PSYCHONEUROENDOCRINE EVALUATION OF AN ACCEPTANCE AND COMMITMENT BASED STRESS MANAGEMENT TRAINING

Andrew T. Gloster[1], Jens Klotsche[2], Tatiana Aggeler[3], Noemi Geisser[3], Gregory Juillerat[3], Nicole Schmidlin[3], Sophie Müller-Siemens[3], Jens Gaab[3]

[1]Division of Clinical Psychology and Intervention Science
Department of Psychology
University of Basel

[2]German Rheumatism Research Center Berlin, Germany
Institute for Social Medicine, Epidemiology and Health Economics, Charitè Universitaetsmedizin Berlin

[3]Division of Clinical Psychology and Psychotherapy

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Corresponding Author:
Andrew T. Gloster
University of Basel
Division of Clinical Psychology and Intervention Science
Department of Psychology
Missionsstrasse 60-62
CH-4055 Basel
Email: andrew.gloster@unibas.ch

ABSTRACT

Background and Objectives: Acceptance and Commitment Therapy (ACT), a behavioral therapy that targets psychological flexibility, has been shown to be efficacious across a wide range of problems, including chronic work-related stress and perceived stress. ACT's effect on the multiple levels of the acute stress response (i.e., subjective and biological) is less well understood. The aim of the current study was to test whether ACT, by working toward psychological flexibility, would reduce both the endocrine and subjective evaluations of participants' acute stress response.

Methods: Participants (n = 35) were randomized to an ACT condition or waitlist (WL). Participants in the ACT condition received a two-day ACT workshop on how to flexibly deal with stress. All participants completed a standardized laboratory stress test.

Results: The ACT and WL groups did not differ on main comparisons of the endocrine response (i.e., cortisol) or subjective evaluation. Baseline levels of psychological flexibility moderated some outcomes. Avoidant participants had a stronger endocrine stress reaction if they received the ACT intervention.

Limitations: The control condition was a WL and not an active intervention comparison.

Conclusions: ACT is not useful in reducing the acute stress response and may even be iatrogenic, at least during tasks with little real-world impact for their personal values.

Keywords: stress; acceptance and commitment therapy; psychophysiology; cortisol; TSST

PSYCHONEUROENDOCRINE EVALUATION OF AN ACCEPTANCE AND COMMITMENT BASED STRESS MANAGEMENT TRAINING

Acceptance and Commitment Therapy (ACT) is a behavioral therapy that aims to promote psychological flexibility. Psychological flexibility (PF) refers to a range of inter- and intra-personal skills that can be defined as the ability to "recognize and adapt to various situational demands; shift mindsets or behavioral repertoires when these strategies compromise personal or social functioning; maintain balance among important life domains; and be aware, open, and committed to behaviors that are congruent with deeply held values[1]" (Kashdan & Rottenberg, 2010). ACT-based interventions have been tested in over 100 randomized controlled trials and demonstrated efficacy across a breadth of mental disorders ranging from anxiety and depression to psychotic disorders and behavioral health issues (Hayes, Luoma, Bond, Masuda, & Lillis, 2006; Ruiz, 2012). Evidence suggests that ACT-based interventions are also useful in areas not traditionally associated with cognitive behavioral interventions, including such varied things as reducing the frequency of epileptic seizures (Lundgren, Dahl, Melin, & Kies, 2006), decreasing rehospitalization following in schizophrenia (Bach & Hayes, 2002), and improving outcomes in treatment-resistant patients (Clarke, 2014; Gloster, Sonntag, et al., 2015).

Built upon a basic behavioral account of cognition and verbal relations (Dymond & Roche, 2013; Hayes, Barnes-Holmes, & Roche, 2001), ACT techniques utilize an experiential approach to alter the context in which a person operates (Hayes, Strosahl, & Wilson, 2012). For example, an ACT approach might try to increase PF by helping someone to be open to and nonjudgmentally notice stressors and to hold

[1] Values are freely chosen, verbally constructed consequences of ongoing, dynamic, evolving patterns of activity, which establish predominant reinforcers for that activity that are intrinsic in engagement in the valued behavioral pattern itself (Wilson, 2009).

stress-related evaluations lightly, while simultaneously taking steps towards what is genuinely important to them. By altering one's relationship with the stressor via the processes that comprise PF, the subjective meaning and impact of the stressor changes from something that must be eliminated to something that is now longer a barrier, even if the stressor remains uncomfortable. PF can thus be viewed as the opposite of experiential avoidance.

