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A randomized controlled trial of a self-guided, multimedia, stress management and resilience training program

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ABSTRACT

Background: Stress is a common and costly behavioral health issue. Technology-based behavioral health programs (e.g., computer or web-based programs) are effective for treating anxiety or depression. These programs increase availability of evidence-based interventions to individuals who are not able or willing to receive such in-person treatments. Stress management training has empirical support, but little data exists on its efficacy with stressed but healthy individuals, and there are no prior studies employing a self-guided, multimedia intervention. We conducted a randomized controlled trial of a self-guided, multimedia stress management and resilience training program (SMART-OP) with a stressed but healthy sample.
Methods: Participants ($N = 66$) were randomized to SMART-OP or an attention control (AC) group that received marketed videos and published material on stress management. Participants were evaluated on self-report measures and Trier Social Stress Test (TSST) performance. Analyses were based on study completers ($N = 59$).
Results: SMART-OP group reported significantly less stress, more perceived control over stress, and rated SMART-OP as significantly more useful than AC. During the TSST, the data suggests the SMART-OP group showed greater within-task α-amylase recovery at post-assessment.
Conclusions: SMART-OP is highly usable and is a more effective and useful stress management training program than an educational comparison.

Technology can significantly improve the delivery of evidence-based behavioral healthcare (e.g., cognitive-behavioral therapy; CBT). The use of computers, the Internet, tablets, or smartphones can provide secure and confidential treatment to individuals at a place and time of their choosing. These programs can also address barriers to care, such as the limited availability of clinicians trained in evidence-based interventions (Weissman et al., 2006) or patient reluctance to attend clinical settings due to stigma (Corrigan, 2004).

Efficacy of technology-based behavioral healthcare

A growing body of literature supports the efficacy of technology-based (i.e., computer/Internet) interventions for anxiety and depression (e.g., Andrews, Cuijpers, Craske, McEvoy, & Titov, 2010; Proudfoot et al., 2003). To date, studies have not targeted stressed but otherwise healthy populations. Typically, technology-based programs developed for and tested with clinical samples are as efficacious as face-to-face therapy or better than treatment as usual (Proudfoot et al., 2003; Titov, Sachdev, & Andrews, 2010), though dropout rates are high (35–45%; Van Den Berg, Shapiro, Bickerstaffe, & Cavanagh, 2004). In technology-based effectiveness trials, dropout rates are even worse, with fewer than 25% of participants completing treatment (Eysenbach, 2005).

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Stress and resilience

Stress has various definitions that converge upon the notion of "strain" (Webster's Online Dictionary, 2012) or "the nonspecific response of the body to any demand placed upon it" (Selye, 1956). Resilience is "the ability of individuals to adapt successfully in the face of acute stress, trauma, or chronic adversity, maintaining or rapidly regaining psychological well-being and physiological homeostasis" (Charney, 2004).

In the short-term, the body's response to stress can be helpful and adaptive (McEwen, 1998; Sapolsky, 2004). But, the allostatic load associated with repeated or long-term activation of the stress response (i.e., hypothalamic-pituitary adrenal axis; HPA axis) can damage the body over time (McEwen & Stellar, 1993; Seeman, Singer, Rowe, Horwitz, & McEwen, 1997), and the long-term effects of chronic stress are common and costly (e.g., Madhu, 2002). Chronic stress is associated with cardiac disease, lowered immune functioning, inflammation, impaired memory, and premature aging of genes (Kiecolt-Glaser, McGuire, Robles, & Glaser, 2002; McEwen, 2006; O'Donovan et al., 2012; Sapolsky, 2003). Also, stress contributes to the onset of many psychiatric disorders, such as anxiety and depression (e.g., Zuckerman, 1999). These effects highlight the importance of successfully managing stress or improving recovery from stress (i.e., resilience).

Stress management training (SMT), also referred to as Stress Inoculation Training, is an empirically supported intervention (Meichenbaum, 2007). SMT is comprised of CBT approaches (e.g., cognitive restructuring, relaxation techniques, and behavioral skills) and is commonly applied in clinical samples, such as medically ill (e.g., HIV patients; Brown & Vanable, 2008) or anxious populations (e.g., test/performance; Hussian & Lawrence, 1978). There is sparse data on the effects of SMT with "healthy" (i.e., non-medically ill and non-psychiatrically ill) but stressed samples. One study (Gaab et al., 2003) reported that group SMT improved perceived control over stress and attenuated cortisol responses in healthy individuals in comparison to a control group. Given the long-term deleterious effects of chronic stress on health and functioning, establishing the positive effects of SMT in healthy but stressed samples is essential.

