17.43
SD	(4.40)	(3.89)	(4.44)	(3.67)	(5.03)	(5.09)	(3.18)	(4.40)	(4.02)	(4.49)	(5.22)
PSWQ											
M	67.09	57.70[af]	53.79	63.70	59.03[d]	54.62	60.34	55.89[c]	51.40	63.33	62.86
SD	(8.67)	(10.33)	(12.70)	(9.24)	(9.22)	(10.56)	(10.55)	(9.05)	(9.59)	(8.99)	(7.82)
PSS											
M	26.06	20.34[b]		24.21	21.28		23.25	18.84[b]	–	24.33	23.60
SD	(4.90)	(6.77)		(5.82)	(6.06)		(4.09)	(5.39)		(4.68)	(6.14)
GPA											
M	3.43	3.48	–	3.27	3.41	–	3.09	3.25	–	3.23	3.14
SD	(.59)	(.47)		(.66)	(.61)		(.86)	(.72)		(.84)	(.99)
Health											
M	1.28	1.12	–	1.03	1.17	–	.95	.86	–	.77	1.00
SD	(1.97)	(1.48)		(1.66)	(1.36)		(1.02)	(1.01)		(.93)	(1.53)

Key: health = # of health visits; a = outperformed WLC $p < .001$; b = outperformed WLC $p < .01$; c = outperformed WLC $p < .05$; d = outperformed WLC $p < .10$; e = outperformed EW $p < .05$; f = outperformed EW $p < .10$; g = outperformed APS $p < .05$.
Note: Participants assigned to the WLC condition were not assessed at FU.

Grade-point average (GPA)

Analyses performed for the ITT sample revealed no significant pre- to post-treatment improvement for any of the four treatment groups. For the completer sample, those assigned to the EW condition showed significant improvement in GPA from pre- to post-treatment, $F(1, 14) = 5.59$, $p < .05$, $\eta^2 = .29$, power = .60.The homogeneity of variances assumption was not met on the repeated measures ANOVAs for GPA and transformations were unable to correct this violation. Consequently, between-group differences were examined using a univariate ANCOVA controlling for baseline GPA. This analysis revealed no significant condition effect for either the ITT or completer samples.

Because of the overall high baseline GPA for all randomized participants ($M = 3.26$; SD = .73), a ceiling effect may have obscured changes in GPA across time within and between groups. Thus, an exploratory analysis was conducted to assess for the presence of between-group differences at post-treatment considering only those whose GPAs fell below the baseline mean. Limiting the analysis to this group did not result in any ANOVA violations and yielded a significant effect of time, $F(1, 31) = 4.81$, $p < .05$, $\eta^2 = .13$, power = .57. Simple effects tests within groups for the ITT sample revealed significant pre- to post-treatment change for those in WE ($p < .05$), with no other groups showing significant pre- to post-treatment GPA improvement. This same analysis conducted on the completer sample revealed significant pre − to post-treatment improvement for the WE and EW groups (p's $< .05$) and a non-significant trend ($p = .06$) for the APS group.

Perceived stress (PSS)

A significant effect of time was observed from pre- to post-treatment, $F(1, 108) = 38.92$, $p < .001$, $\eta = .27$, power = 1.00. This improvement was observed for those assigned to WE, EW, and APS ($ps < .001$ for WE and APS; $p < .01$ for EW) but not for WLC ($p = .54$). A significant time × condition effect was also observed, $F(3, 108) = 3.36$, $p < .05$, $\eta = .09$, power = .75. Simple effects tests revealed a significant condition effect at post-treatment, $F(3, 107) = 3.19$, $p < .05$, $\eta = .08$, power = .72, with those receiving WE and APS outperforming WLC ($ps < .01$). No other inter-group differences attained statistical significance.

Maintenance of treatment gains

AWQ. Continued improvement from post-treatment to follow-up was observed overall on the AWQ, $F(1, 109) = 67.61$, $p < .001$, and this improvement was significant for participants assigned to each of the three self-help interventions ($p < .001$ for WE and EW; $p < .01$ for APS). No significant time (pre to follow-up) × condition interaction at follow-up was observed on the AWQ ($p = .33$). Similarly, of the proportion of participants achieving reliable change at follow-up for each of the three groups (76% for WE, 70% for EW, and 69% for APS) did not differ significantly.

