THE SWEATING COGNITIONS INVENTORY: A MEASURE OF COGNITIONS IN HYPERHIDROSIS

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Abstract

MICHAEL G. WHEATON: The Sweating Cognitions Inventory: A Measure of Cognitions in Hyperhidrosis
(Under the direction of Jonathan S. Abramowitz, PhD)

Primary hyperhidrosis is a dermatological condition involving excessive sweating. Stress and emotional cues play a significant role in the onset of sweating, but little research has been conducted on this aspect of the condition. A cognitive-behavioral approach to hyperhidrosis would suggest that dysfunctional beliefs about the nature and consequences of sweating play a role in increased sweating. I investigated the psychometric properties and construct validity of a new measure of the cognitions hypothesized to be involved in hyperhidrosis: the Sweating Cognitions Inventory (SCI). The SCI demonstrated good internal consistency and a stable, unidimensional factor structure in both a clinical sample of individuals diagnosed with hyperhidrosis and a student comparison group. Sweating cognitions differentiated between the two groups, indicating discriminative validity. Correlations indicated that sweating cognitions were strongly related to sweating severity, and also social anxiety and anxiety sensitivity. Implications for the conceptualization and treatment of hyperhidrosis are discussed.

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ABBREVIATIONS

ASI	Anxiety Sensitivity Index
AUC	Area Under the Curve
BIS	Behavioral Inhibition Scale
CES-D	Center for Epidemiological Studies Depression Scale
IIRS-H	Illness Intrusiveness Rating Scale-Hyperhidrosis
MAP	Minimum Allowable Partial
ROC	Receiver Operating Characteristic
SCI	Sweating Cognitions Inventory
SPIN	Social Phobia Inventory

THE SWEATING COGNITIONS INVENTORY: A MEASURE OF COGNITIONS IN HYPERHIDROSIS

Sweating is a normal physiological response that functions to regulate body temperature. Sweat glands continually produce secretions but are further stimulated by other factors, including gustation, external and internal temperature, and emotions (e.g., anxiety and stress) (Eisenach, Atkinson, & Fealey, 2005). The sudomotor system, which controls sweat output, dysfunctions in some individuals; and one such dysfunction is *hyperhidrosis*. Broadly defined, hyperhidrosis is a medical condition involving excessive sweating beyond that required to maintain homeostasis. It may be focal to discrete regions of the skin (e.g., hands and feet), or generalized to the entire body. Whereas generalized hyperhidrosis often occurs secondary to other medical conditions such as fever and hypoglycemia, primary hyperhidrosis—with which the present research is concerned—is not attributable to another condition. Primary hyperhidrosis is defined as bilateral and relatively symmetric excessive sweating localized to the hands, feet, underarms or face that causes marked distress or impairment and ceases during sleep (Glaser, & Benson, 2007). The onset of this condition is usually in adolescence or early adulthood, and a family history is noted in 30-50% of family members (Kowalski, Ravelo, Glaser & Lowe, 2003). Although males sweat more than females in general, the prevalence of primary hyperhidrosis is similar across genders, with an estimated prevalence of 2.8% in the general population (Strutton, Kowalski, Glaser, & Stang, 2004).

Hyperhidrosis has a negative impact on many life domains, including physical, occupational, and interpersonal functioning (Amir et al., 2000). For example, many affected individuals feel extremely uncomfortable shaking hands with authority figures and many avoid intimacy (Glaser & Benson, 2007). Not surprisingly, hyperhidrosis is associated with substantial quality of life impairments, with 20% of sufferers rating their symptoms as intolerable or significantly interfering with their daily activities (Strutton et al., 2004).

The etiology of primary hyperhidrosis is not precisely known, but is believed to be related more to *emotional sweating*—sweating in response to psychological factors—rather than *thermoregulatory sweating*, which is regulated by internal homeostatic factors (Eisenach, Atkinson, & Fealey, 2005). Thermoregulatory sweating is controlled by the pre-optic and anterior nuclei of the hypothalamus, which monitor core body temperature through the bloodstream and prompt sweating through the activation of the sympathetic nervous system (Glaser & Benson, 2007). Thermoregulatory sweating occurs during the day and at night, and involves body-wide activation of sweat glands as a means to dissipate body heat. Emotional sweating, in contrast, is always diurnal and believed to be controlled by the anterior cingulate cortex (Vetrugno, Liguori, Cortelli, & Montagna, 2003). Moreover, it is usually localized to the face, underarms, hands and feet (Vetrugno, et al., 2003). Most individuals suffering from primary hyperhidrosis report that their sweating occurs in sudden profuse bouts that are triggered by environmental cues such as emotional stressors (e.g., meeting a new person), or physical activity, which is consistent with the view that primary hyperhidrosis is associated with emotional sweating.

