Reliability, validity and sensitivity of a computerized visual analog scale measuring state anxiety

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ARTICLE INFO

ABSTRACT

Background and objectives: Assessment of state anxiety is frequently required in clinical and research settings, but its measurement using standard multi-item inventories entails practical challenges. Such inventories are increasingly complemented by paper-and-pencil, single-item visual analog scales measuring state anxiety (VAS-A), which allow rapid assessment of current anxiety states. Computerized versions of VAS-A offer additional advantages, including facilitated and accurate data collection and analysis, and applicability to computer-based protocols. Here, we establish the psychometric properties of a computerized VAS-A.
Methods: Experiment 1 assessed the reliability, convergent validity, and discriminant validity of the computerized VAS-A in a non-selected sample. Experiment 2 assessed its sensitivity to increase in state anxiety following social stress induction, in participants with high levels of social anxiety.
Results: Experiment 1 demonstrated the computerized VAS-A's test-retest reliability ($r = .44$, $p < .001$); convergent validity with the State-Trait Anxiety Inventory's state subscale (STAI-State; $r = .60$, $p < .001$); and discriminant validity as indicated by significantly lower correlations between VAS-A and different psychological measures relative to the correlation between VAS-A and STAI-State. Experiment 2 demonstrated the VAS-A's sensitivity to changes in state anxiety via a significant pre- to during-stressor rise in VAS-A scores ($F(1,48) = 25.13$, $p < .001$).
Limitations: Set-order administration of measures, absence of clinically-anxious population, and gender-unbalanced samples.
Conclusions: The adequate psychometric characteristics, combined with simple and rapid administration, make the computerized VAS-A a valuable self-rating tool for state anxiety. It may prove particularly useful for clinical and research settings where multi-item inventories are less applicable, including computer-based treatment and assessment protocols. The VAS-A is freely available: http://people.socsci.tau.ac.il/mu/anxietytrauma/visual-analog-scale/.

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Measuring state anxiety has always been a challenge for researchers and clinicians. The use of visual analog scales (VAS) in the measurement of transient and subjective psychological states is becoming increasingly popular (Bijur, Silver, & Gallagher, 2001; de Boer et al., 2004; Gift, 1989; McCormack, Horne, & Sheather, 1988; Rossi & Pourtois, 2012). These single-item measures (also referred to as subjective units of distress), in which participants mark their subjective status on a visual scale, afford simple and rapid administration, and increased comprehension and completion rates (Rossi & Pourtois, 2012). These properties are particularly advantageous for the assessment of state anxiety when the completion of gold-standard multi-item inventories of state anxiety, such as Spielberger's State-Trait Anxiety Inventory (STAI-State; Spielberger, Gorsuch, & Lushene, 1970), may be burdensome. Indeed, visual analog scales for the measurement of anxiety (VAS-A) usefully complement multi-item questionnaires in a variety of clinical settings requiring rapid and unobtrusive anxiety measurement, including psychotherapy sessions and anxiety assessment among patients that are severely-ill, or are before or in surgery (e.g., Chlan, 2004; Kellner, Wiedemann, Yassouridis, & Muhtz, 2012; Kindler, Harms, Amsler, Ihde-Scholl, & Scheidegger, 2000; Mouthaan, Sijbrandij, Reitsma, Gersons, & Olff, 2011). Similarly, experimental designs that require rapid and repeated anxiety assessments (MacLeod, Rutherford, Campbell, Ebsworthy, & Holker,

2002; Poma et al., 2005) may benefit from the use of the VAS-A instead of a multi-item inventory, as the latter may prove more disruptive to the experiment flow and possibly obscure the transient, situational essence of state anxiety. Different psychometric properties of various paper-and-pencil versions of VAS-A have been explored in a number of studies (reviewed in Rossi & Pourtois, 2012), collectively establishing adequate test-retest reliability, convergent and divergent validity, and sensitivity to stress-induced changes in state anxiety of these instruments (Bond, Shine, & Bruce, 1995; Cella & Perry, 1986; Chlan, 2004; Davey, Barratt, Butow, & Deeks, 2007; Hornblow & Kidson, 1976; Kindler et al., 2000; Luyk, Beck, & Weaver, 1988; Seddon et al., 2011).

Computer-based applications for medical and psychological data collection, including self-assessment and psychological inventories, are becoming increasingly available and frequently used (e.g., Allenby, Matthews, Beresford, & McLachlan, 2002; Broderick & Vikingstad, 2008; Burton, Weller, & Sharpe, 2009; Jamison et al., 2001; Schulenberg & Yutrzenka, 1999). These electronic measures may offer various advantages over paper measures, such as facilitation of data collection, handling, and analysis, and increased patient compliance and recording accuracy (Gwaltney, Shields, & Shiffman, 2008; Palermo, Valenzuela, & Stork, 2004; Ryan, Corry, Attewell, & Smithson, 2002; Stone, Shiffman, Schwartz, Broderick, & Hufford, 2003). They may also enable more seamless data collection when embedded in computerized experiments (Grafton, Mackintosh, Vujic, & MacLeod, 2013; Maoz, Abend, Fox, Pine, & Bar-Haim, 2013), or in situations where paper measures are not applicable, such as during magnetic resonance imaging (Lueken, Muehlhan, Evens, Wittchen, & Kirschbaum, 2012; Thorpe, Salkovskis, & Dittner, 2008). Importantly, as the dissemination of psychological assessment and treatment via computer-based means, including the Internet, is rapidly growing, the clinical applications of computerized state anxiety measurement are likewise increasing. For example, VAS assessment of anxiety can be embedded in computer- or Internet-based protocols of therapy interventions (Farrer et al., 2013; Grafton et al., 2013; Mouthaan et al., 2011). Likewise, the growing prevalence of smartphones and other mobile devices is being utilized for more ecological momentary assessment of clinical subjective states, including anxiety (Dockray et al., 2010; Reid et al., 2009; Schaffer, Kreindler, Reis, & Levitt, 2013; Shiffman, Stone, & Hufford, 2008). However, the use of the computerized medium should also be coupled with validation of the instruments used in it (Bishop et al., 2010; Coons et al., 2009; Hirsch, Hauschild, Schmidt, Baum, & Christiansen, 2013; Kongsved, Basnov, Holm-Christensen, & Hjollund, 2007). While it may be argued that paper and computerized VASs are graphically comparable and should therefore hold the same psychometric properties, it has been shown that ratings using the two formats may be similar but not necessarily completely equivalent (Junker et al., 2008; Kvien et al., 2005; Stratton et al., 1998; Stubbs et al., 2000; Whybrow, Stephen, & Stubbs, 2006), thus suggesting that the assessment of psychometric properties of such instruments is warranted. A number of studies validated computerized VASs for the measurement of different subjective states, such as chronic pain, hunger, and quality of life (Hollen et al., 2013; Jamison et al., 2002; Kvien et al., 2005; Salaffi, Gasparini, & Grassi, 2009; Stubbs et al., 2000; Whybrow et al., 2006). To the best of our knowledge, the psychometric properties of a computerized VAS for the assessment of state anxiety have yet to be comprehensively studied.