PSWQ. Overall post-treatment to follow-up improvement was observed on the PSWQ, $F(1, 109) = 43.33$, $p < .001$, with improvement observed for those assigned to all three conditions ($p < .01$ for WE and APS; $p < .001$ for EW). No significant pre to follow-up time × condition interaction was observed on the PSWQ ($p = .47$). The proportion of those achieving reliable improvement for each of the three groups at the 3-month follow-up (48% for WE, 31% for EW, and 41% for APS) did not differ significantly.

Discussion

Our overarching aim was to conduct a preliminary controlled comparative test of three brief self-administered treatments for uncontrollable worry related to academic concerns among college students. Within this broad objective, we focused on addressing the following specific questions: (a) Will college students reporting clinically significant levels of worry take time out of their busy day to implement worry/anxiety interventions? (b) Does the type of intervention strategy make a difference with respect to either students' willingness to use the strategy or its clinical efficacy for those who use the strategy? and (c) Does reduction in academic worry influence academic and health outcomes?

Acceptability, utilization and distinctiveness of the three interventions

Our data suggest that each of the three interventions were perceived as moderately credible for reducing worrying about academic matters, with none of the three distinguishing itself as more or less credible than the others. An important index of the acceptability of the treatments is the number of reported home practice sessions completed by those in each of the three intervention conditions. For this important outcome, those in the audio-photic stimulation condition reported completing about two-thirds of the

12 assigned home practice sessions, whereas those assigned to worry exposure or expressive writing completed on average only about half of the 12 prescribed practice sessions. These adherence data suggest that audio-photic stimulation may offer a slight advantage over the other two self-help modalities with respect to treatment utilization. This finding may be due to differences in the effort needed to execute the respective interventions. From this perspective, the APS user need only put on the glasses and headphones and press one button in order to complete a practice session. In contrast, expressive writing or worry exposure requires the participant to take a more active role to complete a practice session.

Our approach in assessing the distinctiveness of the three interventions was to probe participants as to the specific procedural elements they were using during their home practice sessions. Our findings provide strong evidence supporting the integrity of the three treatments. Specifically, none of the subjects in the worry exposure or expressive writing condition reported using an audio-photic stimulation device during the course of the study, despite the fact that these devices are commercially available on the internet. Similarly, none of the participants in the audio-photic stimulation group reported writing about their academic worries or engaging in repeated worry exposure exercises, although one subject did report listening to a relaxation tape.

Clinical efficacy of the self-administered interventions in reducing worry

The pre- to post-treatment effect sizes for the primary outcome measure (Academic Worry Questionnaire) were large for each of the three interventions (Worry Exposure – $d = 1.33$; Audio-Photic Stimulation – $d = 1.32$; Expressive Writing – $d = .83$); and significantly larger than that observed for the WLC group ($d = .41$). Moreover, each intervention led to significant reductions in general worry as indexed by the Penn State Worry Questionnaire. Pre- to post-treatment effect sizes were in the range considered large for Worry Exposure ($d = .99$) and moderate for those receiving Expressive Writing ($d = .51$) and Audio-Photic Stimulation ($d = .45$). In contrast, the pre- to post-treatment effect size on the Penn State Worry Questionnaire was $d = .06$ for the WLC condition.

These effect sizes, particularly on the primary outcome measure, compare favorably to those derived from previously published studies of minimal-therapist interventions for GAD (Bowman et al., 1997; Jannoun et al., 1982; Newman et al., 1999). The effect sizes observed in the current study also compare favorably to effect sizes observed in several studies of self-administered CBT for anxiety disorders, including bibliotherapy plus monitoring in the treatment of panic disorder (Febbraro et al., 1999) and bibliotherapy for social phobia (Rapee et al., 2007). Internet-based self-administered protocols for anxiety disorders yield somewhat larger effects than bibliotherapy (Carlbring et al., 2005), and are more in line with the effect sizes observed in the current study. It is noteworthy that the effect sizes for worry exposure and audio-photic stimulation in the current study were comparable to an internet-based intervention for panic disorder that included ten modules such as cognitive restructuring, exposure, and education (Carlbring et al., 2005). The current findings are also comparable to effects observed in clinical trials of therapist-directed CBT for GAD (e.g., Butler et al., 1991; Ost & Breitholtz, 2000). Not surprisingly, the effects of therapist-directed treatment are generally larger than those of self-administered treatment. However, considering that most treatment outcome studies of GAD investigate treatment protocols consisting of several treatment components over multiple sessions, the effect sizes observed in the current study are promising.