Most approaches to understanding hyperhidrosis have involved a medical model in which putatively dysfunctional sweat glands have been the focus of research and therapeutic intervention. For the most part, however, the sweat glands of patients with hyperhidrosis appear to be morphologically normal; but more *reactive* to environmental cues (Eisenach, Atkinson & Feely, 2005). Psychological factors appear to play a crucial role in symptoms, yet there is a dearth of empirical investigations of this topic. Given the apparent role of emotional factors, such as anxiety, in hyperhidrosis, a cognitive-behavioral conceptualization of this problem could lead to an improved understanding of the condition, much in the way that cognitive-behavioral models have improved our understanding of other anxiety disorders with a psychophysiological component such as panic disorder (Clark, 1986) and shy bladder syndrome—the inability to urinate in public (Boschen, 2007).

Based on Beck’s (1976) cognitive specificity hypothesis that dysfunctional beliefs give rise to emotional responses, a cognitive-behavioral model of hyperhidrosis would implicate sweating-related dysfunctional beliefs, such as overly negative appraisals of sweating (“I will be extremely uncomfortable if I sweat”) and exaggerations of the social consequences of sweating (“Others will negatively evaluate me for sweating”). When individuals with these cognitions are confronted with situations or stimuli that provoke sweating, such as warm rooms, exercise, or meeting new people, these dysfunctional beliefs are activated, leading to anxiety. The resultant anxiety activates the sympathetic nervous system (i.e., physiological arousal), which includes increased perspiration. This produces an escalating and self-sustaining cycle in which increased anxiety begets more sweating, which in turn begets more anxiety and so on. Even the mere *anticipation* of sweating in a social situation may also cue this vicious cycle. Readers might recognize some similarity between this proposed model and cognitive-behavioral models of social anxiety (which involves negative appraisals of self-presentation) and panic disorder (which involves negative appraisals of physiologic arousal; Clark 1999).

Few studies, however, have systematically examined psychological processes in patients with hyperhidrosis, and none have investigated the role of dysfunctional beliefs about sweating. Therefore, the present study aimed to empirically examine the dysfunctional sweating cognitions hypothesized by the cognitive-behavioral model of hyperhidrosis outlined above. Specifically, the present article describes the development, psychometric properties, and construct validity of a new measure to assess sweating cognitions: the Sweating Cognitions Inventory (SCI). In the first step (Part 1), a pool of rationally-developed items were administered to a large sample of individuals with hyperhidrosis, and subsequently reduced to form the final scale according to current recommendations for scale development (DeVellis, 1991). In the second step (Part 2), the reduced SCI was administered to a group of undergraduate students to assess the psychometric properties in an independent sample and seek evidence for discriminative validity. Finally, in a third step (Part 3) the SCI's intercorrelations with other variables were investigated in the hyperhidrosis sample in order to examine evidence for convergence and divergence with other constructs.

Part 1: Development of the Sweating Cognitions Inventory

Method

Participants and Procedure

Patients receiving a diagnosis of primary hyperhidrosis between 2000-2005 at the Mayo Clinic in Rochester, MN were identified through retrospective chart review and invited to participate in a research survey. Once identified, these patients were mailed a packet including all of the study measures and instructions (see below). Of 973 surveys mailed, 311 were returned, yielding a 32% response rate. Of the surveys received, missing data and misdiagnosis (e.g., hyperhidrosis secondary to a general medical condition) caused the sample size to be reduced to 226 patients with primary hyperhidrosis. The mean age of this group was 35.7 years (*SD*=13.31, Range 18-80). The majority of the sample was female (68%) and 95% classified themselves as Caucasian.

Measure

Sweating Cognitions Inventory, Preliminary Version. The preliminary version of the SCI consisted of a pool of 28 items that were collaboratively developed by two clinicians with substantial experience with hyperhidrosis patients and knowledge of the condition. Items were designed to assess patients' beliefs about the nature and consequences of sweating (e.g., "People are disgusted by my sweat"). Respondents rated their agreement with each item on a 5-point scale ranging from 0 ("very little") to 4 ("very much").

Results

The performance of the 28 preliminary items was first analyzed following current recommendations for item retention (DeVellis, 1991). Table 1 presents the mean, standard deviation, corrected item-total correlation and average inter-item correlation for each of the 28 SCI items. As can be seen, corrected item-total correlations for all 28 items exceeded the minimum criterion for acceptability of .30 (range in *r*'s = .35 to .82; Nunnally & Bernstein, 1994). All but one item met Nunally and Bernstein's (1994) recommended threshold of .30 for average inter-item correlation. This item (item 11) was therefore excluded from the remaining analyses and not retained in the final scale.