In the present study, we report on the development and evaluation of a self-guided, multimedia, CBT-based stress management and resilience training program called SMART-OP (Stress Management and Resilience Training for Optimal Performance). SMART-OP is designed for individuals who work in stressful or challenging environments with a focus on building resilience and optimizing performance. While SMART-OP was developed for ultimate use by the National Aeronautics and Space Administration (NASA), this phase 1 randomized controlled trial (RCT) was conducted with stressed but otherwise healthy graduate students to assess its efficacy, usefulness, and usability. We compared SMART-OP to an attention control (AC) group that received videos and reading material on stress management.

We hypothesized that participants in the SMART-OP group would report lower levels of perceived stress and higher levels of perceived control over stress than the AC group from pre- to post-assessment and that SMART-OP participants would rate the activities in the program as more useful than the AC group. Also, we expected the SMART-OP group would show improvements in cardiovascular and autonomic reactivity and recovery from a psychologically stressful task, the Trier Social Stress Test (TSST), from pre- to post-assessment.

Methods

All study procedures were approved by the UCLA Office of Human Research Protection Program.

Participants

Participants were recruited through email, flyers, and in-person presentations from schools of management, law, and other graduate programs at UCLA, with the offer of \$315-340 remuneration. Graduate students with no psychiatric or chronic medical conditions who scored $\geq$16 out of 40 on the Perceived Stress Scale-10 (PSS-10; see Measures section) were eligible to participate. A score of 16 on the PSS-10 is half a standard deviation above a community mean (Cohen & Williamson, 1988).

Potential participants were screened by telephone, during which they completed the Mini International Neuropsychiatric Interview Version 5.0.0 (MINI; Sheehan et al., 1998) – a fully structured diagnostic interview that assesses for major Axis I disorders. The MINI was administered by research assistants, who were trained to established reliability criteria. Any participant who met diagnostic criteria for a DSM-IV-TR Axis I diagnosis was excluded from the study. Eligible and interested participants were then scheduled for their pre-assessment, conducted within three weeks of completing the eligibility screener.

Two hundred twenty-seven individuals inquired about the study, 66 were randomized to SMART-OP or AC, and 59 participants completed all stress management training sessions and pre- and post-assessments (see Fig. 1 for patient flow from eligibility screening to completion). Of the 66 randomized participants, 50% were male, mean age was 27.32 years (SD = 3.53), 44 were School of Management students, 15 School of Law students, two were in both schools, and five were in other UCLA graduate programs. The sample was diverse: 52% were Caucasian, 32% Asian or Asian American, 9% Hispanic or Latino, and 7% other (see Table 1).

Procedures

At pre-assessment, participants gave written informed consent and then completed self-report questionnaires (see Measures Section), followed by the TSST (e.g., Kirschbaum, Pirke, & Hellhammer, 1993), which was modified to include two tasks relevant to optimal performance in stressful situations. These were the Wechsler Adult Intelligence Scale (WAIS-IV) Block Design Subtest and the Wechsler Memory Scale (WMS-IV) Logical Memory I and II Subtests, which include Immediate Recall, Delayed Recall, and Delayed Recognition. Then, participants were randomized to either SMART-OP or AC, both of which included six weekly sessions. Afterward, the TSST and questionnaires were repeated at post-assessment.

Measures

Pre- and post-assessment self-report measures

Perceived Stress Scale-10 (PSS-10; Cohen & Williamson, 1988) The PSS-10 has 10 items that assess the degree to which experiences during the previous month are perceived as stressful. Cronbach's alpha is .85, and test–retest reliability is .55 (six-week interval; Cohen, Kamarck, & Mermelstein, 1983). The questionnaire was modified to ask about the prior two weeks.

Stress and Perception of Control Scale (SPOCS; unpublished instrument[1]): This scale was developed for this study to assess participants' perceptions of control and ability to cope with stress (e.g., I could handle various stressful situations). Cronbach's alpha for this sample is .71.

[1] The scale is available upon request from the first author.