The pattern and magnitude of between-group differences varied as a function of the outcome domain. With respect to our primary outcome – academic worry, a greater percentage of participants receiving either audio-photic stimulation or worry exposure showed reliable improvement relative to those assigned to either expressive writing or waitlist control, which did not differ from each other. Interestingly, the effects of the three interventions in reducing participants' general worry were less pronounced as evidenced by the generally lower percentages of participants achieving reliable change. Note too, that the pattern of between-group differences for general worry appears somewhat different than that observed for academic worry, with all three interventions outperforming WLC but in contrast to the findings observed for academic worry, APS did not outperform EW.

Maintenance of treatment effects

Across all three treatment conditions, academic worry and general worry symptoms continued to improve between the post-treatment and 3-month follow-up assessment, with three-quarters of those assigned to worry exposure achieving reliable improvement on the primary outcome measure. The post-treatment to follow-up improvement observed for those assigned to expressive writing was most dramatic, resulting in non-significant differences between groups at follow-up on both academic and general worry. These findings suggest that (a) participants assigned to a brief, self-directed intervention continued to see improvement in symptoms three months after discontinuing the treatment phase of the study; and (b) the benefits of expressive writing for the reduction in academic and general worry symptoms appear to be delayed.

Impact of the interventions on health center visits and academic performance

Despite our findings suggesting the beneficial impact of these self-administered treatments on students' level of academic worry and perceived stress, we found little evidence to suggest that this benefit led to improvements in students' physical health status as indexed by number of visits to the health center obtained via archival records from the university health center. Perhaps a longer period of reduced academic stress is necessary before physical health benefits emerge. One possibility is that low base rates of student health center utilization may have led to insufficient power to detect within and between-group differences.

Our investigation of the impact of the interventions on academic performance was hindered by the relatively high baseline GPA of the study participants and significant heterogeneity of variance in the GPA data across the treatment groups. Among the overall intent-to-treat sample, we found little evidence to support the claim that participants' academic performance improved as a result of the interventions they received. However, among the completer sample, expressive writing emerged as the only self-administered treatment to show a significant improvement in GPA. This finding is consistent with previous reports of improved GPA among student samples receiving expressive writing interventions (e.g., Pennebaker & Francis, 1996). To explore the possibility that ceiling effects were responsible for the overall lack of improvement observed in students' GPA, we examined the effects of the interventions on GPA for the subset of participants with low GPAs at baseline. This analysis revealed that those who received one of the three interventions showed significant improvement in their GPA relative to waitlist controls, [$F(1.29) = 8.65$, $p < .01$, $\eta = .23$, power = .81].

Issues related to the specific self-administered treatments

We were somewhat surprised by our finding that expressive writing performed poorly relative to the other two self-help

interventions at post-treatment, and failed to outperform a waitlist control on measures of both academic worry and perceived stress. One possibility is that unlike the many domains in which expressive writing has shown beneficial effects, writing assignments constitute a major class of academic stressors contributing to academic worry and thus through association may take on a negative connotation. Partial support for this hypothesis comes from our adherence data showing that participants assigned to expressive writing completed fewer sessions than participants assigned to audio-photic stimulation. Another explanation can be drawn from the formulation of Borkovec (1994) asserting that worry is a verbal process that may be used to avoid more intense anxiety, which would be experienced via imagery. Because expressive writing itself is a verbal process, one possibility is that participants who wrote about their worries were, in essence, "worrying" as they wrote without sufficient imagery to activate fear and emotionally process threat-disconfirming information related to academic concerns. Thus, participants may have continued to hold threatening associations to these worry-provoking academic topics.