Here, we evaluated the reliability, validity, and sensitivity of a computerized single-item VAS-A in measuring state anxiety. In Experiment 1, we assessed the VAS-A's: a) reliability, using test–retest measures; b) convergent validity, by testing whether VAS-A scores significantly correlated with STAI-State scores (Spielberger, 1983); and c) discriminant validity, by comparing the magnitude of correlation between the VAS-A and the STAI-State to the correlations between the VAS-A and other negative affect instruments not assumed to directly measure state anxiety, such as trait anxiety, social anxiety, depression, and state anger. In Experiment 2, we examined whether the VAS-A was sensitive to changes in state anxiety following stress-induction in a sample of socially-anxious individuals participating in a public speaking task.

1. Experiment 1: reliability, convergent validity, and discriminant validity of the VAS-A

In Experiment 1, we tested the reliability, convergent validity, and discriminant validity of the computerized VAS-A in measuring state anxiety.

1.1. Method

1.1.1. Participants
We recruited 172 undergraduate students (mean age 23.8 years, SD = 2.8; 125 females) from Tel Aviv University ($n = 99$) and the Yezreel Valley College ($n = 73$). The study was approved by the local institutional review boards. Participants provided signed informed consent, and received course credit or monetary compensation for their participation.

1.1.2. Measures
1.1.2.1. Computerized VAS-A. The VAS-A was administered on a standard 15.6" laptop screen using a Java applet (Fig. 1). Consistent with common VAS presentations, the scale was a 100-mm horizontal line (Ahearn, 1997; Wewers & Lowe, 1990) divided into 30 equal-sized partitions (MacLeod et al., 2002). The left edge of the scale was marked "calm" and the right edge was marked "anxious" (for relevant uses, see Buhr & Dugas, 2009; MacLeod et al., 2002; Watson & Tellegen, 1985). A sliding locator was initially positioned at the midpoint of the scale. The scale was presented within a gray window 128 mm wide and 96 mm tall. The experimenter instructed the participants to use the computer mouse to place the locator at the scale position representing their current level of anxiety ("How anxious do you feel right now?"). Score was automatically calculated by rounding the relative distance of the locator from the left edge of the scale to the nearest integer value between 0 and 30. The participants were not informed of this numerical value. The VAS-A is freely available for download at http://people.socsci.tau.ac.il/mu/anxietytrauma/visual-analog-scale/.

1.1.2.2. State-Trait Anxiety Inventory − state subscale (STAI-State). The STAI-State (Spielberger et al., 1970) consists of 20 items relating to present anxious moods answered on a 4-point scale from 1 = *Not at all* to 4 = *Very much so.* Item scores are summed to a total score (range: 20−80). The STAI-State scale has high internal consistency, with Cronbach's alpha coefficient ranging between .86 and .95 and item−remainder correlations of .55−.63 (Rossi & Pourtois, 2012; Spielberger, 1983; Spielberger & Sydeman, 1994). Its stability co-efficients are relatively low (test−retest $r = .34−.62$ in various
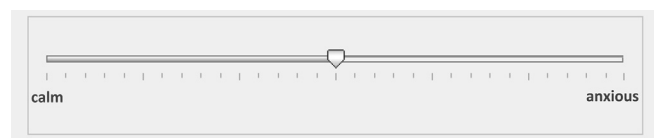

Fig. 1. The computerized VAS-A. Participants were instructed to use the computer mouse to place the locator at the scale position representing their current level of anxiety in response to the question, "How anxious do you feel right now?"

samples), as expected (Spielberger, 1983; Spielberger & Sydeman, 1994) given the influence of trait disposition for anxiety on the one hand, and the transient, situational factors on the other. Validity of the STAI-State has been reported by Spielberger (1983). The STAI-State's strong psychometric properties and frequent use in research and clinical settings (reviewed in Rossi & Pourtois, 2012) have led many to consider it a "gold standard" for measuring state anxiety and use it as a reference for the validation of other instruments (Davey et al., 2007; Kindler et al., 2000; Moerman, van Dam, Muller, & Oosting, 1996). In that vein, the STAI-State served here as a reference measure of state anxiety. In the current sample, internal consistency of the STAI-State as measured by Cronbach's α was .95.

1.1.2.3. State-Trait Anxiety Inventory − trait subscale (STAI-Trait). The STAI-Trait (Spielberger et al., 1970) consists of 20 items relating to general anxious moods answered on a 4-point scale from 1 = *Almost never* to 4 = *Almost always*. Item scores are summed to a total score (range: 20−80). It is one of the most commonly used scales for the assessment of trait anxiety (Sylvers, Lilienfeld, & LaPrairie, 2011), and possesses strong psychometric properties (reviewed in Elwood, Wolitzky-Taylor, & Olatunji, 2012). In the current sample, internal consistency of the STAI-Trait was α = .93.

1.1.2.4. Liebowitz Social Anxiety Scale (LSAS). The LSAS (Fresco et al., 2001; Liebowitz, 1987) is composed of 24 items divided into two subscales addressing social interaction and performance situations. The participant is required to rate fear and avoidance during the past week on a 4-point scale from 0 = *None* to 3 = *Severe/Usually*. The total score of the LSAS was used in this study (range: 0−72). The LSAS is one of the most commonly used scales for the assessment of social anxiety, and was found to be reliable, valid and treatment-sensitive (Fresco et al., 2001; Heimberg et al., 1999). In the current sample, internal consistency of the LSAS was α = .92.

1.1.2.5. Patient Health Questionnaire-9 (PHQ-9). The PHQ-9 is the depression module from the full PHQ instrument (Spitzer, Kroenke, & Williams, 1999). It consists of 9 items representing depressive symptom criteria occurring in the last two weeks, which are answered on a 4-point scale from 0 = *Not at all* to 3 = *Nearly every day*. Item scores are summed to a total score (range: 0−27). It was found to be a reliable and valid measure of depression severity (Kendel et al., 2010; Kroenke, Spitzer, & Williams, 2001). In the current sample, internal consistency of the PHQ-9 was α = .84.

1.1.2.6. State-Trait Anger Expression Inventory-2 (STAXI-2). The STAXI-2 is a reliable and valid 57-item measure with scales developed to assess anger as situational anger (state anger scale), a dispositional characteristic (trait anger scale), and the expression of anger (anger expression scale) (Spielberger, 1999; Spielberger & Sydeman, 1994). We used the state anger scale in this study, which consists of 15 items referring to statements regarding present anger reactions which are answered on a 4-point scale from 1 = *Not at all* to 4 = *Very much so*. Item scores are summed to a total score (range: 15−60). In the current sample, internal consistency of the STAXI-2 was α = .96.