Meditational and laboratory studies suggest that PF is an active and salient process involved in changes of functioning and symptoms (Gloster et al., 2014; Levin, Hildebrandt, Lillis, & Hayes, 2012). Among these, several studies have examined the impact of ACT on stress-related outcomes, including experimental stressors (Levin, Hildebrandt, et al., 2012) and more chronic workplace stress (Bond, Flaxman, & Bunce, 2008). Further, PF was found to consistently moderate the relationship between daily stress and outcomes of physical disability, psychological health, and well-being in the general population ((Gloster, Meyer, Witthauer, Lieb, & Mata, 2017)) as well as mediating therapeutic change in both ACT (Hayes et al., 2006) and traditional CBT (Gloster et al., 2014).

Given these effects, it stands to reason that an ACT intervention could help individuals cope with acute stress. An established approach used to examine the acute stress response involves exposing participants to highly standardized stressors in the laboratory and then measuring both subjective and biological reactions (i.e., salivary cortisol). Salivary free cortisol assesses the unbound, i.e. biological active fraction of cortisol and is considered a valid marker of the endocrine response to stress (Kirschbaum & Hellhammer, 1994). To date, two studies have examined the impact of a values intervention (one aspect of the ACT model) on participants' biological stress response. Employing a writing intervention (i.e. writing about one's most

important personal versus about a less-important value), (Creswell et al., 2005) reported significantly reduced cortisol responses to a standardized stressor, with no effects on subjective stress responses. In a second study, participants were randomly assigned to either a brief values clarification intervention or to a control group that answered trivia questions before entering a standardized stress test (Gregg, Namekata, Louie, & Chancellor-Freeland, 2014). The values clarification group had a significantly lower cortisol response to the standardized stress test than the control group. We are unaware of any study that administered all aspects of the ACT model in the form of PF training (as opposed to isolating only values) in order to test the effect on the subjective and biological stress response in a standardized situation.

Considering other psychotherapeutic approaches, a number of randomized-controlled trials have found cognitive-behavioral as well as resource-orientated stress management trainings to effectively reduce cortisol stress responses in participants two weeks to four months after the intervention (Gaab et al., 2003; Hammerfald et al., 2006; Storch, Gaab, Kuttel, Stussi, & Fend, 2007). Furthermore, cognitive-behavioral stress management training prevented the presumable chronic stress-induced hyporesponsiveness of cortisol in students undergoing an important academic exam (Gaab, Sonderegger, Scherrer, & Ehlert, 2006).

The aim of this study was to test whether the promising collection of processes within ACT (i.e., acceptance, mindfulness, values, etc.) is effective in attenuating the acute stress response at the subjective and biological levels. The study examined a brief group-administered ACT intervention on a biological marker of the stress response (i.e., cortisol) in response to a well-established standardized stress situation that has been tested with other therapeutic interventions.

METHOD

Subjects and Design

Potential participants were recruited at the University of Basel, Switzerland and interested subjects were interviewed by telephone to assure eligibility. Participants received study information and informed consent by email. Inclusion criteria consisted of being between 18 – 40 years of age and availability to participate in all aspects of the study. Exclusion criteria consisted of any acute or chronic somatic disease or psychiatric disorder, habitual smoking, i.e. over 5 cigarettes per day, pregnancy, current medical treatment (except for hormonal contraceptives), current psychological or psychiatric treatment, insufficient German language skills to understand the instructions, previous participation in studies using the Trier Social Stress Test (TSST), and daily consumption of more than three alcoholic standard beverages per day (i.e., either 3dl beer, 1dl wine, or 2cl spirits). Of the 133 interested participants, 5 were excluded due to ineligibility and 84 did not complete the informed consent procedure. 44 people completed the informed consent and these participants were randomly assigned to either the ACT group (ACT) or control group (CG). After randomization, a total of 9 participants dropped out for various reasons so that 35 completed the study (ACT: n=16, CG: n=19) (see Figure 1). The inequality of the groups resulted from 3 participants withdrawing the day prior to the workshop (due to lack of time and illness). The final sample consisted of n = 25 females (71.4%) with a mean age of 22.3 years.

Procedure

This study was a randomized experimental design with two groups (ACT intervention and control group) who completed clinical assessments at baseline (T1), post-intervention (T2), and four weeks following the standardized Trier social stress test (T3). These three assessment time points occurred on average over 36 days.

Additional experimental assessments were conducted during the stress test itself. The protocol and consent procedure was approved by the institutional review board of the Faculty of Psychology of the University of Basel.