Although it was expected that expressive writing would outperform waitlist control at post-treatment, the delayed benefits observed in this study are not anomalous. Consistent with previous research on expressive writing (e.g., Pennebaker & Beall, 1986; Smyth, Stone, Hurewitz, & Kaell, 1999), the benefits gained from writing about the emotional topic (in this case, academic worry) led to delayed improvement that appeared several months after the intervention. However, in the current health care system, rapid change is preferred over delayed improvement. Thus, while imagery may not be necessary for reduction of worry, it may lead to more rapid improvement, and thus may be preferred over expressive writing because of the more proximal benefits over expressive writing.

This is the first controlled study examining the efficacy of worry exposure alone for reducing pathological worry. Several issues deserve mention with respect to its utility as a stand-alone self-administered intervention. First, the current findings indicate that individuals with pathological academic worry are willing to self-administer an anxiety-provoking treatment at home with only one session in the laboratory in which the rationale is presented for exposure treatment. Second, worry exposure exerted a large effect on a measure of academic worry, suggesting that this may be a particularly useful intervention for a student who is unwilling or unable to seek out a therapist-directed course of treatment. Third, despite its brevity and problem-specific focus on academic worry, the large effects of worry exposure were also observed on measures of perceived stress and general worry, indicating that effects may have generalized to other domains. Worry exposure exerted a particularly large effect on general worry relative to the other treatments, suggesting that this treatment in particular should be tested for other worries and/or with individuals who worry about a number of topics, as seen in GAD.

Several issues related to the self-administration of audio-photic stimulation deserve mention. Our treatment utilization data suggest that participants assigned to self-administer audio-photic stimulation completed about 25% more of the prescribed sessions than participants assigned to either expressive writing or worry exposure. These data suggest that APS may be a more palatable self-help intervention for this population relative to the other two self-help treatments under study. This is perhaps not surprising, as the intervention required little effort on the part of the participant. For these reasons, the APS intervention has the potential to make a significant public health impact by providing symptom relief, particularly for those unwilling or unlikely to engage in behavioral interventions. In clinical practice, APS devices are most often used by biofeedback practitioners, who often assume, that their principal therapeutic effects are achieved through *brain wave entrainment* – a process in which the brain responds to repeated rhythmic incoming stimulation by synchronizing its own electrical cycles. However, alternative or complimentary therapeutic mechanisms are quite possible such as the redirection of the patient's attention away from anxious thought, changes in perceived self-efficacy to control anxious thought, or expectancy effects brought about by the belief that one's brain waves are being altered in a favorable fashion. It is worth noting that contrary to expectation, those self-administering APS did not report enhanced relaxation effects but did report that using the device helped distract them from their worries. Practical considerations prevented us from including a sham APS condition that would have provided useful information on the mechanism of action of APS.

Limitations and future directions

There are several limitations of this study that should be noted. First, our sample was comprised primarily of university undergraduates across all major academic departments experiencing clinically significant worry concerning academics. Although about a third of the sample displayed clinically significant worry related to other life spheres (and thus met for GAD), most of the sample did not, even though the overall sample scored in the clinical range for GAD on the Penn State Worry Questionnaire. Consequently, evidence from future studies of GAD samples is needed in order to determine whether these same self-help interventions are efficacious in the treatment of individuals presenting with other spheres of pathological worry.

Second, our findings showing minimal effects of the interventions on students' physical health and academic performance should be interpreted with caution given the brevity of the interventions. Future studies with longer intervention and follow-up periods are needed to better capture the full impact of these interventions on students' physical health and academic performance. Similarly, assessment of the durability of these interventions in reducing academic stress and worry should be the focus of future work.

Acknowledgements

We would like to acknowledge Dave Siever, President of Mind Alive Co., for the programming and use of the APS devices. We would also like to thank Van Walker, Allison Martir, Kelli Lemke, Ashley Stansbury, and Deepa Maheswari for their assistance in data collection and management. Finally, we would like to thank James Pennebaker for his input regarding the expressive writing paradigm and Gregory Hixon for statistical consultation.

This research was funded by a Ruth L. Kirschstein Individual National Research Service Award (NRSA), National Institute of Mental of Health (F31 MH076706-01).

This research was in partial fulfillment of Philosophy Doctorate in Clinical Psychology for the first author (KWT) under the supervision of the senior author (MJT).

References

Aldwin, C., & Greenberger, E. (1987). Cultural differences in the predictors of depression. *American Journal of Community Psychology, 15*, 789–813.