1.1.3. Procedure

Participants completed two sessions in a laboratory setting. In the first session, we assessed state anxiety using the STAI-State and the VAS-A. In the second session, exactly one week later and in the same laboratory room, we again administered the VAS-A and STAI-State, as well as the STAI-Trait, LSAS, PHQ-9, and STAXI-2 questionnaires. The VAS-A, STAI-State, and STAI-Trait were administered at both sites (n = 172); due to time constraints in data

collection at the Yezreel Valley College, the LSAS, PHQ-9, and STAXI-2 were administered only at Tel Aviv University (n = 99).

1.1.4. Data analysis

All relations between variables were assessed using Spearman rank correlation coefficients since the distributions of the VAS-A and STAI-State scores in the current sample differed from the normal distribution (Kolmogorov−Smirnov test, p's < .02). Fisher's *r*-to-*Z* transformations were used to test for significant differences between correlation magnitudes.

Reliability of the VAS-A was assessed using test-retest correlation between VAS-A measures in Sessions 1 and 2. We expected the VAS-A to show significant but relatively low stability (and similar to STAI-State stability), noting the influence of both transient, situational factors and the propensity for anxiety reactivity on state anxiety levels (Spielberger, 1983). It should be noted that internal consistency of the VAS-A cannot be assessed as it is a single item.

Convergent validity of the VAS-A was assessed by the extent to which it correlated with an established measure of state anxiety. To that end, we calculated the correlation between the VAS-A and the STAI-State. Under the assumption that the STAI-State score is a valid representation of state anxiety, we expected this correlation to be significant.

As the VAS-A is expected to measure state anxiety, high correlations with instruments that do not measure state anxiety per se were not expected. Discriminant validity of the VAS-A was therefore assessed by the degree to which it correlated with several instruments that measure other properties, namely STAI-Trait (trait anxiety), LSAS (social anxiety), PHQ-9 (depression), and STAXI-2 (state anger) scores. We expected these correlations to be significant, due to the reported associations between anxiety, depression, and anger (Deschenes, Dugas, Fracalanza, & Koerner, 2012; Schulz, Alpers, & Hofmann, 2008; Woody & Rodriguez, 2000; Zimmerman, McDermut, & Mattia, 2000), yet significantly lower than the correlation between VAS-A and STAI-State scores (hypothesized to measure the same construct). Further, we calculated partial correlations between VAS-A scores and STAI-Trait, LSAS, PHQ-9, and STAXI-2 scores, while controlling for STAI-State scores. Assuming that the STAI-State score is a valid representation of state anxiety, non-significant partial correlations would suggest that the VAS-A does not effectively measure constructs not directly related to state anxiety. All statistical tests were conducted under two-tailed hypotheses with alpha set to .05.

1.2. Results

Table 1 provides descriptive statistics for the instruments measured in Sessions 1 and 2. STAI-State scores in the sample

Table 1
Descriptive statistics for instrument scores measured in Sessions 1 and 2 (Experiment 1).

Measure	Session	N	Mean	Median	Range	SD	CI
VAS−A	Session 1	172	8.6	6.0	0−29	7.4	7.0−9.7
	Session 2	172	8.4	6.0	0−30	7.3	7.3−10.4
STAI−State	Session 1	172	33.3	31.0	20−77	10.1	30.8−34.8
	Session 2	172	33.5	31.5	20−79	11.0	32.1−36.7
STAI−Trait	Session 2	172	39.7	38.0	22−65	9.6	38.1−41.9
LSAS	Session 2	99	36.3	33.0	2−97	19.8	32.5−40.4
PHQ-9	Session 2	99	7.9	6.0	0−21	5.0	6.8−8.8
STAXI-2	Session 2	99	17.8	15.0	15−60	6.5	16.6−19.2

Note: Possible score range for the VAS-A: 0 (calm) to 30 (anxious); STAI-State (state anxiety): 20−80; STAI-Trait (trait anxiety): 20−80; LSAS (social anxiety): 0−144; PHQ-9 (depression): 0−27; STAXI-2 (state anger): 15−60. SD = standard deviation. CI = 95% confidence interval for population mean, calculated using bootstrapping. The LSAS, PHQ-9, and STAXI-2 were administered in only one of the two contributing sites.

spanned most of the range of possible scores (20−77 and 20−79 in Sessions 1 and 2, respectively) assuring that the sample represented a broad range of state anxiety. Similarly, VAS-A scores covered most of the scale range (0−29 and 0−30 in Sessions 1 and 2, respectively). As noted, the internal consistency of all questionnaires was good to excellent (Cronbach's α range = .84−.96). Mean scores did not significantly differ between the two sites for all instruments (p's > .22). All participants operated the VAS-A and completed the questionnaires without any reported difficulties.

1.2.1. Reliability of the VAS-A

Test−retest reliability of the VAS-A was significant, $r(172) = .44$, $p < .001$. To provide a benchmark for state anxiety stability, test−retest reliability was also calculated for the STAI-State scores and found significant, $r(172) = .56$, $p < .001$. Both measures therefore revealed low to medium stability in measuring state anxiety, which may be lower than typical reliability estimates, but expected given the focus of these measures on momentary anxiety (Hornblow & Kidson, 1976; Spielberger, 1983). Dependent-samples t-tests demonstrated no significant systematic differences (Deyo, Diehr, & Patrick, 1991) between the two time points in either measure, p's > .63.

1.2.2. Convergent validity of the VAS-A

VAS-A scores were highly correlated with STAI-State scores in both Session 1, $r(172) = .60$, $p < .001$, and Session 2, $r(172) = .62$, $p < .001$.

1.2.3. Discriminant validity of the VAS-A

Table 2 presents the zero-order and partial correlations between VAS-A scores and STAI-Trait, LSAS, PHQ-9, and STAXI-2 scores (Session 2). As expected, all zero-order correlations were significant. However, the correlations between each of the non-state anxiety measures and the VAS-A were significantly smaller than the correlation between the VAS-A and the STAI-S scores (STAI-Trait: Fisher's r-to-$Z = 4.54$, $p < .001$; LSAS: r-to-$Z = 3.27$, $p = .001$; PHQ-9: r-to-$Z = 3.32$, $p < .001$; and STAXI-2: r-to-$Z = 3.29$, $p = .001$), confirming that the VAS-A was more strongly associated with state anxiety than with these related but different constructs. Moreover, once we controlled for variance associated with state anxiety (as represented by STAI-State scores), the partial correlations between VAS-A scores and STAI-Trait, LSAS, PHQ-9, and STAXI-2 scores were no longer significant.

2. Experiment 2: sensitivity of the VAS-A to stress induction

This experiment tested whether the VAS-A is sensitive in detecting changes in state anxiety related to externally-induced stress (Deyo et al., 1991). This was assessed in a sample of students reporting high levels of social anxiety who underwent stress induction via a public speaking task. As social anxiety is associated with increased anxiety during public speaking (American Psychiatric Association., 2000), we anticipated a marked increase in state anxiety scores during the stress induction task relative to baseline (Kirschbaum, Pirke, & Hellhammer, 1993; Poma et al., 2005; Schulz et al., 2008; Taylor, Bomyea, & Amir, 2010).