To examine the dimensionality of the SCI, I next submitted the remaining 27 items to a principal axis factor analysis with oblique (promax) rotation to allow the factors to be correlated. The decision of how many factors to retain was based on a combination of several criteria that have been recommended (Zwick & Velicer, 1986), including: visual inspection of the scree plot, parallel analysis (Glorfeld, 1995) and Velicer's Minimum Average Partial Correlation (MAP; Velicer, 1976). The suitability of factor solutions was evaluated according to satisfaction of Thurstone's principles of simple structure (Thurstone, 1947).

Figure 1 presents the observed eigenvalues from this analysis, as well as the 95% eigenvalues from parallel analysis (Glorfeld, 1995). As can be seen, the first four observed eigenvalues were 13.58, 2.04, 1.60 and 1.23 while the eigenvalues from the parallel analysis were 1.81, 1.67, 1.58 and 1.50. Thus these results suggest retaining a three-factor solution. Results from Velicer's Minimum Average Partial (MAP) test, however suggested that four factors should be retained. In light of these discrepant results the three-factor solution is preferable on the basis of parsimony and to maximize factor stability (Gorsuch, 1983). Table 2 presents the three-factor solution with oblique (promax) rotation. The first extracted factor consisted of thirteen items with salient loadings and accounted for 50.3% of item variance. Eight items had salient loadings on the second factor, which accounted for an additional 7.6% of the variance. The third factor consisted of three items and accounted for an additional 5.9% of the variance. However, factors identified by three or fewer items are often less replicable, and so I decided to follow Guadagnoli and Velicer's (1988) most stringent criterion for stability and replicability, which require four or more salient loadings per component when sample size is less than 300. Therefore, I elected to remove the two items from the third factor with the lowest corrected item-total correlations in order to maximize the replicability of the scale's factor structure.

The remaining 25 items were re-analyzed via principal axis factor analysis. The first four observed eigenvalues from this analysis were 13.03, 1.63, 1.45 and .95 while the eigenvalues from parallel analysis were 1.77, 1.64, 1.55 and 1.46 as shown in Figure 2. These results suggest that a single factor underlies the items. Velicer's Minimum Average Partial (MAP) test, however, suggested that three factors should be retained. I chose to adopt the one-factor solution on the basis of parsimony and to maximize factor stability. This single factor accounted for 52.1% of the variance.

In light of the unifactorial structure of the SCI and in order to reduce the burden placed upon respondents, I next sought to condense the scale. Scales are often reduced by selecting a subset of items with the highest corrected item-total correlation, which is appealing in that it tends to increase the internal consistency of the resulting shortened version (DeVellis, 1991). However, such an approach often results in narrower coverage of the original construct, and Stanton (2000) has instead suggested retaining the subset of items that has the highest correlation with the original test score when summed. Therefore I employed Rcrunch (Stanton, 2000) to examine the distribution of correlations between short form and full scale scores in order to reduce the scale. The results of this analysis showed that a subset of 12 items was highly correlated with performance on the full set of items (r = .99). These twelve items were retained and comprise the final version of the SCI. Cronbach's alpha indicated that the shortened version had excellent reliability in the clinical sample (α = .92).

Part 2: Performance in a Student Sample and Discriminative Validity

Method

Participants and Procedure

To verify the psychometric properties of the SCI in an independent sample and assess known-groups validity I next recruited a sample of 482 undergraduate students enrolled in introductory psychology at the University of North Carolina at Chapel Hill. Participants received course credit for completing an online survey that included the SCI and provided informed consent prior to data collection. The mean age for this group was 19.5 (*SD* = 2.9) years and the majority of the participants were female (73%). The ethnic breakdown of the sample according to self report was as follows: approximately 67% Caucasian, 17% African American, 8% Asian, 4% Hispanic and 4% of another ethnicity.

Results

Item-level analysis

Table 3 presents the item properties for the 12 items selected to comprise the final SCI in the student sample. All 12 items had a mean inter-item correlation greater than .30 (range = .33 to .54) and a corrected item-total correlation greater than .30 (range = .46 to .77). Internal consistency for the total score was good (α = .91).

To determine the dimensionality of the SCI in the student sample, I next conducted a principal axis factor analysis in the same manner as that conducted in the hyperhidrosis sample. Examination of the scree plot (Figure 3) and parallel analysis both suggested a single factor should be retained (first three observed eigenvalues = 6.33, 1.05, .86; 95% eigenvalues from parallel analysis = 1.32, 1.24, 1.18). Velicer’s Minimum Average Partial (MAP) test also suggested that only one factor should be retained. This single factor accounted for 52.8% of the item variance and all 12 items saliently loaded on this factor as shown in Table 4.