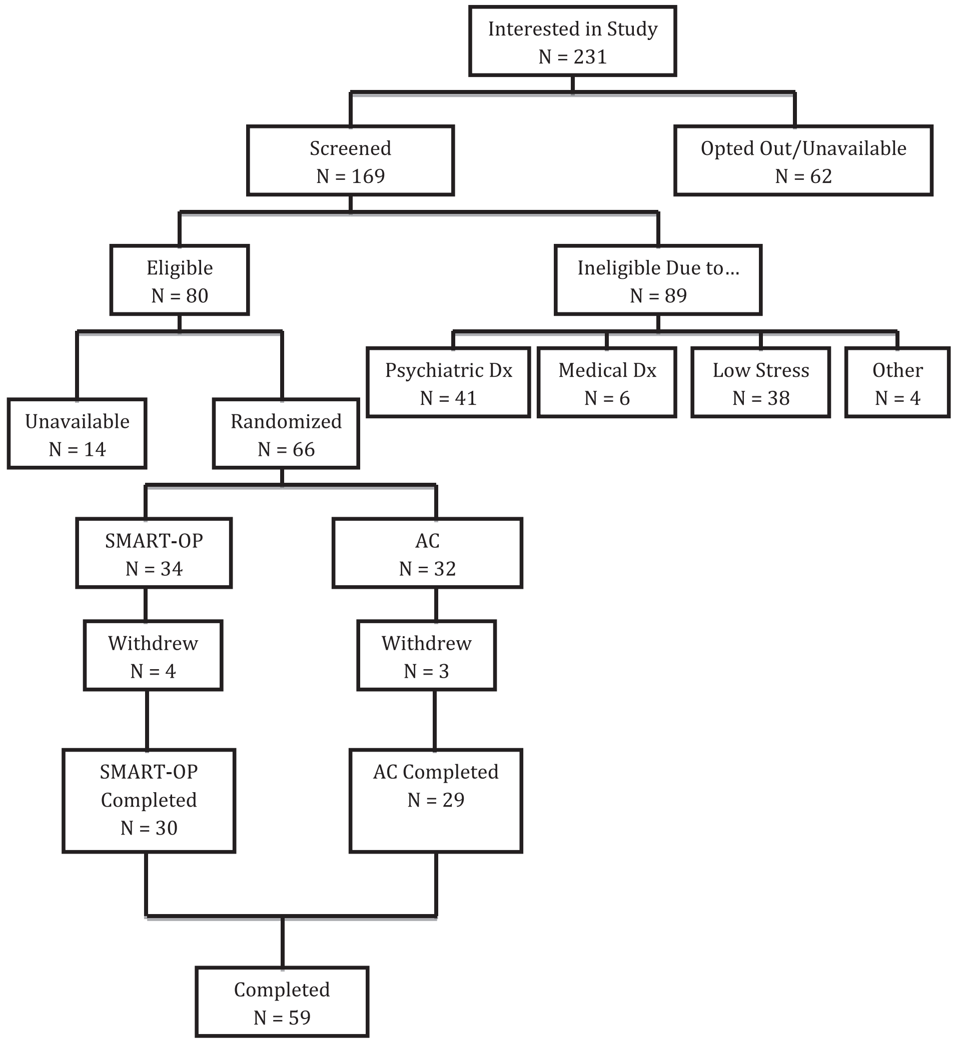


Fig. 1. Consort diagram.

Other self-report measures

Stress Management Training Surveys: These surveys were created for this study to assess the usefulness and user experience with SMART-OP and AC materials on a 1–7 scale (e.g., "Overall usefulness for learning stress management; 1 = Not At All Useful, 4 = Somewhat Useful, and 7 = Extremely Useful"). Participants were also asked to provide free-response feedback. The surveys were administered at the conclusion of session 6, and the number of items ranged from 8 (AC) to 24 (SMART-OP).

Table 1
Sample demographics.

Randomized participants (*N* = 66)	
Gender (%)	
Male	50
Female	50
Age (mean years)	27.3
Ethnicity (%)	
Caucasian	52
Asian	32
Hispanic	9
Other	7
Relationship status (%)	
Relationship/married	63
Single	27

System Usability Scale (SUS; Brooke, 1996): The SUS is an 11-item measure of satisfaction with a technological system (e.g., computer program) that was administered to SMART-OP participants only at the conclusion of Session 6. Scores range from 0 to 100. Cronbach's alpha is .91 (Bangor, Kortum, & Miller, 2008).