2.1. Method

2.1.1. Participants

Participants were 49 Tel Aviv University undergraduate students (mean age 22.7 years; 40 females). Selection of participants was based on the outcome of two LSAS measurements: the first was conducted as part of a mass screening procedure (Grafton et al., 2013; MacLeod et al., 2002) to identify students with elevated degrees of social anxiety, and the second was conducted (three months later, several weeks prior to the start of the current study) to ascertain that selected students had reliably maintained a high level of social anxiety. To be included in the study participants had to have a score of 31 or higher on both measurements (based on Mennin et al., 2002; Rytwinski et al., 2009). Mean LSAS scores in the sample were 53 (SD = 15) and 56 (SD = 17) for the first and second measurements, respectively, placing the sample more than 2 standard deviations above the mean for individuals with no axis I diagnosis (Fresco et al., 2001). The study was approved by the local institutional review board. Participants provided signed informed consent, and received course credit or monetary compensation for their participation. None of the participants in this study took part in Experiment 1.

2.1.2. Measures

The measures used were the VAS-A and STAI-State (described in Experiment 1).

2.1.3. Procedure

Participants completed the STAI-State and VAS-A at two time points: before and during a public speaking stress induction task. During the stressor task (Amir, Weber, Beard, Bomyea, & Taylor, 2008; Kirschbaum et al., 1993), participants were asked to choose one of three discussion topics (use of nuclear energy to produce electricity, mandatory school uniform, or use of toll roads) and prepare a 5-min speech concerning claims in favor of and against the selected topic. Participants were informed that their speech would be videotaped and later evaluated for quality by the research staff. During the speech task an unfamiliar male experimenter was present in the room, provided instructions, and operated the video camera. The pre-stressor measurements were taken at the beginning of the session, before participants were aware of the speech task. Two minutes into their speech, participants were asked to pause, and again completed the STAI-State and VAS-A before completing their speech (this order of administration was maintained across participants). The participants' marks on the previous measures were never visible.

2.1.4. Data analysis

First, we conducted repeated-measures analyses of variance (ANOVA) with a within-subject factor of Time (pre-stressor, during-stressor) separately on VAS-A and STAI-State scores, to confirm that the stress manipulation yielded the expected elevations in state anxiety (Amir et al., 2008; Seddon et al., 2011). The VAS-A ANOVA was then repeated, with during-stressor STAI-State scores entered as a covariate. Under the assumption that the STAI-State score is a valid representation of state anxiety, we expected that the rise in VAS-A scores will not be maintained after variance related to state anxiety (STAI-S scores) was controlled for in the analysis.

Table 2
Discriminant validity of the computerized VAS-A. Zero-order Spearman correlations and partial correlations between VAS-A and STAI-Trait (trait anxiety), LSAS (social anxiety), PHQ-9 (depression), and STAXI-2 (state anger) scores.

Measure	Zero-order correlation			Partial correlation		
	N	r	p-value	N	r	p-value
STAI−Trait	172	.24	.002	172	−.07	.387
LSAS	99	.31	.002	97	.05	.561
PHQ-9	99	.30	.003	99	.00	.969
STAXI-2	99	.30	.002	99	−.04	.636

Note: Partial correlation for each measure reflects the correlation between VAS-A scores and the measure while controlling for STAI-State scores. The LSAS, PHQ-9, and STAXI-2 were administered in only one of the two contributing sites.

Second, to test the concordance between the VAS-A and the STAI-State in measuring the stress-induced rise in state anxiety, we calculated separate difference scores for the VAS-A and the STAI-State (during-stressor minus pre-stressor). We then calculated the correlation between the two sets of difference scores, with the expectation that if both measures similarly reflect state anxiety, then this correlation would be significant. All statistical tests were conducted under two-tailed hypotheses with alpha set to .05. All measures did not differ from the normal distribution (Kolmogorov–Smirnov test, p's > .35), permitting the use of parametric tests.

2.2. Results

The public speaking task produced the expected rise in state anxiety as evidenced by a pre- to during-stressor increase in STAI-State scores (rise from $M = 39.2$ to $M = 51.4$, $F(1,48) = 59.95$, $p < .001$, $\eta_p^2 = .55$) observed in 43 of the 49 participants (88% of the sample). Accordingly, a significant pre- to during-stressor increase in VAS-A scores was observed (rise from $M = 12.4$ to $M = 19.5$, $F(1,48) = 25.13$, $p < .001$, $\eta_p^2 = .34$) in 41 of the 49 participants (84% of the sample). When during-stressor STAI-State scores were controlled for in the VAS-A analysis, the effect of Time was no longer significant, $F(1,47) = .01$, $p = .93$, $\eta_p^2 = .00$, suggesting that the significant stress-induced rise in VAS-A scores specifically reflected an increase in measured state anxiety (STAI-S). Furthermore, the rise in VAS-A scores was significantly correlated with the rise in STAI-State scores (Fig. 2), $r(49) = .51$, $p < .001$.

3. General discussion

The current experiments investigated the reliability, validity, and sensitivity of a computerized VAS-A as a self-report measure of state anxiety. First, VAS-A scores exhibited low to medium test-retest reliability. Second, the VAS-A were highly correlated with the STAI-State, an established measure of state anxiety indicating convergent validity of the instrument. Third, the VAS-A demonstrated discriminant validity by not measuring other psychological constructs beyond variance related to state anxiety. Finally, the VAS-A was sensitive to a rise in state anxiety among socially-anxious individuals following stress induction. Thus, the computerized VAS-A enables a rapid, reliable, and valid measurement of state anxiety.

These characteristics, in addition to facilitated data collection, handling, and analysis, make the computerized VAS-A useful in complementing multi-item state anxiety inventories in a variety of clinical and research settings. For example, the VAS-A may be particularly convenient in clinical situations requiring rapid or unburdening assessment of state anxiety, such as among patients before and during operation, or repeatedly within psychotherapy sessions (e.g., cognitive-behavioral therapy) (Chlan, 2004; Kellner et al., 2012; Kindler et al., 2000; Liverant, Suvak, Pineles, & Resick, 2012; Mouthaan et al., 2011). Such application of the VAS-A should be accompanied by further validation of the instrument in clinical samples. Likewise, researchers employing computerized experimental designs that require the assessment of change in state anxiety following an experimental manipulation (e.g., Amir, et al., 2008; Grafton et al., 2013) may find the use of VAS-A less disruptive to the experimental procedure than having to repeatedly administer multi-item questionnaires. At the same time, the ability of the VAS-A to capture more subtle fluctuations in anxiety measured at multiple time points during an experiment may be of great interest to the field of anxiety and emotional reactivity. Since the current study measured changes in VAS-A only at two time points, future studies could explore the reliability and sensitivity of the VAS-A over multiple assessments. In addition to the direct assessment of subjective anxiety, the computerized administration of the VAS-A could also enable measurement of response latency to the scale, potentially providing complementary information associated with the influence of anxiety on cognitive processes (e.g., Corby & Tryon, 2006). This option was not available for the current studies but is available in the software link provided in Methods.