Psychosocial Stress Test. The Trier Social Stress Test (TSST) is a standardized psychosocial stress test that induces profound endocrine and cardiovascular responses in 70–80% of subjects tested (Kirschbaum, Pirke, & Hellhammer, 1993). After a basal sample of salivary free cortisol and the completion of a subjective measure of state anxiety (STAI X-1; (Laux, Glanzmann, Schaffner, & Spielberger, 1981)), subjects were introduced to the TSST (2 minutes). They were told that they would have to speak freely for 5 minutes in order to make an excellent impression in a fictitious job interview. After these instructions, the subjects were led to a different room, where they were given ten minutes to prepare the job interview and to complete a questionnaire designed to assess cognitive appraisal processes (PASA; (Gaab, Rohleder, Nater, & Ehlert, 2005)) regarding the anticipated stress situation as well as the second STAI X-1. After a second sample of saliva had been collected, participants were led back into the TSST room, where they took part in the simulated job interview (5 minutes). This was followed by a mental arithmetic task (5 minutes) in front of an audience of two people (one male and one female master student). Immediately after the TSST, a third saliva sample was taken, with further samples taken at 10, 20, 30, 45, and 60 minutes after the TSST to assess salivary free cortisol. Besides reporting absolute levels of salivary fee cortisol, we also calculated the two different variants of the area under the response curves as single estimate of the endocrine response ((Preussner, Kirschbaum, Meinlschmid, & Hellhammer, 2003), see also below). Furthermore, the STAI X-1 was assessed directly after the TSST and with the last saliva sample 60 minutes post-TSST. The TSST was

performed from 1400h to 1800h to control for variations of cortisol levels over the circadian rhythm.

Acceptance and Commitment Therapy (ACT) stress management intervention. All participants in the ACT group received a group-based ACT stress management intervention based on a manual developed for employees (Flaxman, Bond, & Livheim, 2013) The intervention was twelve hours in total, administered in two six-hour trainings conducted seven days apart. In order to allow for smaller groups, the intervention was administered in subgroups (n=10 and n=6). A clinical psychologist (ATG), led the intervention that covered brief education about daily stressful situations and addressed each participant's struggle with stress using characteristic ACT components. The ACT intervention covered the following concepts:

- Increasing acceptance and willingness, thus being open to unpleasant experiences without unnecessary struggle, being willing to have these experiences if they help to move towards personal values.
- Defining individual personal values via values clarification exercises and value-based actions, thus articulating mean life directions in different domains, e.g. family, spirituality, and articulating what steps would bring the person closer to them
- Encouraging cognitive defusion, thus distancing oneself from the literal content of thoughts by distinguishing the process of thinking from the products of thinking, e.g. instead of thinking "I am no good", telling oneself "I am having the thought that I am no good"
- Fostering present moment awareness, thus developing the skill of nonjudgmentally noticing qualities of experience as they occur in the here and

now and, when useful, the ability to return to this perspective after being pulled into the past or future viewing experiences from the "self-as-context" perspective

- Developing the skill of perspective taking, thus, when useful, viewing experience from the stable locus of "I", "here", "now"

Each concept was explained and experientially practiced using metaphors, individual and group exercises, such as:

- Learning to focus on and accept body experience using mindfulness exercises that concentrate on breath and sensations in different body parts
- Using the picture of a bus, where the participant is the driver and all the passengers represent memories, thoughts, and emotions to practice acceptance
- Creating a life compass including values and goals for different domains, as well as perceived barriers
- Identifying the observer self in a mindfulness exercise that facilitates perspective taking
- Creating the inscription for one's own gravestone by answering the question "What should my life represent"

Participants received a manual containing the covered information and were encouraged to practice the skills at home. Homework was given to facilitate this practice. Participants of the ACT group received the intervention 2 weeks before the TSST.

Measures

TSST Assessments. The following psychometric and endocrine parameters were used to assess the psychobiological stress responses during the stress test as indicated above.

The Primary Appraisal Secondary Appraisal Scale. The PASA (Gaab et al., 2005) specifically assesses cognitive appraisal processes in the TSST according to transactional stress theory. The PASA is composed of four situation-specific subscales assessing primary (*Challenge* and *Perceived Threat*) as well as secondary appraisal (*Self-Concept of One's Own Competence* and *Control Expectancy*). The primary scales can be summarized to form two secondary scales (*Primary Appraisal* and *Secondary Appraisal*) and a tertiary scale (*Stress index*). Scales range from 1 (*very little*) to 6 (*very much*). To be able to assess anticipatory cognitive appraisals, the PASA is administered between the introduction to the TSST and the actual TSST. The reliability and factorial validity of the PASA has been shown to be good (Gaab et al., 2005).

The State-Trait Anxiety Inventory. The STAI (Laux et al., 1981) is used to asses a patient's state and trait anxiety. There are two subscales that are often administered separately. The STAI-X-2 consists of a set of 20 statements and measures trait anxiety. The answers are used to assess a patient's tendency to react to situations with anxiety. The STAI X-2 was completed prior to the introduction to the stress test, just before, and 1 hour after the TSST. The STAI-X1 also consists of a set of 20 statements and measures state anxiety. It was measured at T1, T2, and T3 (as shown in Table 2). The overall score for both subscales ranges from 20 to 80; and is commonly classified as "little or no anxiety" (20–37), "moderate anxiety" (38–44), and "extreme anxiety" (45–80). Psychometric qualities of the STAI are satisfactorily, with internal consistency of $\alpha = .90$; retest reliability between $r = .77$ and $r = .90$ and repeated confirmation of the construct validity (Spielberger, 1989).