Trier Social Stress Test

At pre- and post-assessment, participants were asked to complete four tasks in front of a "critical" audience of two research assistants with instructions that their performance was being videotaped. The TSST is a reliably stressful task that raises heart rate (HR) and α-amylase levels, a stress biomarker (e.g., Kirschbaum et al., 1993; Van Stegeren, Wolf, & Kindt, 2008). Following a 5-min baseline, participants completed the WAIS-IV Block Design and WMS-IV Logical Memory I. After a 5-min interval, participants were given 5 min to prepare a speech on one of two topics, then 5 min to deliver the speech. Next, they completed a 5-min arithmetic task (counting out loud backwards by 13 s from 1022 with instructions to start over when an error was made) and the WMS-IV Logical Memory II. The speech topics were counterbalanced between pre-and post-assessment and stratified by gender and condition. Research assistants recorded participants' performance on the tasks.

Research assistants were trained to create a stressful environment by withholding positive remarks or gestures (e.g., not saying "good job," no smiling). They gave standardized comments during the speech and arithmetic tasks (e.g., "You are spending too much time on this aspect; please move on to another point," "Please elaborate"). During the WAIS-IV and WMS-IV, the research assistants administered the tasks according to standard administration protocol and recorded participant performance. Throughout the TSST, a third research assistant in the room took saliva samples for α-amylase and recorded psychophysiological measures.

Saliva was collected using Salivette (Sarstedt, Rommelsdorf, Germany) collection devices and stored at −20 °C within 2 h of acquisition. The α-amylase assay is based on an enzymatic action of α-amylase (Lorentz, Gütschow, & Renner, 1999) that is positively correlated with stress and reliably increases during the TSST (e.g., Nater et al., 2005). The intra-assay coefficient of variation was between 2.78% and 6.25%, and the corresponding inter-assay coefficients of variation were between 5.54% and 7.60%. The sensitivity of the assay was 2.34 U/ml.

Psychophysiological measures included HR, heart rate variability (HRV), skin conductance level (SCL), systolic blood pressure (SBP), and diastolic blood pressure (DBP). HRV yielded estimates of parasympathetic activity (high frequency spectral power (HF-HRV) and root mean square of successive differences (RMSSD)), as well as sympathovagal balance (ratio of low frequency to high frequency spectral power (LF/HF-HRV)). HR and HRV were derived from electrocardiography (ECG) with a modified lead II electrode configuration with two electrodes (Cacioppo et al., 1995). SCL was used as an estimate of sympathetic activity assessed from two electrodes attached to the index and middle fingers of the participant's non-dominant hand. ECG and SCL were recorded using Biopac MP150 system (Biopac Systems, CA). Biopac Acqknowledge software was used to detect R waves from the ECG recorded at 1000 Hz and to generate time-series output of interbeat intervals that was subsequently analyzed using spectral analytic software (Kubios 2.0). This program produced estimates of high frequency (measured from .15 to .4 Hz) and low frequency (.04–.15 Hz) spectral power. SBP and DBP were measured with a Dinamap DCP 220X. The blood pressure cuff was attached to participants' non-dominant arm, and readings were taken at specific intervals during the TSST.

TSST: additional tasks

Block Design Subtest from WAIS-IV (Wechsler, 2008): Block Design assesses visuospatial and motor skills and was administered during the TSST. Test–retest reliability is .84 and Cronbach's alpha is .90 with a normative sample ages 25–29 (Wechsler, 2008).

Logical Memory I and II Subtests from WMS-IV (Wechsler, 2009): Logical Memory I (Immediate Recall) and II (Delayed Recall and Delayed Recognition) assess auditory memory and were administered during the TSST. Test–retest reliabilities are .74 and .71, respectively, and Cronbach's alphas are .87 and .90, respectively, with a normative sample ages 25–29 (Wechsler, 2009).

Conditions

Participants were randomized to SMART-OP or AC. Each condition included six training sessions ranging from 30 to 50 min (AC participants were time-matched with SMART-OP participants by session). All sessions were conducted individually using a Windows-based desktop computer with a 21″ screen, external speakers, and an attached printer. Research assistants were available for set up and troubleshooting. At the conclusion of session 6, participants in both conditions completed a survey about their stress management training program (see Measures).