These findings support the strong psychometric properties of the SCI across the two samples. In both groups the 12-item version of the scale demonstrated acceptable inter-item and corrected item-total correlations, good internal consistency and a unidimensional factor structure.

Evidence for Known-Groups Validity

To examine whether individuals diagnosed with hyperhidrosis endorse more sweating cognitions than those without this condition, I compared SCI scores across the two groups. Within the student sample, 15 individuals (3.1%) reported that they had been diagnosed with hyperhidrosis by a medical professional. This group of individuals had a similar gender distribution compared to the Mayo Clinic hyperhidrosis group, $\chi^2 = 0.88$, $p > .05$, but were significantly younger, $t(238) = -4.93$, $p < .001$, and had a different ethnic composition as shown by a Chi Square test collapsing ethnicity into Caucasian/non-Caucasian categories, $\chi^2 = 26.3$, $p < .01$. However, there were no significant differences between the Mayo Clinic group and the students reporting a diagnosis of hyperhidrosis in terms of sweating severity as measured by the IIRS-H $t(230) = -.59$, $p >05$. or on the SCI $t(230) = -.05$, $p > .05$. These students were therefore included in the hyperhidrosis group for all subsequent analyses. Figure 4 shows the distribution of SCI scores by group. A Kolmogorov-Smirnov test indicated that the hyperhidrosis group's SCI scores were normally distributed, $z = 1.07$, $p > .05$; but that the student sample's scores were positively skewed, $z = 2.67$, $p < .01$; skewness = .98. Given that the *t*-test is robust to moderate violations of the assumption of normality with sufficient sample size, I elected to compare means across groups using this statistic. Individuals diagnosed with hyperhidrosis had a mean SCI score of 36.75 (SD = 12.53), while those without diagnosis of hyperhidrosis had a mean of 23.70 (SD = 8.99). This difference was statistically significant, $t(355) = 14.18$, $p < .001$ accounting for unequal variance across groups. There was no difference in gender composition across groups (χ^2 =

1.14, $p > .05$), but the hyperhidrosis group was significantly older than the student group, $t(710) = 17.06$, $p < .001$. In addition, ethnic composition differed across groups ($\chi^2 = 66.52$, $p < .001$), with the Mayo Clinic sample having a higher proportion of Caucasian participants. The hyperhidrosis group's mean SCI score, however, remained significantly higher than the student group's mean score after controlling for age and ethnic composition differences, $F(1, 679) = 172.26$, $p < .001$.

To further investigate the ability of sweating cognitions to differentiate between individuals, I next computed a receiver operating characteristic (ROC) curve to determine how well SCI scores distinguish between positive (diagnosis of hyperhidrosis) and negative (no reported diagnosis) cases (as shown in Figure 5). The area under the curve (AUC) indicates accuracy, with a value of 1.0 indicating perfect classification and .50 indicating chance performance. The AUC estimate for the SCI was .79 (95% CI = .76-.83), indicating that the SCI discriminates well between individuals. To account for age differences across groups I next regressed SCI total score on age and submitted the residuals to a second ROC analysis. The AUC estimate for this analysis was .70 (95% CI = .66-.75), indicating that the SCI is able to distinguish between those diagnosed with hyperhidrosis and those not reporting a diagnosis, even accounting for age differences across groups. These results suggest that individuals with hyperhidrosis endorse more sweating cognitions, which provides criterion evidence for the SCI.

Part 3: Validity Evidence Based on Relations to Other Variables

I investigated convergent and discriminant validity evidence for the SCI by examining its zero-order Pearson correlations with measures of other constructs in the hyperhidrosis group. I hypothesized that the SCI would be more strongly correlated with a measure of sweating severity (convergent evidence) than with measures of general trait anxiety and depression (discriminant evidence). On the basis of previous findings of a link between hyperhidrosis and social anxiety (Davidson, Foa, Connor, & Churchill, 2002), I hypothesized that the SCI would be correlated with measures related to social anxiety symptoms and cognitions.

Method

Measures

Anxiety Sensitivity Index – 3 (ASI-3; Taylor, et al., 2007). The ASI-3 is an 18 item self-report questionnaire that measures the fear of anxiety-related sensations (e.g., racing heartbeat, dizziness, trembling) based on beliefs about their harmful consequences. The ASI-3 was developed to measure three dimensions of anxiety sensitivity: physical (e.g., fear of dying), cognitive (concerns of losing sanity), and social (worries about social rejection). However, three of the items used in this study came from a preliminary version of this scale and were not included in the final edition. In order to make comparison easier, the student sample was given the same version as the hyperhidrosis sample. Internal consistency for each ASI-3 subscale was acceptable in the present sample (range in α = .82 to .93).