Saliva cortisol. Participants collected saliva using Salivette (Sarstedt, Sevelen, Switzerland) collection devices. Sampling time lasted exactly 1 min during which

subjects chewed on the cotton swabs as regularly as possible. Salivettes were stored at -20 °C until biochemical analysis took place. After thawing, biochemical analyses were conducted in the biochemical laboratory of the Clinical Psychology and Psychotherapy department at the University of Zurich, Switzerland by means of a highly sensitive liquid chromatography–tandem mass spectrometry (LC–MS/MS) method (Perogamvros et al., 2009).

Clinically-Oriented Assessments. In addition to the TSST, questionnaires were used to assess subjective levels of psychological components and reactions to stress (anxiety, depression and stress) as well as ACT-based constructs over the course of the study (i.e., T1 before the intervention, T2 immediately following the intervention (but before the TSST), and T3 4 weeks after the training).

Perceived Stress Scale. The PSS (Cohen, Kamarck, & Mermelstein, 1983) assesses the degree of perceived stressful situations experienced during the preceding days. Items in the PSS are designed to assess how predictable, uncontrollable, and overloaded participants evaluate their lives. The questionnaire has shown a high reliability of α=.84-.86 in three different samples and a short-term re-test reliability of α=.85 and correlates moderately with number of stressful life events.

Acceptance and Action Questionnaire – 2nd Version. The AAQ-II (Bond et al., 2011; Gloster, Klotsche, Chaker, Hummel, & Hoyer, 2011) measures psychological flexibility. Items in the AAQ-II measure how individuals generally interact with their emotions and the degree with which they engage in life despite negative emotions. The internal consistency of the AAQ-II has shown to be consistently high (α=.78-.88) and re-test reliability over a period of 3 months (α=.81) as well as 12 months (α=.79) is also high (Bond et al., 2011).

Open and Engagement State Questionnaire. (Benoy, Knitter, Doering, Knellwolf, & Gloster, 2017): The OESQ measures the core concepts inherent in the ACT model: control, acceptance, defusion, values, present moment awareness, willingness, avoidance, and committed action. Consisting of only four items, it is an efficient screening instrument to be used in ACT-related research. The internal consistency has shown to be sufficiently high across three different samples, (α=.83-.87). In contrast to the trait-like questions in the AAQ-II, the OESQ queries only about the past seven days.

Statistical Analysis

A two-level random slope model was used for the analyses of the means of endocrine responses and the other outcome variables between groups. The two levels were subject (level-2) and time within subjects (level-1). Time was taken as within-subjects factor and group as between-subjects factor. In addition to a random intercept we included a random slope coefficient for time in order to account for individual time trajectories among subjects. The curvilinear association between endocrine responses and the other outcome variables with time was modeled by adding a quadratic term. Areas under the response curve were calculated with respect to increase (AUCi) and ground (AUCg) for saliva cortisol responses (Preussner et al., 2003). While the former parameter (AUCi) takes baseline values of salivary cortisol into account and therefore is an estimate of the integral salivary cortisol response, the latter (AUCg) is an estimate of the total amount of available salivary cortisol during assessed time. Based on previous studies examining the effects of psychological stress management trainings on cortisol responses in the TSST utilizing this study design (Gaab et al., 2003; Hammerfald et al., 2006; Storch et al., 2007), we assumed a medium multivariate effect (f=0.25) of the intervention on the primary outcome, i.e.

the cortisol stress response in the TSST. On the basis of a statistical power ≥0.80, α = .05, two groups, eight cortisol assessments and a nonsphericity correction of epsilon=0.25, the optimal total sample size of *N*=32 (16 per group) was calculated a priori using the statistical software G-Power (Buchner, Faul, & Erdfelder, 1997). For all analyses, the significance level was .05. Unless indicated, all results are shown as means and standard deviations.

Statistical analyses were conducted with STATA 12.1.