Barrett, J. E., Barrett, J. A., & Oxman, T. E. (1988). The prevalence of psychiatric disorders in a primary care practice. *Archives of General Psychiatry, 45*, 1100–1106.

Berg, K. A. & Siever, D. (1997). Audio-visual entrainment (AVE) as a treatment modality for seasonal affective disorder. Unpublished manuscript.

den Boer, P. C. A. M., Wiersma, D., & van den Bosch, R. J. (2004). Why is self-help neglected in the treatment of emotional disorders? A meta-analysis. *Psychological Medicine, 34*, 959–971.

Borkovec, T. D. (1994). The nature, origins, and functions of worry. In G. C. L. Davey, & F. Tallis (Eds.), *Worrying: Perspectives on theory, assessments, and treatment*. New York: Wiley.

Borkovec, T. D., & Hu, S. (1990). The effect of worry on cardiovascular response to phobic imagery. *Behaviour Research and Therapy, 28*, 69–73.

Borkovec, T. D., Wilkinson, L., Folensbee, R., & Lerman, C. (1983). Stimulus-control applications to the treatment of worry. *Behaviour Research and Therapy, 21*, 247–251.

Bowman, D., Scogin, F., Floyd, M., Patton, E., & Gist, L. (1997). Efficacy of self-examination therapy in the treatment of generalized anxiety disorder. *Journal of Counseling Psychology, 44*, 267–273.

Butler, G., Wells, A., & Dewick, H. (1995). Differential effects of worry and imagery after exposure to a stressful stimulus. *Behavioural and Cognitive Psychotherapy, 23*, 45–56.

Brown, T. A., O'Leary, T. A., & Barlow, D. H. (2001). Generalized anxiety disorder. In D. Barlow (Ed.), *Clinical handbook of psychological disorders* (3rd ed.). (pp. 154–208) New York, NY: Guilford.

Carlbring, P., Nilsson-Ihrfelt, E., Waara, J., Kollenstam, C., Buhrman, M., Kaldo, V., et al. (2005). Treatment of panic disorder: live therapy vs. self-help via the internet. *Behaviour Research and Therapy, 43*, 1321–1333.

Carlbring, P., Westling, B. E., Ljungstrand, L. E., & Andersson, G. (2001). Treatment of panic disorder via the internet: a randomized trial of a self-help program. *Behavior Therapy, 32*, 751–764.

Cohen, S., Kamarck, T., & Mermelstein, R. (1983). A global measure of perceived stress. *Journal of Health & Social Behavior, 24*, 385–396.

Devilly, G. J., & Borkovec, T. D. (2000). Psychometric properties of the expectancy/credibility questionnaire. *Journal of Behavior Therapy and Experimental Psychiatry, 31*, 73–86.

Dugas, M. J., Freeston, M. H., Ladouceur, R., Leger, E., Langlois, Provencher, et al.. (2003). Group cognitive-behavioral therapy for generalized anxiety disorder: treatment outcome and long-term follow-up. *Journal of Consulting and Clinical Psychology, 71*, 821–825.

Febbraro, G. A. R., Clum, G. A., Roodman, A. A., & Wright, J. H. (1999). The limits of bibliotherapy: a study of the differential effectiveness of self-administered interventions in individuals with panic attacks. *Behavior Therapy, 30*, 209–222.

Frattaroli, J. (2006). Experimental disclosure and its moderators. *Psychological Bulletin, 132*, 823–865.

Goldman, N., Dugas, M. J., Sexton, K. A., & Gervais, N. G. (2007). The impact of written exposure on worry. *Behavior Modification, 31*, 512–538.

Gould, R. A., & Clum, G. A. (1993). A meta-analysis of self-help treatment approaches. *Clinical Psychology Review, 13*, 169–186.

Hazlett-Stevens, H., & Craske, M. G. (2003). The catastrophizing worry process in generalized anxiety disorder: a preliminary investigation of an analog population. *Behavioural and Cognitive Psychotherapy, 31*, 387–401.

Hirai, M., & Clum, G. A. (2006). A meta-analytic study of self-help interventions for anxiety problems. *Behavior Therapy, 37*, 99–111.

Horowitz, J. D., & Telch, M. J. (2008). Laboratory induced dissociation and pain tolerance in an undergraduate population. *Journal of Traumatic Stress*.