Behavioral Inhibition Scale (BIS; Carver & White, 1994). The BIS is a 7-item self-report questionnaire measuring negative affect in response to threatening cues. Lower scores on this measure indicate greater behavioral inhibition. The behavioral inhibition system is theorized to control the experience of anxiety in response to novel or threatening cues as a means to reduce the probability of harm. The BIS has been found to have high convergence with other measures of trait anxiety and neuroticism (Campbell-Sills, Liverant, & Brown, 2004). Internal consistency was acceptable in the present sample (α =.87).

Center for Epidemiological Studies Depression Scale (CES-D; Radloff, 1977). The CES-D is a 20-item self-report measure of depressive symptoms. The CES-D consists of 20 items developed as a global measure to assess psychological distress or well-being in general community samples. Participants are asked to rate how often they have felt (or behaved) in certain ways (e.g., "I felt sad"; "My sleep was restless") over the past week from 0 (rarely) to 3 (most of the time). Items are summed (4 are reverse scored) to obtain a total score ranging from 0 to 60. Scores of 16 or greater indicate the possibility of clinical depression. Internal consistency in the present sample in was good (α=.94).

Illness Intrusiveness Rating Scale-Hyperhidrosis (IIRS-H; Cina & Clase, 1999). The IIRS-H is a modified version of Devin's original 13-item self-report questionnaire measuring the impact of a medical illness on quality of life (e.g., Devins, et al., 1990). The IIRS-H has been used with clinical populations of hyperhidrosis patients and found to have good internal consistency, test-retest reliability and sensitivity to change (Cina & Clase, 1999). The scale uses a seven point likert scale to measure the impact of hyperhidrosis on multiple domains of quality of life, including: social relations, intimate relations, health, and recreation. For the purpose of this study the IIRS-H was considered as a proxy measure of sweating severity through its impact on quality of life. Internal consistency in the present sample was good (α = .91).

Social Phobia Inventory (SPIN; Connor, et al., 2000). The SPIN is a 17-item self-rated questionnaire assessing symptoms of social phobia. Questions assess a range of social anxiety symptoms including fear, avoidance, and physiological symptoms. The scale has shown good test-retest reliability and convergent validity with other measures of social anxiety (Connor, et al., 2000). Internal consistency in the present sample was excellent (α = .94).

Results

Table 5 presents the correlations between all study measures. As can be seen, the SCI was strongly correlated with the IIRS-H but was also significantly correlated with all of the other study measures. To determine with which measures the SCI was most correlated, I used Steiger's equation for comparing correlation coefficients (Cohen & Cohen, 1983). Results revealed that the SCI was more strongly correlated with the IIRS-H than with either the CES-D (p <.01) or the BIS (p <.01), indicating that sweating cognitions are more related to sweating severity than depression or trait anxiety. With regard to anxiety sensitivity, the SCI was more strongly correlated with the social domain of this construct (ASI-3 social) than with either the ASI-3 cognitive (p < .01) or ASI-3 physical (p <. 01).The magnitude of the correlation between the SCI and ASI-3 social was not significantly different than that between the SCI and IIRS-H (p > .05). Similarly, the SCI was also strongly correlated with the SPIN and Steiger's equation revealed that this correlation magnitude was not significantly different from that with the IIRS-H (p > .05).

It is important to note, however, that both the SPIN and ASI-3 social include questions that pertain to sweating in social situations. For example, item seven on the SPIN asks respondents to rate how much they agree with the statement: "Sweating in front of people causes me distress," while item 13 on the ASI-3 presents respondents with the statement: "When I begin to sweat in a social situation, I fear people will think negatively of me." The content of these items is similar to that of the SCI items, and therefore I computed adjusted totals for both the SPIN and ASI-3 social removing the sweating-related items. The

SCI remained strongly and significantly correlated with the adjusted SPIN total (r = .57, p <.001) and the adjusted ASI-3 social total (r = .51, p <.001). In both cases however, Steiger's equation revealed that the SCI was more strongly correlated with the IIRS-H.

General Discussion

I sought to develop and validate a new measure of the cognitions proposed as part of a cognitive-behavioral model of hyperhidrosis and provide a tool to facilitate future research on this condition. From an initial pool of 28 items, 12 were selected on the basis of their psychometric performance, factor structure, and construct coverage to form the final version of this instrument, the SCI. In both a clinical sample of patients diagnosed with hyperhidrosis and a student sample, the SCI demonstrated good psychometric properties, a stable unidimensional factor structure, and good internal consistency.