RESULTS

TSST: Salivary cortisol, affective and cognitive stress responses

The TSST resulted in a significant salivary free cortisol response over time (β=7.65, 95%CI [6.43, 8.89], *p<.001*), but groups did not differ in their endocrine stress responses over time (β=-.89, 95% CI [-1.89, .11], *p=.080*, Figure 2). Although cortisol levels at baseline (-20 minutes) were lower in the ACT group in comparison to the control group, this difference was not significant (β=-3.4, 95% CI [-1.43, 8.29], *p=.160*). Further, although baseline cortisol levels significantly influenced the following cortisol stress responses (β=.62, 95% CI [.56, .69], *p<.001*), controlling for baseline cortisol levels did not affect the cortisol responses between groups (β=1.20, 95% CI [-.64, 3.04], *p<.202*). Groups did not differ in the number of participants who did not adequately respond to the TSST procedures (non-responders), which is commonly defined as a ≤ 15.5% ((R. Miller, Plessow, Kirschbaum, & Stalder, 2013)) increase above the participant's baseline level (ACT group: 4/12, control group: 6/12; $\chi 2$=0.28, *p=0.44*). Also, groups did not differ in their areas under the cortisol responses curves as indicated by AUCg (β=14.4, 95% CI [-38.4, 67.3], *p=.583*) and AUCi (β=-13.0, 95% CI [-63.4, 37.37], *p=.602*). The ACT training was provided separately for two intervention groups (n=10 and n=6). These groups did not

significantly differ in their endocrine stress responses over time (β=2.01, 95 %CI [-7.08, 11.11], *p=.664*).

Because our sample consisted of women and men, gender was treated as an additional grouping variable. Results indicated that gender had no influence on cortisol responses (β=-.67, 95% CI [-2.17, .82], *p=0.377*) and gender did not interact with group effects on cortisol responses over time (β=0.96, 95% CI [-12.43, 10.52], *p=0.176*). Use of contraceptives did not have a significant influence on cortisol responses per se (β=-1.02, 95% CI [-2.55, .50], *p=.189*) or cortisol responses between groups (β=-.40, 95% CI [-2.81, 2.00], *p=.742*).

Furthermore, the TSST resulted in significant increases of state anxiety over time (β=4.76, 95% CI [2.14, 6.38], *p<.001*), but groups did not differ significantly in their anxiety responses (β=-1.36, 95% CI [-3.37, 0.64], *p=.183*, Figure 3). A total of 32 patients (91.4%) had any increase of state anxiety and 14 patients (40.0%) experienced a reduction in state anxiety by at least one standard deviation (SD=7.4 at baseline) in follow-up. Groups did not differ in their anticipatory cognitive appraisal of the TSST (PASA primary scales: β=.08, 95% CI [-.57, .74], *p=.802*), PASA secondary scales: β=.43, 95% CI [-.05, .91], *p=.075*, PASA stress index: β=-.35, 95% CI [-1.31, .61], *p=.461*).

Based on research documenting the moderating role of trait-like psychological flexibility (Fledderus, Bohlmeijer, Fox, Schreurs, & Spinhoven, 2013; Levin, Hildebrandt, et al., 2012; Levin, Lillis, & Hayes, 2012; S. J. Miller, O'Hea, Block-Lerner, Moon, & Foran-Tuller, 2011; Pickett, Lodis, Parkhill, & Orcutt, 2012), the moderating effect of trait-level flexibility on salivary cortisol during the standardized stress test was also examined. The comparison of interest was the interaction of group (intervention vs. control) by trait flexibility level (flexible vs. experientially avoidant),

where stratified was made based on baseline levels of trait flexibility (AAQ-II scores). Results showed that participants who were highly flexible had an equivalent cortisol response whereas those who were highly experientially avoidant differed by condition – those who were in the intervention group had a higher response than those in the control group (β=1.25, 95% CI [.70, 3.21], *p=.036*).

Course of anxiety, stress, and ACT-based constructs over time and between groups

Levels of anxiety (STAI X-2 scores) and stress (PSS scores) did not change significantly over time (i.e., before, directly after, and four weeks following the intervention) for the ACT group (STAI X-2: β=.85, 95% CI [-5.32, 7.03], *p=0.787*; PSS: β=.75, 95% CI [-7.17, 8.68], *p=.853*) and there were no differences in the course of anxiety and stress levels between groups (STAI X-2: β=-.21, 95% CI [-2.14, 1.72], *p=.830*; PSS: β=1.67, 95% CI [-.61, 3.95], *p=.150*). There were no changes the trait-like measure of psychological flexibility (AAQ-II scores) over time (β=1.25, 95% CI [-5.87, 8.38], *p=.731*) and groups did not differ in their course of AAQ-II scores over time (β=.29, 95% CI [-1.86, 2.45], *p=790*). Similarly, state-like measurement of psychological flexibility (OESQ scores) did not change significantly over time (β=7.08, 95% CI [-3.76, 17.91], *p=.201*) and groups did not differ significantly in their OESQ scores over time (β=1.98, 95% CI [-1.11, 5.07], *p=210*). For means and standard deviation see Table 1.