The growing access to computers and the Internet has substantially expanded the range of psychological assessment and intervention. The prevalence of smartphones and other mobile devices now enables the ecological momentary assessment of different subjective states, often in scale form (Dockray et al., 2010; Reid et al., 2009; Shiffman et al., 2008). The computerized VAS-A is particularly useful for this purpose, allowing for real-word, online monitoring and recording of state anxiety, without the need to return to the lab and retroactively assess anxiety levels or maintain a written record of changes in anxiety. In addition to data collection, much effort is devoted to the development of novel therapy protocols relying on computerized delivery, including via the Internet, for the efficacious and cost-effective dissemination of psychological treatment for anxiety and other mental disorders (Farrer et al., 2013; Hedman, Ljotsson, & Lindefors, 2012; Kaltenthaler et al., 2006; MacLeod & Mathews, 2012; Mouthaan et al., 2011; Van Voorhees et al., 2009). Such protocols may readily utilize computerized means to assess current levels of anxiety in patients, in lieu of traditional paper-and-pencil VAS-A or multi-item inventories, which can be less convenient or applicable in this medium. The current results suggest that the use of a computerized VAS-A for this purpose relies on adequate psychometric properties.

Potential limitations of the current experimental design should be acknowledged. First, counterbalancing the administration of the different measures in both experiments would have helped ruling out possible carry-over effects when completing the measures, and should be taken into consideration in future studies employing a number of assessment instruments. Second, Experiment 2 would have benefitted from a control group not undergoing stress induction in order to diminish possible confounding effects related to the experimental procedure. Third, we did not include a clinically-anxious population in the study; thus, validity of the VAS-A should be extended to such samples. Lastly, the study samples were
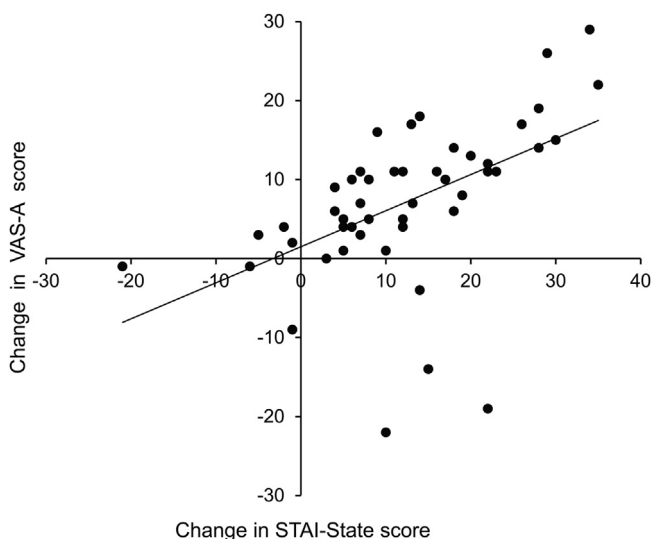

Fig. 2. Sensitivity of the computerized VAS-A to changes in state anxiety. The scatterplot and regression line depict the correlation between changes in STAI-State scores and VAS-A scores following a social stress induction task (Experiment 2), from pre- to during-stressor measurements. *Note*: Change scores were calculated by subtracting the *pre-stressor* score from the *during-stressor* score.

predominantly female; more balanced samples in terms of gender would allow for broader generalization of findings. In addition to these practical limitations, it may be argued that any construct, including state anxiety, cannot be adequately represented by a single-item visual scale. While fully addressing this conceptual and contested notion (e.g., Aitken, 1969) is beyond the scope of this study, we can nevertheless suggest that if the comprehensive assessment of state anxiety is required, and time and other practical constraints are of no concern, well-validated multi-item inventories should be used as the primary measures. However, the current experiments demonstrate that when such constraints are present, the VAS-A could serve as a viable, valid, and convenient alternative.

In conclusion, the demonstrated psychometric characteristics of the computerized VAS-A, combined with its wide applicability, and simple and rapid administration, make it a valuable self-rating tool for the situational assessment of state anxiety. The VAS-A may prove particularly useful in clinical and research settings where multi-item questionnaires or paper-and-pencil measures are less applicable.

References

Ahearn, E. P. (1997). The use of visual analog scales in mood disorders: a critical review. *Journal of Psychiatric Research, 31*(5), 569–579. http://dx.doi.org/10.1016/S0022-3956(97)00029-0.

Aitken, R. C. B. (1969). Measurement of feelings using visual analogue scales. *Proceedings of the Royal Society of Medicine-London, 62*(10), 989–993.

Allenby, A., Matthews, J., Beresford, J., & McLachlan, S. A. (2002). The application of computer touch-screen technology in screening for psychosocial distress in an ambulatory oncology setting. *European Journal of Cancer Care, 11*(4), 245–253. http://dx.doi.org/10.1046/j.1365-2354.2002.00310.x.

American Psychiatric Association. (2000). *Diagnostic criteria from DSM-IV-TR.* Washington, D.C.: American Psychiatric Association.

Amir, N., Weber, G., Beard, C., Bomyea, J., & Taylor, C. T. (2008). The effect of a single-session attention modification program on response to a public-speaking challenge in socially anxious individuals. *Journal of Abnormal Psychology, 117*(4), 860–868. http://dx.doi.org/10.1037/a0013445.

Bijur, P. E., Silver, W., & Gallagher, E. J. (2001). Reliability of the visual analog scale for measurement of acute pain. *Academic Emergency Medicine, 8*(12), 1153–1157. http://dx.doi.org/10.1111/j.1553-2712.2001.tb01132.x.

Bishop, F. L., Lewis, G., Harris, S., McKay, N., Prentice, P., Thiel, H., et al. (2010). A within-subjects trial to test the equivalence of online and paper outcome measures: the Roland Morris disability questionnaire. *BMC Musculoskeletal Disorders, 11*, 113. http://dx.doi.org/10.1186/1471-2474-11-113.

Bond, A., Shine, P., & Bruce, M. (1995). Validation of visual analog scales in anxiety. *International Journal of Methods in Psychiatric Research, 5*(1), 1–9.

Broderick, J. E., & Vikingstad, G. (2008). Frequent assessment of negative symptoms does not induce depressed mood. *Journal of Clinical Psychology in Medical Settings, 15*(4), 296–300. http://dx.doi.org/10.1007/s10880-008-9127-6.

Buhr, K., & Dugas, M. J. (2009). The role of fear of anxiety and intolerance of uncertainty in worry: an experimental manipulation. *Behaviour Research and Therapy, 47*(3), 215–223. http://dx.doi.org/10.1016/j.brat.2008.12.004.