Houghton, V. (2008). A quantitative study of the effectiveness of mindfulness-based stress reduction treatment, using an Internet-delivered self-help program, for women with generalized anxiety disorder. Unpublished dissertation.

Jacobsen, N. S., & Truax, P. (1991). Clinical significance: a statistical approach to defining meaningful change in psychotherapy research. *Journal of Consulting and Clinical Psychology, 59*, 12–19.

Jannoun, L., Oppenheimer, C., & Gelder, M. (1982). A self-help treatment program for anxiety state patients. *Behavior Therapy, 13*, 103–111.

Kennedy, B. L., & Schwab, J. J. (1997). Utilization of medical specialists by anxiety disorder patients. *Psychosomatics, 38*, 109–112.

Kessler, R. C., DuPont, R. L., Burglund, P., & Wittchen, H.-U. (1999). Impairment in pure and comorbid generalized anxiety disorder and major depression at 12 months in two major surveys. *American Journal of Psychiatry, 156*, 1915–1923.

Ladouceur, R., Dugas, M. J., Freeston, M. H., Leger, E., Gagnon, & Thibodeau. (2000). Efficacy of a cognitive-behavioral treatment for generalized anxiety disorder: evaluation in a controlled clinical trial. *Journal of Consulting & Clinical Psychology, 68*, 957–964.

Leonard, K. N., Telch, M. J., & Harrington, P. J. (1999). Dissociation in the laboratory: a comparison of strategies. *Behaviour Research and Therapy, 37*, 49–61.

Lucock, M., Padgett, K., Noble, R., Westley, A., Atha, C., Horsefield, C., et al. (2008). Controlled clinical trial of a self-help for anxiety intervention for patients waiting for psychological therapy. *Behavioural and Cognitive Psychotherapy, 36*, 541–551.

McDonald, A. S. (2001). The prevalence and effects of test anxiety in school children. *Educational Psychology, 21*, 89–101.

McWilliams, R. A., Goodwin, L. D., & Cox, B. J. (1997). Depression and anxiety associated with three pain conditions: results from a nationally representative sample. *Pain, 111*, 77–83.

Marrs, R. W. (1995). A meta-analysis of bibliotherapy studies. *American Journal of Community Psychology, 23*, 843–870.

Meyer, T. J., Miller, M. L., & Metzger, R. L. (1990). Development and validation of the Penn State worry questionnaire. *Behaviour Research & Therapy, 28*, 487–495.

Molina, S., & Borkovec, T. D. (1994). The Penn State Worry Questionnaire: psychometric properties and associated characteristics. In G. Davey, & S. Tallis (Eds.), *Worrying: Perspectives on theory, assessment & treatment* (pp. 265–283). Sussex, England: John Wiley & Sons.

Newman, M. G., Consoli, A. J., & Taylor, C. B. (1999). A palmtop computer program for the treatment of generalized anxiety disorder. *Behavior Modification, 23*, 597–619.

Orbach, G., Lindsay, S., & Gray, S. (2007). A randomized placebo-controlled trial of a self-help internet-based intervention for test anxiety. *Behavior Research and Therapy, 45*, 483–496.

Pennebaker, J. W. (1997). *Opening up*. New York: Guilford.

Pennebaker, J. W., & Beall. (1986). Confronting a traumatic event: toward an understanding of inhibition and disease. *Journal of Abnormal Psychology, 95*, 274–281.

Pennebaker, J. W., & Chung, C. K. (2007). Expressive writing, emotional upheavals, and health. In H. Friedman, & R. Silver (Eds.), *Handbook of health psychology*. New York: Oxford University.

Pennebaker, J. W., & Francis, M. (1996). Cognitive, emotional, and language processes in disclosure. *Cognition and Emotion, 10*, 601–626.

Peters, L., & Andrews, G. (1995). Procedural validity of the computerized version of the composite international diagnostic interview (CIDI-Auto) in the anxiety disorders. *Psychological Medicine, 25*, 1269–1280.

Powers, M. B., Smits, J. A., & Telch, M. J. (2004). Disentangling the effects of safety-behavior utilization and safety-behavior availability during exposure-based treatment: a placebo controlled trial. *Journal of Consulting and Clinical Psychology, 72*, 448–454.