SMART-OP

SMART-OP involved self-guided, multimedia stress management and resilience training over six weekly sessions. SMART-OP contains animations, game-like activities that create a personalized user experience, and interactive didactic video presentations from the stress management coach (i.e., the first author of this manuscript) and subject matter experts to create a virtual stress management and resilience training experience. Users receive weekly between-session practice assignments (homework). Homework adherence is monitored weekly via self-report questions in the program; tailored video feedback on progress is provided, along with motivational encouragement.

Each session begins with a "stress briefing" covering educational aspects of stress management, such as the importance of maintaining healthy habits (e.g., regular sleep and exercise). Each session contains at least one activity from each of the following domains: feelings, thoughts, and actions. Feelings activities (i.e., Biofeedback Challenge, Guided Muscle Relaxation, Focused Breathing) address emotion/physiological regulation skills. Focused Breathing is diaphragmatic breathing, Guided Muscle Relaxation is a traditional progressive muscle relaxation activity, and the Biofeedback Challenge is a video racecar game developed by a third party company (SomaticVision, Inc., 2009) where users breathe smoothly and evenly to accelerate their racecar.

Thoughts activities (i.e., Compartmentalization, Weighing Evidence) teach the user cognitive flexibility and a structured approach to realistic/logical thinking with personally relevant stressful content. In Compartmentalization, the user imagines a stressful scenario, then shifts their attention to perform a task quickly and accurately without being distracted by their stressful image. Weighing Evidence is a cognitive restructuring activity (e.g., hypothesis testing, assigning realistic odds).

Action activities (i.e., Effective Communication, Strategic Problem Solving, Resilience Thru Writing) teach the user to take effective actions to manage stress in their lives. Effective Communication teaches assertive communication strategies through an interactive video scenario where the user chooses responses for a couple who is at the precipice of an argument. Strategic Problem Solving is a self-guided version of problem solving therapy, and Resilience Thru Writing is a journaling activity.

Users are strongly encouraged to practice and apply the skills they learn in session. All SMART-OP participants received printouts of session materials, which served as their personalized workbook, and received a flashdrive with a practice version of the program called "Practice SMART-OP." It includes homework exercises, worksheets, activities from the program, the SMART-OP manual, interviews with the members of the research team, and links to articles and resources on stress. Weekly emails and phone calls from research staff reminded participants to practice their skills and about their upcoming session appointments.

Attention control

The AC group attended six weekly sessions where they watched excerpts from commercially available videos and read published material on stress and stress management. The following videos were selected: *Stress: Portrait of a Killer* (2008), *Recharge! Managing Stress and Avoiding Burnout* (2008), *Stress Management with Richard Mulvey* (2009), *Stress & Relaxation Explained: An Introduction to Stress Management and Relaxation Techniques* (2007), and *Stress Management in Difficult Times* (2008). Reading material was taken from *Mastering Stress 2001: A Lifestyle Approach* (Barlow, Rapee, &

Reisner, 2001). The AC group content was a more passive learning experience compared to SMART-OP's personalized, interactive design and did not involve specific between-session practice exercises. Participants received weekly email and phone reminders for upcoming sessions.

Data analysis

We conducted 2 (*Condition*: SMART-OP, AC) × 2 (*Time*: pre, post) repeated measures ANOVAs for perceived stress (PSS-10); perceived control of stress (SPOCS); and reactivity and recovery for α-amylase, HR, HF-HRV, LF/HF-HRV, RMSSD, SCL, SBP, and DBP during the TSST. Raw HRV values were not normally distributed and were log transformed. For SCL, SBP, DBP, HR, HRV, and α-amylase, *reactivity* was defined as the TSST speech task minus baseline. *Recovery* for HR, SCL, and HRV was defined as the first 5 min after the TSST minus the speech task. SBP and DBP *recovery* were defined as the first 7 min after the TSST minus the speech task. *Recovery* for α-amylase was defined as the end of TSST minus start of TSST (speech task). We chose the speech task as the analysis time point because it was consistently the highest point of sympathetic arousal in the TSST. Analyses were based on study completers ($N = 59$).

Results

Baseline data

There were no significant baseline group differences on any measure.