Groups were stratified according to their baseline levels of trait flexibility in order to test for moderating effects. In order to determine how these baseline values moderate one's response to the intervention, only participants in the ACT group were examined. For these participants, a median split was conducted based on baseline AAQ-II scores. In comparison to the "high experiential avoidance" group, the "higher

flexibility" group (i.e., more flexible group) improved significantly more in trait flexibility (AAQ-II; β=13.11, 95% CI [7.59, 18.64], *p<.001*) and in state flexibility over the past seven days (OESQ; β=16.30, 95% CI [6.39, 26.20], *p<.001*), but not perceived stress (PSS; β=3.48, 95% CI [-.43, 6.54], *p=.098*). This suggests that the subgroup of participants with higher levels of trait flexibility had a tendency to improve more in targeted processes than those with higher levels of experiential avoidance.

DISCUSSION

This study examined whether participants who completed an ACT stress management course would have lower biological and subjective stress responses in response to a standardized stress situation (i.e., TSST). In contrast to other stress-management interventions (Gaab, et al. 2003; Gaab et al., 2006; Hammerfald et al., 2006; Storch et al., 2007), our results failed to show that a short intervention based on ACT was beneficial for either the biological or subjective acute stress responses to this standardized stress situation.

Our results showed that the ACT intervention did not alter subjective evaluations of anxiety, stress, or psychological flexibility over the length of the study (35 days). Likewise, all planned comparisons with the control group during the standardized stress test were non-significant, suggesting that the trait-like measures of anxiety, stress, and psychological flexibility were stable (at least over 35 days) and that on average the intervention did not alter participants' evaluations during this time frame. These results are similar to a report that a values intervention did not alter subjective evaluations during a speech challenge (Czech, Katz, & Orsillo, 2011).

Results based on the current sample may suggest a moderating effect of psychological flexibility, in that participants who were high in experiential avoidance prior to the intervention tended to remain so, but the subgroup of participants high in

psychological flexibility at baseline showed a trend for more improvement on this construct as well as an reduced cortisol stress response. At least in this non treatment-seeking population it appears that the intervention might only be effective in exacting change for those participants who already began the study at a more flexible level. For those that were more experientially avoidant, this short intervention was not effective over the short time frame or during the analogue laboratory task.

Analyses also suggested that if the ACT intervention has any effect on the biological level of the acute stress reaction, then it might actually accentuate the cortisol response. For participants in the control condition who did not receive the intervention, those who had a tendency to experientially avoid had a lower stress response than those high in flexibility. In comparison, the opposite effect was observed for those participants who received the ACT intervention. Here, participants with a tendency to be experientially avoidant had a higher cortisol response. Thus, participants high in flexibility did not differ much between the intervention and control groups, whereas participants high in experiential avoidance had a higher cortisol response if they received the ACT intervention (i.e., those that didn't receive the intervention had a pronounced lower response). In the short run, it appears that participants who tend to avoid may benefit from this stance in the face of an acute analogue stressor. This "protective" factor of avoiding is not visible in participants who had the ACT intervention, perhaps because ACT encourages one to be present with and open up to stress and other uncomfortable feelings. Whereas that may be good in the long term, in the short term it may not be helpful, at least in the face of an acute stressor with little real-world impact for their personal values.

Two previous studies have examined whether a single component of the ACT model (i.e., values) could alter the acute cortisol stress response to a standardized

stress test. In one study writing about one's most important personal value resulted in a lower cortisol response than writing about a less important value (Creswell et al., 2005). In a second study, clarifying values led to a lower cortisol response than engaging in trivia test (Gregg et al., 2014). Consistent with our findings, Gregg et al. found that for the subset of participants that actually used the values exercise during the stress challenge (i.e., TSST) this was associated with a stronger cortisol response. These two previous studies suggest that focusing on values has an observable effect on the biological stress response, and the effect may be different for some subgroups. In the present study, it appears that administering the whole ACT model to a non treatment-seeking sample rendered the intervention either ineffective or even iatrogenic for this standardized stress situation. The previous studies differed from our study in that their interventions were administered immediately before the standardized stress test. In contrast, we administered the intervention as a multi-day workshop consistent with studies examining whole therapy packages (Gaab, et al. 2003; Gaab et al., 2006). To the degree that our present results are replicated it represents important contextual information that might help guide interventions. It is possible that participants who engage with personally meaningful content (i.e., a job interview during the TSST in front of experts where one does not wish to embarrass oneself) in an open and psychologically flexible manner may experience more aversive consequences (Dickerson & Kemeny, 2004). Whereas the ACT model stipulates that clients have the resources to deal with such subjective threats, this finding might suggest that clinicians go slowly especially if the client remains experientially avoidant.