A comparison of SCI total scores across groups demonstrated that hyperhidrosis patients scored higher than those not diagnosed with hyperhidrosis, and this difference remained significant even after controlling for differences in age across groups. The ROC analysis suggested that the SCI differentiates between the two groups and is able to accurately identify individuals with the condition. Together these results provide evidence for known-groups validity of the SCI, as individuals with hyperhidrosis had higher levels of sweating cognitions than those without the condition.

Examination of the relationships between the SCI and other measures provide preliminary convergent and discriminant validity evidence for the SCI. Sweating cognitions were strongly related to a measure of sweating severity (convergence) and less related to measures of depression and trait anxiety (discrininant evidence). Sweating cognitions were also strongly correlated with both social anxiety symptoms and the social domain of anxiety sensitivity, suggesting that fears of social evaluation are integral to dysfunctional beliefs about the consequences of sweating. This is consistent with previous research and the cognitive-behavioral model I propose, which suggests a link between primary hyperhidrosis and social anxiety. For example, Endlund (1989) documented the development of social anxiety secondary to hyperhidrosis. Davidson and colleagues (2002) estimated that 25%-32% of social anxiety patients experience moderate to severe sweating. Social anxiety patients with excessive sweating were found to have greater avoidance and impairment compared to their non-sweating counterparts (Davidson, et al., 2002).

The strong association between sweating cognitions and the social domain of anxiety sensitivity is also conceptually consistent. Although anxiety sensitivity was originally investigated as a psychological risk factor for the development of panic disorder (Reiss & McNally, 1985), the construct has been broadened to include other dysfunctional beliefs about the bodily sensations associated with anxious arousal and applied to other anxiety disorders, including social anxiety (e.g., Taylor, 1999). The social domain of anxiety sensitivity involves fear of exhibiting the physical symptoms of anxiety (e.g., blushing, trembling) in front of others. These concerns are common in social anxiety disorder, and Scholing and Emmelkamp (1992) considered the possibility that excessive concern with the public display of physiological symptoms, including blushing, sweating and trembling, represents a distinct subtype of social anxiety disorder. In this context, our data suggest that hyperhidrosis, which involves cognitions about the social consequences of sweating, might be considered as a psychosomatic manifestation of social anxiety in which the particular types of dysfunctional beliefs lead to physiological arousal, and ironically, the very consequences that the person fears (i.e., increased sweating).

The results of this study suggest that dysfunctional sweating cognitions are elevated in individuals with hyperhidrosis, which is consistent with the cognitive-behavioral conceptualization of this condition. These dysfunctional beliefs also provide a possible target for the psychological treatment of primary hyperhidrosis, which could utilize elements from current treatments of social anxiety and panic disorder. The goal of such a therapy would be to correct patients' dysfunctional sweating cognitions through cognitive restructuring and exposure therapy, involving confrontation with feared situations and body states (e.g., sweating while in public). Although cognitive-behavioral treatments based on this model have not been studied for hyperhidrosis, such an approach could be a useful and more cost-effective alternative to existing treatments that are often invasive (e.g., surgical ablation of sympathetic nerves) and associated with negative side effects (Eisenach, et al., 2005).

Several limitations of the present study should be acknowledged. The use of a convenience sample of students as a comparison group is one such limitation. Although participants in the student sample were asked if they had ever received a formal diagnosis of hyperhidrosis (i.e., by a medical professional), these participants were not independently screened. Given that many individuals suffering from excessive sweating do not seek medical attention until years after sweating onset (Haider & Solish, 2005), it is possible that the student group included individuals with undiagnosed hyperhidrosis. The ROC analysis would have been improved if any such false-negative cases had been identified by formal diagnosis. In addition, our measure of sweating severity was indirectly indexed through sweating-related quality of life impairment. Several more direct measures of sweating severity exist, including gravimetric measurement using filter paper to quantify the secretion of sweat (Glaser & Benson, 2007). Future studies should investigate the relationship between sweating cognitions and a direct measure of sweat output.

Additionally, our sample of hyperhidrosis patients may not be entirely representative of the general population of individuals suffering from this condition. For example, while epidemiological estimates (Strutton et al., 2004) suggest that hyperhidrosis affects men and women equally, our sample was predominantly female. This gender disparity has been observed in other treatment-seeking samples (Lear et al., 2007). In addition, our hyperhidrosis sample was predominantly Caucasian, as was reported in a large, multi-site examination of the demographics of those presenting for treatment for hyperhidrosis. These results should be replicated in additional samples with more diverse ethnic and socioeconomic compositions to ensure the generalizability of these results. Finally, the correlational nature of this study limits the conclusions that can be drawn about the validity of the cognitive-behavioral model I propose. Specifically, the cross-sectional design precludes drawing causal inferences, and thus it cannot be concluded that dysfunctional sweating cognitions *cause* excessive sweating. The present study cannot rule out the possibility that such beliefs follow the appearance of sweating symptoms, or that both sweating symptoms and cognitions are caused by one or more third variables. In addition, future studies should investigate the test-retest reliability of the SCI so that it can be used as a process measure in the psychological treatment of hyperhidrosis.