Pre- and post-assessment self-report measures

PSS-10: The Condition × Time interaction was significant (F (1, 57) = 8.04, $p < .01$; $\eta^2 = .14$). Simple main effects analyses showed significant effects for Time within SMART-OP (F (1, 57) = 46.83, $p < .01$) and within AC (F (1, 57) = 7.57, $p < .01$). Also, while the groups did not differ significantly at pre-assessment (F (1, 57) = .45, $p = .51$), SMART-OP was lower than AC at post-assessment (F (1, 57) = 4.59, $p < .04$) (see Table 2).

SPOCS: The Condition × Time interaction was significant (F (1, 57) = 6.20, $p < .02$; $\eta^2 = .07$). Simple main effects analyses showed significant effects for Time within SMART-OP (F (1, 57) = 32.72, $p < .01$) and within AC (F (1, 57) = 4.54, $p < .05$). The groups did not differ at pre-assessment (F (1, 57) = 1.24, $p = .27$) nor at post-assessment (F (1, 57) = 2.24, $p = .14$) (see Table 2).

Other self-report measures

Usefulness: SMART-OP was rated as significantly more useful ($M = 5.73$, SD = .98) than AC ($M = 4.14$, SD = 1.57): ($t = 4.69$, $p < .01$; Cohen's $d = 1.42$.).

SUS: SMART-OP was rated as highly usable (M = 89.5, SD = 7.78).

Table 2
Self-report questionnaire means.

	SMART-OP ($N = 30$)		AC ($N = 29$)	
	Pre	Post	Pre	Post
SPOCS[a]	27.37 (5.19)	33.10 (4.33)	28.86 (5.10)	31.03 (6.14)
PSS[b]	17.67 (5.00)	11.93 (3.85)	16.83 (4.60)	14.48 (5.21)

Note. Standard deviations are shown in parentheses. Results based on study completers.
[a] $p < .05$.
[b] $p < .01$.

TSST

The analysis of α-amylase reactivity did not yield a significant Condition × Time interaction (F (1, 42) = .53, $p = .47$) nor a main effect of Time (F (1, 42) = .01, $p = .93$). The analysis of recovery yielded a significant two-way Condition × Time interaction (F (1, 43) = 6.42, $p < .02$) (see Fig. 2). Simple main effects analyses showed significant effects for Time within SMART-OP (F (1, 43) = 12.15, $p < .01$) but not within AC (F (1, 43) = .02, $p = .89$). Also, while AC had a stronger recovery at pre-assessment (F (1, 43) = 4.66, $p = .04$), there were no group differences at post-assessment (F (1, 43) = .69, $p = .41$).

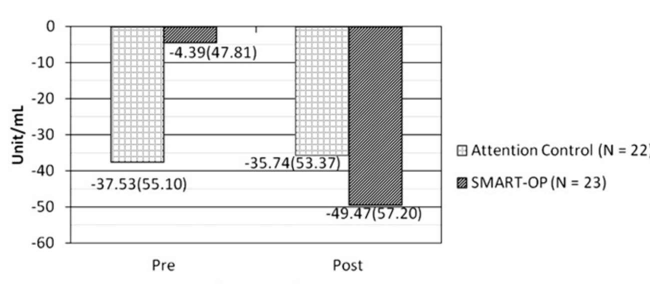
For psychophysiological reactivity, there was a significant Condition × Time interaction for SBP reactivity (F (1, 55) = 4.36, $p = .04$) with the AC group showing significantly less SBP reactivity from pre- to post-assessment compared to the SMART-OP group. Simple main effects analyses showed no significant effects for Time within SMART-OP (F (1, 55) = .57, $p < .46$) but a significant effect of Time within AC (F (1, 55) = 13.43, $p < .01$). The groups did not differ at pre-assessment (F (1, 55) = 0.16, $p = .70$) nor at post-assessment (F (1, 55) = 1.35, $p = .25$). There was also a main effect for HR of Time (F (1, 54) = 17.07, $p < .01$) such that HR reactivity decreased for both conditions. There were no other statistically significant interactions or main effects for reactivity of SBP, DBP, HRV or SCL.

For psychophysiological recovery, there was a main effect of Time (F (1, 57) = 4.58, $p < .04$) for SCL with both conditions showing larger recovery at post-assessment than at pre-assessment. There were no other significant effects for recovery with SBP, DBP, HRV, or SCL (see Table 3).