These results stand in contrast to a series of TSST studies that found controlled effects following various other interventions. For example, other

psychosocial interventions including cognitive behavioral stress management and resource-activating stress management training have demonstrated clear reductions in the acute subjective and objective stress response (Gaab et al., 2003; Gaab et al., 2006; Hammerfald et al., 2006; Storch et al., 2007). These interventions have in common that they attempt to reduce one's stress response, for example via re-appraisal. The ACT approach differs in that acceptance (i.e., being non-judgmentally open) of one's reaction in the face of a stressor serves the purpose of facilitating contact with one's values. In the face of acute stress, attempts to reduce the stress via antecedent regulation as is targeted in CBT and other therapies may be more adaptive in the short run (Gross & John, 2003).

Importantly, the present study included both the subjective evaluations and biological stress responses. Examinations of ACT components in relation to biological parameters are largely lacking. Only a handful of studies have addressed how contextual interventions affect and interact with biological systems (Barnes-Holmes et al., 2005; Gloster, Gerlach, et al., 2015; Gregg et al., 2014). Such studies are necessary to examine the depth of the ACT model (i.e., consistency across levels of analysis) and to better the mechanisms of action involved in the interventions, examining biological parameters is a necessary next step.

This study has several limitations. First, the comparison condition was a WL and not an active intervention that have previously demonstrated effects in this standardized procedure. Second, the participants were students seeking course credit and not individuals seeking clinical care. Whereas previous studies have documented effects in this population and the participants in this study had an equivalent stress response, the ACT model may be more effective in exacting change when suffering and a paucity of valued behaviors are present. Third, whereas the sample size was

comparable with previous studies and based on an a-priori power analysis, it was limited in statistical power to detect small effects. Mitigating this concern somewhat are the significant results observed in the targeted moderator analyses. Finally, the study did not assess the participant's objective performance during the standardized stress situation or the degree to which they "internalized" the intervention. Although this too is consistent with previous studies, the lack of such measurements precludes us from making statements on the important distinction between the stress reaction and how one copes with the stress reaction. That is, any advantages gained from the ACT intervention on how to respond to stress in terms of engaging in the task at hand were not assessed.

These limitations notwithstanding, this study shows that applying the complete ACT model to an acute stress situation may not be useful in reducing the biological or subjective responses. Whereas being present, opening up psychologically, and engaging in valued directions is clearly advantageous in the long-run (e.g. Gloster, Sonntag, et al., 2015), in the short-term results observed in this study were less effective than other stress-management interventions with similar training durations. Future studies are clearly needed to further elucidate the conditions when and at what level of training duration an ACT intervention is functionally useful across multiple levels of analysis.

Declaration of interest

None of the authors have any conflict of interest to declare.

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Table 1

Levels of STAI X-2, PSS, AAQ-II and OESQ *scores over time*

	Assessment (days from baseline)	ACT group (mean/SD)	Control group (mean/SD)
STAI X-2	Baseline (0)	33.2 (5.4)	35.3 (8.6)
	Post (7)	32.7 (5.0)	35.9 (10.0)
	Follow-up (35)	32.4 (7.7)	34.8 (8.9)
PSS	Baseline (0)	31.6 (4.7)	36.2 (9.2)
	Post (7)	32.3 (4.1)	35.4 (8.0)
	Follow-up (35)	32.1 (5.1)	33.4 (8.9)
AAQ-II	Baseline (0)	22.9 (5.9)	24.4 (7.7)
	Post (7)	24.8 (6.8)	24.2 (7.7)
	Follow-up (35)	24.3 (4.9)	25.2 (10.3)
OESQ	Baseline (0)	35.8 (8.0)	36.3 (11.2)
	Post (7)	41.2 (9.1)	37.3 (11.5)
	Follow-up (35)	40.9 (7.6)	36.7 (11.8)

Table 2

Overview of Data Collected at Different Measurement Time Points

			$T1_a$	$T2_b$	$TSST_c$								$T3_d$
Domain	Instrument	Description			-20'	-10'	0'	10'	20'	30'	45'	60'	
Psychological Variables													
Anxiety	STAI-X1	State Anxiety			X	X	X					X	
	STAI-X2	Trait Anxiety	X	X									X
Cognitive Appraisal	PASA	Primary and Secondary Appraisal				X							
Stress	PSS	Perceived Stress	X	X									X
Psychological Flexibility	AAQ-II	Acceptance and Action	X	X									X
	OESQ	ACT-processes	X	X									X
Biological Variables													
Cortisol Stress Response	Salivette	Cortisol Saliva sample			X	X	X	X	X	X	X	X	

Notes. a. T1 assessments were taken on day 1; b. T2 assessments were taken post-intervention; TSST assessments were taken on day T2+14. Numbers under TSST refer to the amount of minutes that the measurement was taken before or after the TSST itself; d. T3 was taken four weeks after TSST (M=Day 36).