Rapee, R. M., Abbot, M. J., Bailee, A. J., & Gaston, J. E. (2007). Treatment of social phobia through pure self-help and therapist-augmented self-help. *The British Journal of Psychiatry, 191*, 246–252.

Rocke, A. J. (1985). Hypothesis and experiment in the early development of Kekule's benzene theory. *Annals of Science, 42*(4), 355–381.

Rosen, G. M. (1987). Self-help treatment books and the commercialization of psychotherapy. *American Psychologist, 42*, 46–51.

Roy-Byrne, P. P., Craske, M. G., Stein, M. B., Sullivan, G., Bystrisky, A., Katon, W., et al. (2005). A randomized effectiveness trial of cognitive-behavioral therapy and medication for primary care panic disorder. *Archives of General Psychiatry, 62*, 290–298.

Rygh, J. L., & Sanderson, W. C. (2004). *Treating generalized anxiety disorder: Evidence-based strategies, tools, and techniques*. New York, NY, US: Guilford Press.

Sanderson, W. C., & Barlow, D. H. (1990). A description of patients diagnosed with DSM-III–R generalized anxiety disorder. *Journal of Nervous & Mental Disease, 178*, 588–591.

Shoenberger, D. (2008). Preliminary investigation of the effectiveness of a self-help intervention for chronic worry. Unpublished dissertation.

Smits, J. A., Powers, M. B., & Telch, M. J. (2006). The efficacy of videotaped feedback for enhancing the effects of exposure-based treatment for social anxiety disorder: a controlled trial. *Behaviour Research and Therapy, 44*, 1773–1785.

Smyth, J. M., Stone, A. A., Hurewitz, A., & Kaell, A. (1999). Effects of writing About stressful experiences on symptom reduction in patients with asthma or rheumatoid arthritis. *Journal of the American Medical Association, 281*, 1304–1309.

Swendsen, J. D., Merikangas, K. R., & Canino, G. J. (1998). The comorbidity of alcoholism with anxiety and depressive disorders in four geographic communities. *Comprehensive Psychiatry, 39*, 176–184.

Telch, M. J., Smits, J. A., Brown, M., & Beckner, V. (2002). Treatment of anxiety disorders: implications for medical cost offset. In N. A. Cummins, W. T. O'Donahue, & K. E. Ferguson (Eds.), *The impact of medical cost offset on practice and research: Making it work for you: A report of the first Reno conference on medical cost offset*. Reno: Context.

Tillfors, M., Carlbring, P., Furmark, T., Lewenhaupt, S., Spak, M., Eriksson, A., et al. (2009). Treating university students with social phobia and public speaking fears: internet delivered self-help with or without live group exposure sessions. *Depression and Anxiety, 25*, 708–715.

Wachelka, D., & Katz, R. C. (1999). Reducing test anxiety and improving academic self-esteem in high school and college students with learning disabilities. *Journal of Behavior Therapy and Experimental Psychiatry, 30*, 191–198.

White, J., Keenan, M., & Brooks, N. (1992). Stress control: a controlled comparative investigation of large group therapy for generalized anxiety disorder. *Behavioural Psychotherapy, 20*, 97–113.

Wittchen, H.-U. (2002). Generalized anxiety disorder: prevalence, burden, and cost to society. *Depression & Anxiety, 16*, 162–171.

Wittchen, H.-U., & Hoyer, J. (2001). Generalized anxiety disorder: nature and course. *Journal of Clinical Psychiatry, 62*, 15–19.

Wittchen, H., Carter, R. M., & Pfister, H. (2000). Disabilities and quality of life in pure and comorbid generalized anxiety disorder and major depression in a national survey. *International Clinical Psychopharmacology, 5*, 319–328.

Wolitzky, K. B. & Telch, M. J. (2005). Academic worry questionnaire.

Wolitzky, K. B., & Telch, M. J. (2009). Augmenting *in vivo* exposure with fear antagonistic action strategies: a preliminary test. *Behavior Therapy, 40*, 57–71.

World Health Organization, (1997). Composite International Diagnostic Interview (CIDI-Auto).

Yadusky-Holahan, M., & Holahan, W. (1983). The effect of academic stress upon the anxiety and depression levels of gifted high-school students. *Gifted Child Quarterly, 27*, 42–46.