WAIS-IV Block Design and WMS-IV Logical Memory I and II: There were no significant Condition × Time interactions for WAIS-IV or WMS-IV performance (see Table 4). There were main effects of Time for WAIS-IV Block Design (F (1, 57) = 62.99, $p < .01$), WMS-IV Immediate Recall (F (1, 57) = 41.09, $p < .01$), WMS-IV Delayed Recall (F (1, 57) = 79.72, $p < .01$), and WMS-IV Delayed Recognition (F (1, 57) = 16.99, $p < .01$) with both conditions improving from pre- to post-assessment.

Discussion

Stress management training is empirically supported in clinical populations (e.g., Meichenbaum, 2007), yet stress is a common and costly behavioral health problem (Madhu, 2002). While there is growing empirical support for computer-based interventions for anxiety and depression (Proudfoot et al., 2003), to our knowledge, there are no studies examining the efficacy of computer-based stress management training in stressed but otherwise healthy populations. We report the results of an RCT of a brief, self-guided, multimedia stress management and resilience training program



Condition x Time (F (1, 43) = 6.42, $p < .02$)
Note. Standard deviations are shown in parentheses. Results based on study completers and usable A-Amylase samples

Fig. 2. A-amylase recovery during TSST.

Table 3
TSST psychophysiological change scores for reactivity during TSST and recovery from TSST.

	SMART-OP ($N = 30$)				AC ($N = 29$)			
	Reactivity		Recovery		Reactivity		Recovery	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post
HR	15.12 (10.93)	12.64 (9.85)	−13.14 (10.04)	−12.44 (8.88)	20.36 (11.57)	14.76 (13.46)	−16.36 (9.37)	−14.00 (11.60)
HF-HRV	−850 (1810)	−739 (1660)	553 (958)	581 (1042)	−691 (1370)	−408 (1102)	243 (587)	199 (594)
RMSSD	−15.27 (24.69)	−11.97 (31.97)	11.58 (23)	9.98 (23.91)	−13.78 (24.64)	−8.88 (22.70)	8.92 (17.73)	10.28 (17.26)
LF/HF-HRV	.24 (3.36)	−.67 (3.65)	.06 (2.24)	.03 (2.25)	1.62 (2.43)	1.09 (2.53)	−.25 (1.93)	.56 (3.03)
SCL	5.45 (3.31)	5.83 (3.09)	−.89 (1.35)	−1.49 (1.25)	6.48 (4.81)	6.04 (3.32)	−.83 (1.55)	−1.01 (1.31)
SBP[a]	28.91 (11.94)	27.43 (15.88)	−20.59 (11.44)	−21.26 (14.92)	30.29 (14.30)	22.93 (11.15)	−23.96 (10.39)	−20.46 (8.76)
DBP	21.69 (8.70)	19.29 (8.23)	−15.18 (8.16)	−14.28 (9.10)	18.21 (9.52)	17.75 (8.07)	−15.36 (7.88)	−14.41 (7.24)

Note. This table presents raw change score HRV values, though analyses were conducted using a log 10 function. Standard deviations are shown in parentheses. Results based on study completers.
[a] $p < .05$ for reactivity.

compared to an AC group with a sample of stressed but otherwise healthy graduate students at UCLA.

On measures of self-report, participants in the SMART-OP group reported significantly greater reductions in perceived stress and increases in control over stress as compared to the AC group from pre- to post-assessment, with medium to large effect sizes. The participants in this study were graduate students enrolled in demanding programs with very high performance expectations. Since we excluded individuals with medical or psychiatric conditions, these findings may have relevance to other similar populations who are healthy and work in challenging environments. Additional data on implementation with individuals who work in challenging environments (e.g., astronauts or military) is needed.

In comparison to other SMT training that takes nine to 11 h (Van Dixhoorn & White, 2005), SMART-OP is brief (i.e., six 30–45-min sessions). The results suggest that our brief program can significantly improve perceived stress and perceived control over stress in individuals who are functioning well already.

On usability SMART-OP scored an 89.5 which is between “Excellent” and “Best Imaginable” (Bangor, Kortum, & Miller, 2009; Brooke, 1996), and users found the activities in the program significantly more useful as compared to the AC group. There was a 12% (4 out of 34) attrition rate within SMART-OP. These findings indicate high user satisfaction with SMART-OP, which may address a reported problem with self-guided programs (i.e., high dropout rates; see Van Den Berg et al., 2004). If users find the program useful and easy to use, they may be more likely to stay engaged, complete the program, and benefit from it. Additional research with users who are not compensated for their time would be required to examine this hypothesis more carefully.