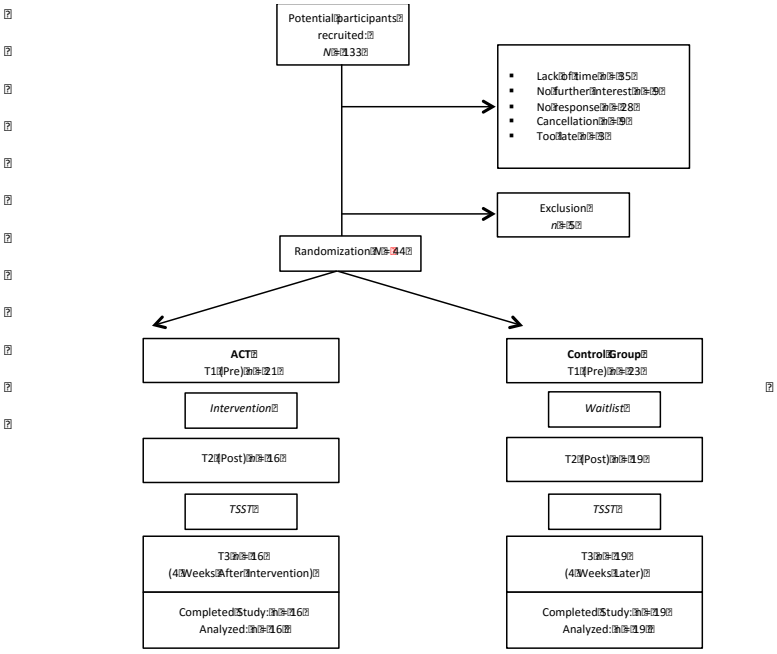

Figure 1: Flowchart of Participant Progression Through the Study

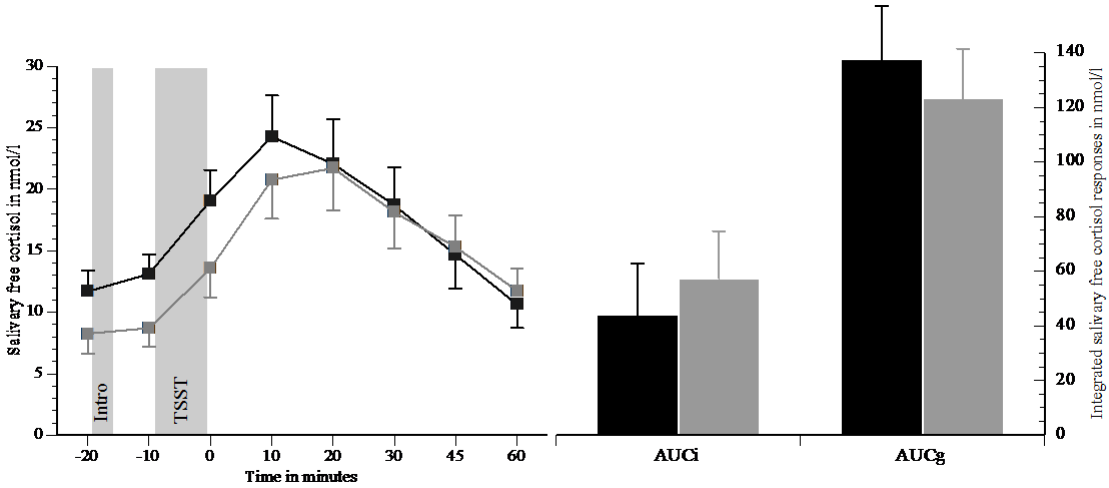

Figure 2. Absolute and integrated salivary cortisol responses in the TSST (grey=control group, black=ACT group).

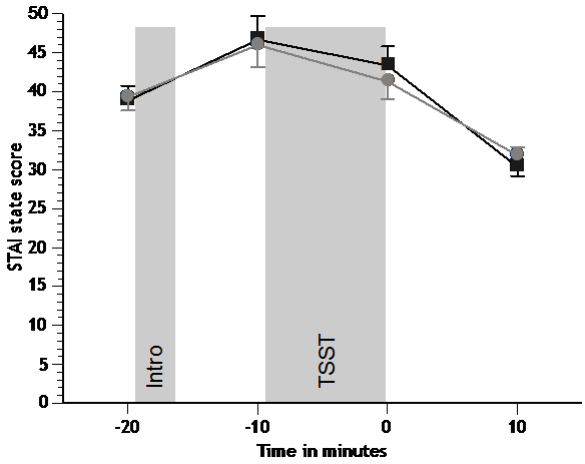

Figure 3. STAI state anxiety responses in the TSST (grey=control group, black=ACT group).