Table 1.

Item properties of the Sweating Cognitions Inventory in the hyperhidrosis sample (N=226).

Item	M (SD)	inter-tem	item-total
1. Others will negatively evaluate me if I sweat.	3.32 (1.31)	0.51	0.74
2. When I sweat, I ruin some things I touch.	2.39 (1.50)	0.35	0.53
3. If I sweat, people will think I'm nervous.*	3.62 (1.32)	0.51	0.74
4. Because of my sweating, no one will want to hold my hand.*	2.55 (1.61)	0.41	0.61
5. I worry about smelling because of my sweating.	3.18 (1.49)	0.30	0.43
6. It bothers me that I sweat.	4.32 (1.08)	0.48	0.69
7. I will be very uncomfortable if I sweat.*	4.13 (1.13)	0.47	0.68
8. People don't like shaking my hand because my hands feel clammy.	2.60 (1.61)	0.37	0.56
9. I will be embarrassed if I sweat in front of people.*	3.85 (1.32)	0.56	0.81
10. I try not to think about my sweating.	3.23 (1.30)	0.32	0.45
11. If I avoid stressful situations, I won't sweat.	2.06 (1.25)	0.25	0.35
12. My sweating causes me to worry about meeting new people and dating.*	2.82 (1.54)	0.53	0.78
13. I worry about others noticing my sweat.	3.84 (1.37)	0.55	0.81
14. People in authority will think less of me because I sweat.*	2.86 (1.47)	0.51	0.74
15. Few people will want to be intimate with me because of my sweating.	2.36 (1.43)	0.46	0.66
16. Even when I'm not sweating, I worry about the possibility of sweating.*	3.00 (1.60)	0.55	0.80
17. I sweat when I'm being evaluated.*	3.16 (1.41)	0.49	0.73

18. People are disgusted by my sweat.*	2.41 (1.38)	0.51	0.74
19. If I get anxious, I will sweat more.	3.58 (1.38)	0.45	0.65
20. I have a hard time with interviews because of my sweating.	2.71 (1.49)	0.52	0.76
21. People won't take me seriously if I sweat in front of them.	2.28 (1.36)	0.50	0.74
22. I'm afraid my sweat will drip and leave a mark.	3.07 (1.62)	0.45	0.67
23. People will think I'm incompetent if I sweat.*	2.11 (1.37)	0.48	0.72
24. If I sweat, my clothes will be damp and I'll be uncomfortable.*	3.67 (1.38)	0.38	0.54
25. My sweating bothers other people.	2.28 (1.33)	0.50	0.73
26. If I didn't sweat so much, I would be more confident.	3.37 (1.63)	0.56	0.82
27. People will think I didn't shower because I'm sweaty.	2.13 (1.36)	0.38	0.54
28. I can never lead a happy life due to my sweat problem.	2.03 (1.34)	0.44	0.65

Note. Inter-item= Mean inter-item correlation; item-total= Mean corrected item-total correlation

* item retained in final scale

Table 2.

Exploratory Factor Analysis of the Sweating Cognitions Inventory: Factor Loadings for the Three-factor Solution.

Item	Factor I	Factor II	Factor III
1. Others will negatively evaluate me if I sweat.	**.67**	.14	.01
2. When I sweat, I ruin some things I touch.	-.09	.06	**.76**
3. If I sweat, people will think I'm nervous.	**.62**	-.02	.26
4. Because of my sweating, no one will want to hold my hand.	-.05	-.04	**.96**
5. I worry about smelling because of my sweating.	**.42**	.28	-.27
6. It bothers me that I sweat.	**.87**	-.12	.01
7. I will be very uncomfortable if I sweat.	**.84**	-.09	-.02
8. People don't like shaking my hand because my hands feel clammy.	-.03	-.11	**.95**
9. I will be embarrassed if I sweat in front of people.	**.95**	-.04	-.03
10. I try not to think about my sweating.	.35	-.01	.16
12. My sweating causes me to worry about meeting new people and dating.	.33	.38	.19
13. I worry about others noticing my sweat.	**1.01**	-.05	-.10
14. People in authority will think less of me because I sweat.	.30	**.51**	.01
15. Few people will want to be intimate with me because of my sweating.	.05	**.62**	.10
16. Even when I'm not sweating, I worry about the possibility of sweating.	**.73**	.21	-.07
17. I sweat when I'm being evaluated.	**.50**	.10	.24