A-amylase levels indicate a pattern suggesting a greater recovery during the TSST for the SMART-OP group compared to the AC group from pre- to post-assessment. However, the results are difficult to interpret because there were significant differences between SMART-OP and AC at pre-assessment and no significant group differences at post-assessment. More data are needed to clarify this finding.

Table 4
WAIS-IV and WMS-IV means during TSST.

	SMART-OP ($N = 30$)		AC ($N = 29$)	
	Pre	Post	Pre	Post
WAIS-IV block design	54.00 (7.57)	57.47 (8.30)	51.55 (9.19)	56.90 (6.71)
WMS-IV immediate recall	29.43 (5.84)	33.93 (6.35)	28.55 (7.75)	33.48 (6.07)
WMS-IV delayed recall	26.80 (6.16)	32.10 (6.30)	25.69 (7.24)	31.79 (6.14)
WMS-IV delayed recognition	25.77 (2.85)	26.73 (1.96)	24.79 (2.53)	26.48 (2.08)

Note. Standard deviations are shown in parentheses. Results based on study completers.

The SMART-OP program did not lead to greater improvements in HRV, SCL, SBP or DBP relative to the AC group during the TSST. However, the AC group had less SBP reactivity from pre- to post-assessment as compared to the SMART-OP group, but the groups did not differ significantly at pre- or post-assessment. Given our healthy sample and brief intervention, psychophysiological measures were probably mitigated by floor effects. Furthermore, psychophysiology was not assessed over 24-h sampling, which may have been a more sensitive index of intervention effects than response to the TSST. Finally, we are not aware of any pre/post intervention studies that utilize the TSST, so it may be that habituation to the study procedures took place, as the data suggests both groups improved at post-assessment.

Since SMART-OP was developed for NASA, it may have particular relevance to those working in operational environments (e.g., military, spaceflight, emergency first responders). These individuals often face challenging and potentially stressful situations that can decrease both well-being and performance. Military personnel report that the most stressful time is not necessarily while deployed but rather the period leading up to and after deployment (Maguen, Litz, Wang, & Cook, 2004; McNulty, 2005). Common sources of stress for military personnel include family issues, conflicts with colleagues, finances, and job concerns. In fact, suicide rates are highest for military personnel when at home as opposed to on deployment (Kapur, While, Blatchley, Bray, & Harrison, 2008; Thoresen, Mehlum, & Moller, 2003). A program like SMART-OP – with its confidential, autonomous focus on optimal performance for healthy individuals – may be very applicable for those who work in demanding environments.

Also, programs like SMART-OP may address barriers to behavioral healthcare delivery, such as stigma and availability of evidence-based treatment. SMART-OP is confidential, autonomous, and can be used in the privacy of one’s own office or home and at a time of one’s choosing. It also delivers evidence-based care without the need to train clinicians, which can address a major limitation in the dissemination and implementation of evidence-based care (i.e., lack of clinicians trained in such approaches).

There are some limitations to our study. Our sample size was adequate to measure usability, usefulness, and levels of perceived stress and control over stress, but a larger sample size would likely be needed to show changes in the psychophysiological measures. The measure of perceived control over stress (SPOCS) was developed by the researchers for this study and lacks full psychometric validation. Participants in the RCT were not blind to condition, so it possible that demand characteristics contributed to their self-report ratings. While our sample was screened to be healthy, it consisted of individuals at a competitive and selective university, which may limit generalizability to other healthy populations who may be less intelligent and not used to self-guided instruction. However, SMART-OP was designed to be practical and very easy to use, as indicated by the excellent SUS score. Future research should evaluate applications in community samples or other relevant populations. Long-term follow up data should also be collected to examine intervention effects over time.

Conclusions

To our knowledge, this is the first RCT to test a fully self-guided, multimedia stress management and resilience training program. SMART-OP significantly decreased perceived stress while increasing perceived control over stress. It was useful, acceptable, and easy to use. Data also suggests a faster recovery from a social stressor based on α-amylase levels. This approach could be an effective way to bring validated stress management techniques to individuals who would ordinarily not seek behavioral healthcare due to problems with stigma, cost, or access to care. Creating innovative ways to deliver evidence-based interventions for common behavioral health issues, such as stress, to a wide audience is a challenging but worthy endeavor.

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