Burton, C., Weller, D., & Sharpe, M. (2009). Functional somatic symptoms and psychological states: an electronic diary study. *Psychosomatic Medicine, 71*(1), 77–83. http://dx.doi.org/10.1097/PSY.0b013e31818f2acb.

Cella, D. F., & Perry, S. W. (1986). Reliability and concurrent validity of three visual-analogue mood scales. *Psychological Reports, 59*(2 Pt 2), 827–833.

Chlan, L. L. (2004). Relationship between two anxiety instruments in patients receiving mechanical ventilatory support. *Journal of Advanced Nursing, 48*(5), 493–499. http://dx.doi.org/10.1111/j.1365-2648.2004.03231.x.

Coons, S. J., Gwaltney, C. J., Hays, R. D., Lundy, J. J., Sloan, J. A., Revicki, D. A., et al. (2009). Recommendations on evidence needed to support measurement equivalence between electronic and paper-based patient-reported outcome (PRO) measures: ISPOR ePRO good research practices task force report. *Value in Health, 12*(4), 419–429. http://dx.doi.org/10.1111/j.1524-4733.2008.00470.x.

Corby, B. J., & Tryon, W. W. (2006). Validating a new method for quantifying traits: the computer-administered visual analog. *Journal of Research in Personality, 40*(3), 285–312. http://dx.doi.org/10.1016/j.jrp.2005.01.002.

Davey, H. M., Barratt, A. L., Butow, P. N., & Deeks, J. J. (2007). A one-item question with a Likert or Visual Analog Scale adequately measured current anxiety. *Journal of Clinical Epidemiology, 60*(4), 356–360. http://dx.doi.org/10.1016/j.jclinepi.2006.07.015.

de Boer, A. G. E. M., van Lanschot, J. J. B., Stalmeier, P. F. M., van Sandick, J. W., Hulscher, J. B. F., de Haes, J. C. J. M., et al. (2004). Is a single-item visual analogue scale as valid, reliable and responsive as multi-item scales in measuring quality of life? *Quality of Life Research, 13*(2), 311–320.

Deschenes, S. S., Dugas, M. J., Fracalanza, K., & Koerner, N. (2012). The role of anger in generalized anxiety disorder. *Cognitive Behaviour Therapy, 41*(3), 261–271. http://dx.doi.org/10.1080/16506073.2012.666564.

Deyo, R. A., Diehr, P., & Patrick, D. L. (1991). Reproducibility and responsiveness of health status measures. Statistics and strategies for evaluation. *Controlled Clinical Trials, 12*(4 Suppl), 142S–158S.

Dockray, S., Grant, N., Stone, A. A., Kahneman, D., Wardle, J., & Steptoe, A. (2010). A comparison of affect ratings obtained with ecological momentary assessment and the day reconstruction method. *Social Indicators Research, 99*(2), 269–283. http://dx.doi.org/10.1007/s11205-010-9578-7.

Elwood, L. S., Wolitzky-Taylor, K., & Olatunji, B. O. (2012). Measurement of anxious traits: a contemporary review and synthesis. *Anxiety, Stress & Coping, 25*(6), 647–666. http://dx.doi.org/10.1080/10615806.2011.582949.

Farrer, L., Gulliver, A., Chan, J. K., Batterham, P. J., Reynolds, J., Calear, A., et al. (2013). Technology-based interventions for mental health in tertiary students: systematic review. *Journal of Medical Internet Research, 15*(5), e101. http://dx.doi.org/10.2196/jmir.2639.

Fresco, D. M., Coles, M. E., Heimberg, R. G., Liebowitz, M. R., Hami, S., Stein, M. B., et al. (2001). The Liebowitz Social Anxiety Scale: a comparison of the psychometric properties of self-report and clinician-administered formats. *Psychological Medicine, 31*(6), 1025–1035. http://dx.doi.org/10.1017/S003329170105405.

Gift, A. G. (1989). Visual analogue scales: measurement of subjective phenomena. *Nursing Research, 38*(5), 286–288.

Grafton, B., Mackintosh, B., Vujic, T., & MacLeod, C. (2013). When ignorance is bliss: explicit instruction and the efficacy of CBM-a for anxiety. *Cognitive Therapy and Research, 1–17.* http://dx.doi.org/10.1007/s10608-013-9579-3.

Gwaltney, C. J., Shields, A. L., & Shiffman, S. (2008). Equivalence of electronic and paper-and-pencil administration of patient-reported outcome measures: a meta-analytic review. *Value in Health, 11*(2), 322–333. http://dx.doi.org/10.1111/j.1524-4733.2007.00231.x.

Hedman, E., Ljotsson, B., & Lindefors, N. (2012). Cognitive behavior therapy via the Internet: a systematic review of applications, clinical efficacy and cost-effectiveness. *Expert Review of Pharmacoeconomics & Outcomes Research, 12*(6), 745–764. http://dx.doi.org/10.1586/erp.12.67.

Heimberg, R. G., Horner, K. J., Juster, H. R., Safren, S. A., Brown, E. J., Schneier, F. R., et al. (1999). Psychometric properties of the liebowitz social anxiety scale. *Psychological Medicine, 29*(1), 199–212.

Hirsch, O., Hauschild, F., Schmidt, M. H., Baum, E., & Christiansen, H. (2013). Comparison of Web-based and paper-based administration of ADHD questionnaires for adults. *Journal of Medical Internet Research, 15*(3), e47. http://dx.doi.org/10.2196/jmir.2225.

Hollen, P. J., Gralla, R. J., Stewart, J. A., Meharchand, J. M., Wierzbicki, R., & Leighl, N. (2013). Can a computerized format replace a paper form in PRO and HRQL evaluation? Psychometric testing of the computer-assisted LCSS instrument (eLCSS-QL). *Supportive Care in Cancer, 21*(1), 165–172. http://dx.doi.org/10.1007/s00520-012-1507-7.

Hornblow, A. R., & Kidson, M. A. (1976). The visual analogue scale for anxiety: a validation study. *Australian and New Zealand Journal of Psychiatry, 10*(4), 339–341.

Jamison, R. N., Gracely, R. H., Raymond, S. A., Levine, J. G., Marino, B., Herrmann, T. J., et al. (2002). Comparative study of electronic vs. paper VAS ratings: a randomized, crossover trial using healthy volunteers. *Pain, 99*(1–2), 341–347. http://dx.doi.org/10.1016/S0304-3959(02)00178-1.

Jamison, R. N., Raymond, S. A., Levine, J. G., Slawsby, E. A., Nedeljkovic, S. S., & Katz, N. P. (2001). Electronic diaries for monitoring chronic pain: 1-year validation study. *Pain, 91*(3), 277–285. DOI: S0304395900004504 [pii].

Junker, U., Freynhagen, R., Langler, K., Gockel, U., Schmidt, U., Tolle, T. R., et al. (2008). Paper versus electronic rating scales for pain assessment: a prospective, randomised, cross-over validation study with 200 chronic pain patients. *Current Medical Research and Opinion, 24*(6), 1797–1806. http://dx.doi.org/10.1185/03007990802121059.

Kaltenthaler, E., Brazier, J., De Nigris, E., Tumur, I., Ferriter, M., Beverley, C., et al. (2006). Computerised cognitive behaviour therapy for depression and anxiety update: a systematic review and economic evaluation. *Health Technology Assessment, 10*(33), 1–168. http://dx.doi.org/10.3310/hta10330. iii, xi-xiv.

Kellner, M., Wiedemann, K., Yassouridis, A., & Muhtz, C. (2012). Non-response of cortisol during stressful exposure therapy in patients with obsessive-compulsive disorder-Preliminary results. *Psychiatry Research, 199*(2), 111–114. http://dx.doi.org/10.1016/j.psychres.2012.04.029.

Kendel, F., Wirtz, M., Dunkel, A., Lehmkuhl, E., Hetzer, R., & Regitz-Zagrosek, V. (2010). Screening for depression: Rasch analysis of the dimensional structure of the PHQ-9 and the HADS-D. *Journal of Affective Disorders, 122*(3), 241–246. http://dx.doi.org/10.1016/j.jad.2009.07.004.

Kindler, C. H., Harms, C., Amsler, F., Ihde-Scholl, T., & Scheidegger, D. (2000). The visual analog scale allows effective measurement of preoperative anxiety and detection of patients' anesthetic concerns. *Anesthesia & Analgesia, 90*(3), 706–712. http://dx.doi.org/10.1097/00000539-200003000-00036.

Kirschbaum, C., Pirke, K. M., & Hellhammer, D. H. (1993). The 'Trier Social Stress Test'—a tool for investigating psychobiological stress responses in a laboratory setting. *Neuropsychobiology, 28*(1–2), 76–81. doi: 119004, [pii] 119004.

Kongsved, S. M., Basnov, M., Holm-Christensen, K., & Hjollund, N. H. (2007). Response rate and completeness of questionnaires: a randomized study of Internet versus paper-and-pencil versions. *Journal of Medical Internet Research, 9*(3), e25. http://dx.doi.org/10.2196/jmir.9.3.e25.

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Kroenke, K., Spitzer, R. L., & Williams, J. B. (2001). The PHQ-9: validity of a brief depression severity measure. *Journal of General Internal Medicine, 16*(9), 606—613. http://dx.doi.org/10.1046/j.1525-1497.2001.016009606.x.

Kvien, T. K., Mowinckel, P., Heiberg, T., Dammann, K. L., Dale, O., Aanerud, G. J., et al. (2005). Performance of health status measures with a pen based personal digital assistant. *Annals of the Rheumatic Diseases, 64*(10), 1480—1484. http://dx.doi.org/10.1136/ard.2004.030437.

Liebowitz, M. R. (1987). Social phobia. *Modern Problems of Pharmacopsychiatry, 22,* 141—173.

Liverant, G. I., Suvak, M. K., Pineles, S. L., & Resick, P. A. (2012). Changes in post-traumatic stress disorder and depressive symptoms during cognitive processing therapy: evidence for concurrent change. *Journal of Consulting and Clinical Psychology, 80*(6), 957—967. http://dx.doi.org/10.1037/a0030485.

Lueken, U., Muehlhan, M., Evens, R., Wittchen, H. U., & Kirschbaum, C. (2012). Within and between session changes in subjective and neuroendocrine stress parameters during magnetic resonance imaging: a controlled scanner training study. *Psychoneuroendocrinology, 37*(8), 1299—1308. http://dx.doi.org/10.1016/j.psyneuen.2012.01.003.

Luyk, N. H., Beck, F. M., & Weaver, J. M. (1988). A visual analogue scale in the assessment of dental anxiety. *Anesthesia Progress, 35*(3), 121—123.

MacLeod, C., & Mathews, A. (2012). Cognitive bias modification approaches to anxiety. *Annual Review of Clinical Psychology, 8*, 189—217. http://dx.doi.org/10.1146/annurev-clinpsy-032511-143052.

MacLeod, C., Rutherford, E., Campbell, L., Ebsworthy, G., & Holker, L. (2002). Selective attention and emotional vulnerability: assessing the causal basis of their association through the experimental manipulation of attentional bias. *Journal of Abnormal Psychology, 111*(1), 107—123. http://dx.doi.org/10.1037/0021-843X.111.1.107.

Maoz, K., Abend, R., Fox, N. A., Pine, D. S., & Bar-Haim, Y. (2013). Subliminal attention bias modification training in socially anxious individuals. *Frontiers in Human Neuroscience, 7*, 389. http://dx.doi.org/10.3389/fnhum.2013.00389.

McCormack, H. M., Horne, D. J., & Sheather, S. (1988). Clinical applications of visual analogue scales: a critical review. *Psychological Medicine, 18*(4), 1007—1019.

Mennin, D. S., Fresco, D. M., Heimberg, R. G., Schneier, F. R., Davies, S. O., & Liebowitz, M. R. (2002). Screening for social anxiety disorder in the clinical setting: using the Liebowitz Social Anxiety Scale. *Journal of Anxiety Disorders, 16*(6), 661—673.

Moerman, N., van Dam, F. S., Muller, M. J., & Oosting, H. (1996). The Amsterdam preoperative anxiety and information scale (APAIS). *Anesthesia & Analgesia, 82*(3), 445—451.

Mouthaan, J., Sijbrandij, M., Reitsma, J. B., Gersons, B. P., & Olff, M. (2011). Internet-based prevention of posttraumatic stress symptoms in injured trauma patients: design of a randomized controlled trial. *European Journal of Psychotraumatology, 2*. http://dx.doi.org/10.3402/ejpt.v2i0.8294.

Palermo, T. M., Valenzuela, D., & Stork, P. P. (2004). A randomized trial of electronic versus paper pain diaries in children: impact on compliance, accuracy, and acceptability. *Pain, 107*(3), 213—219. DOI: S0304395903004135 [pii].

Poma, S. Z., Milleri, S., Squassante, L., Nucci, G., Bani, M., Perini, G. I., et al. (2005). Characterization of a 7% carbon dioxide (CO2) inhalation paradigm to evoke anxiety symptoms in healthy subjects. *Journal of Psychopharmacology, 19*(5), 494—503. http://dx.doi.org/10.1177/0269881105056533.

Reid, S. C., Kauer, S. D., Dudgeon, P., Sanci, L. A., Shrier, L. A., & Patton, G. C. (2009). A mobile phone program to track young people's experiences of mood, stress and coping. Development and testing of the mobiletype program. *Social Psychiatry and Psychiatric Epidemiology, 44*(6), 501—507. http://dx.doi.org/10.1007/s00127-008-0455-5.

Rossi, V., & Pourtois, G. (2012). Transient state-dependent fluctuations in anxiety measured using STAI, POMS, PANAS or VAS: a comparative review. *Anxiety, Stress & Coping, 25*(6), 603—645. http://dx.doi.org/10.1080/10615806.2011.582948.

Ryan, J. M., Corry, J. R., Attewell, R., & Smithson, M. J. (2002). A comparison of an electronic version of the SF-36 General Health Questionnaire to the standard paper version. *Quality of Life Research, 11*(1), 19—26.

Rytwinski, N. K., Fresco, D. M., Heimberg, R. G., Coles, M. E., Liebowitz, M. R., Cissell, S., et al. (2009). Screening for social anxiety disorder with the self-report version of the Liebowitz Social Anxiety Scale. *Depression and Anxiety, 26*(1), 34—38. http://dx.doi.org/10.1002/da.20503.

Salaffi, F., Gasparini, S., & Grassi, W. (2009). The use of computer touch-screen technology for the collection of patient-reported outcome data in rheumatoid arthritis: comparison with standardized paper questionnaires. *Clinical and Experimental Rheumatology, 27*(3), 459—468.

Schaffer, A., Kreindler, D., Reis, C., & Levitt, A. J. (2013). Use of mental health telemetry to enhance identification and predictive value of early changes during augmentation treatment of major depression. *Journal of Clinical Psychopharmacology, 33*(6). http://dx.doi.org/10.1097/JCP.0b013e31829e8359.

Schulenberg, S. E., & Yutrzenka, B. A. (1999). The equivalence of computerized and paper-and-pencil psychological instruments: implications for measures of negative affect. *Behavior Research Methods, Instruments, & Computers, 31*(2), 315—321.

Schulz, S. M., Alpers, G. W., & Hofmann, S. G. (2008). Negative self-focused cognitions mediate the effect of trait social anxiety on state anxiety. *Behaviour Research and Therapy, 46*(4), 438—449. http://dx.doi.org/10.1016/j.brat.2008.01.008.

Seddon, K., Morris, K., Bailey, J., Potokar, J., Rich, A., Wilson, S., et al. (2011). Effects of 7.5% CO2 challenge in generalized anxiety disorder. *Journal of Psychopharmacology, 25*(1), 43—51. http://dx.doi.org/10.1177/0269881110364270.

Shiffman, S., Stone, A. A., & Hufford, M. R. (2008). Ecological momentary assessment. *Annual Review of Clinical Psychology, 4*, 1—32. http://dx.doi.org/10.1146/annurev.clinpsy.3.022806.091415.

Spielberger, C. D. (1983). *Manual for the State-Trait Anxiety Inventory (Form Y) self-evaluation questionnaire.* Palo Alto, CA: Consulting Psychologists Press.

Spielberger, C. D. (1999). *State-Trait Anger Expression Inventory-2: STAXI-2 professional manual.* Odessa, FL: Psychological Assessment Resources.

Spielberger, C. D., Gorsuch, R. L., & Lushene, R. E. (1970). *Manual for the State-Trait Anxiety Inventory.* Palo Alto, CA: Consulting Psychologists Press.

Spielberger, C. D., & Sydeman, S. J. (1994). State-trait anxiety inventory and state-trait anger expression inventory. In M. E. Maruish (Ed.), *The use of psychological testing for treatment planning and outcome assessment* (pp. 292—321). Hillsdale, NJ: Lawrence Erlbaum Associates, Inc.

Spitzer, R. L., Kroenke, K., & Williams, J. B. (1999). Validation and utility of a self-report version of PRIME-MD: the PHQ primary care study. Primary Care Evaluation of Mental Disorders. Patient Health Questionnaire. *Journal of the American Medical Association, 282*(18), 1737—1744. DOI: joc90770 [pii].

Stone, A. A., Shiffman, S., Schwartz, J. E., Broderick, J. E., & Hufford, M. R. (2003). Patient compliance with paper and electronic diaries. *Controlled Clinical Trials, 24*(2), 182—199. http://dx.doi.org/10.1016/S0197-2456(02)00320-3.

Stratton, R. J., Stubbs, R. J., Hughes, D., King, N., Blundell, J. E., & Elia, M. (1998). Comparison of the traditional paper visual analogue scale questionnaire with an Apple Newton electronic appetite rating system (EARS) in free living subjects feeding ad libitum. *European Journal of Clinical Nutrition, 52*(10), 737—741.

Stubbs, R. J., Hughes, D. A., Johnstone, A. M., Rowley, E., Reid, C., Elia, M., et al. (2000). The use of visual analogue scales to assess motivation to eat in human subjects: a review of their reliability and validity with an evaluation of new hand-held computerized systems for temporal tracking of appetite ratings. *British Journal of Nutrition, 84*(4), 405—415. http://dx.doi.org/10.1017/S0007114500001719.

Sylvers, P., Lilienfeld, S. O., & LaPrairie, J. L. (2011). Differences between trait fear and trait anxiety: Implications for psychopathology. *Clinical Psychology Review, 31*(1), 122—137. http://dx.doi.org/10.1016/j.cpr.2010.08.004.

Taylor, C. T., Bomyea, J., & Amir, N. (2010). Attentional bias away from positive social information mediates the link between social anxiety and anxiety vulnerability to a social stressor. *Journal of Anxiety Disorders, 24*(4), 403—408. http://dx.doi.org/10.1016/j.janxdis.2010.02.004.

Thorpe, S., Salkovskis, P. M., & Dittner, A. (2008). Claustrophobia in MRI: the role of cognitions. *Magnetic Resonance Imaging, 26*(8), 1081—1088. doi: 10.1016/j.mri.2008.01.022 S0730-725X(08)00043-X [pii].

Van Voorhees, B. W., Fogel, J., Reinecke, M. A., Gladstone, T., Stuart, S., Gollan, J., et al. (2009). Randomized clinical trial of an Internet-based depression prevention program for adolescents (Project CATCH-IT) in primary care: 12-week outcomes. *Journal of Developmental & Behavioral Pediatrics, 30*(1), 23—37. http://dx.doi.org/10.1097/DBP.0b013e3181966c2a.

Watson, D., & Tellegen, A. (1985). Toward a consensual structure of mood. *Psychological Bulletin, 98*(2), 219—235.

Wewers, M. E., & Lowe, N. K. (1990). A critical review of visual analogue scales in the measurement of clinical phenomena. *Research in Nursing & Health, 13*(4), 227—236.

Whybrow, S., Stephen, J. R., & Stubbs, R. J. (2006). The evaluation of an electronic visual analogue scale system for appetite and mood. *European Journal of Clinical Nutrition, 60*(4), 558—560. http://dx.doi.org/10.1038/sj.ejcn.1602342.

Woody, S. R., & Rodriguez, B. F. (2000). Self-focused attention and social anxiety in social phobics and normal controls. *Cognitive Therapy and Research, 24*(4), 473—488.

Zimmerman, M., McDermut, W., & Mattia, J. I. (2000). Frequency of anxiety disorders in psychiatric outpatients with major depressive disorder. *American Journal of Psychiatry, 157*(8), 1337—1340. http://dx.doi.org/10.1176/appi.ajp.157.8.1337.