18. People are disgusted by my sweat.	.04	**.73**	.10
19. If I get anxious, I will sweat more.	**.63**	-.03	.12
20. I have a hard time with interviews because of my sweating.	.36	.20	.33
21. People won't take me seriously if I sweat in front of them.	.10	**.69**	.06
22. I'm afraid my sweat will drip and leave a mark.	**.40**	.09	.30
23. People will think I'm incompetent if I sweat.	-.09	**.80**	.13
24. If I sweat, my clothes will be damp and I'll be uncomfortable.	**.58**	.20	-.21
25. My sweating bothers other people.	-.15	**.88**	.14
26. If I didn't sweat so much, I would be more confident.	**.71**	.15	.04
27. People will think I didn't shower because I'm sweaty.	.03	**.86**	-.32
28. I can never lead a happy life due to my sweat problem.	.15	**.58**	-.01

Note. Factor loadings ≥ |.40| are listed in boldface type.

Table 3.

Item properties of the Sweating Cognitions Inventory in the student sample (N=482).

Item	M (SD)	inter-tem	item-total
1. If I sweat, people will think I'm nervous.	2.35 (1.10)	0.45	0.62
2. Because of my sweating, no one will want to hold my hand.	2.21 (1.20)	0.33	0.46
3. I will be very uncomfortable if I sweat.	2.83 (1.33)	0.46	0.66
4. I will be embarrassed if I sweat in front of people.	2.55 (1.25)	0.54	0.77
5. My sweating causes me to worry about meeting new people and dating.	1.64 (1.05)	0.52	0.72
6. People in authority will think less of me because I sweat.	1.61 (0.95)	0.52	0.72
7. Even when I'm not sweating, I worry about the possibility of sweating.	1.66 (1.06)	0.52	0.72
8. I sweat when I'm being evaluated.	1.84 (1.00)	0.46	0.62
9. People are disgusted by my sweat.	1.52 (0.93)	0.50	0.70
10. People will think I'm incompetent if I sweat.	1.34 (0.75)	0.49	0.67
11. If I sweat, my clothes will be damp and I'll be uncomfortable.	2.77 (1.24)	0.46	0.65
12. People will think I didn't shower because I'm sweaty.	1.70 (1.05)	0.44	0.60

Note. Inter-item= Mean inter-item correlation; item-total= Mean corrected item-total correlation

Table 4.

Exploratory Factor Analysis of the Sweating Cognitions Inventory: Factor Loadings for the One-factor Solution in the student sample.

Item	Factor I
1. If I sweat, people will think I'm nervous.	0.64
2. Because of my sweating, no one will want to hold my hand.	0.47
3. I will be very uncomfortable if I sweat.	0.68
4. I will be embarrassed if I sweat in front of people.	0.79
5. My sweating causes me to worry about meeting new people and dating.	0.77
6. People in authority will think less of me because I sweat.	0.77
7. Even when I'm not sweating, I worry about the possibility of sweating.	0.77
8. I sweat when I'm being evaluated.	0.66
9. People are disgusted by my sweat.	0.74
10. People will think I'm incompetent if I sweat.	0.72
11. If I sweat, my clothes will be damp and I'll be uncomfortable.	0.67

Table 5.

Correlations between Sweating Cognitions Inventory and Other Study Measures:

	SCI	IIRS-H	BIS	SPIN	CES-D	ASI-cog	ASI-soc
SCI	--						
IIRS-H	.67*	--					
BIS	-.22*	-.08	--				
SPIN	.61*	.48*	-.39*	--			
CES-D	.44*	.45*	-.17*	.62*	--		
ASI-cog	.30*	.32*	-.20*	.49*	.62*	--	
ASI-soc	.61*	.44*	-.29*	.77*	.54*	.60*	--
ASI-phys	.29*	.30*	-.16*	.47*	.46*	.65*	.60*

Note. SCI = Sweating Cognitions Inventory; IIRS-H = Illness Intrusiveness Rating Scale-Hyperhidrosis; BIS = Behavioral Inhibition Scale; SPIN = Social Phobia Inventory; CES-D = Center for Epidemiological Studies Depression Scale; ASI-cog = Anxiety Sensitivity-3-Cognitive Dimension; ASI-soc = Anxiety Sensitivity-3-Social Dimension; ASI-phys = Anxiety Sensitivity-3-Physical Dimension.

* $p < .01$

Figure 1.

Scree Plot for Factor Analysis of Sweating Cognitions Inventory in the Hyperhidrosis Sample.

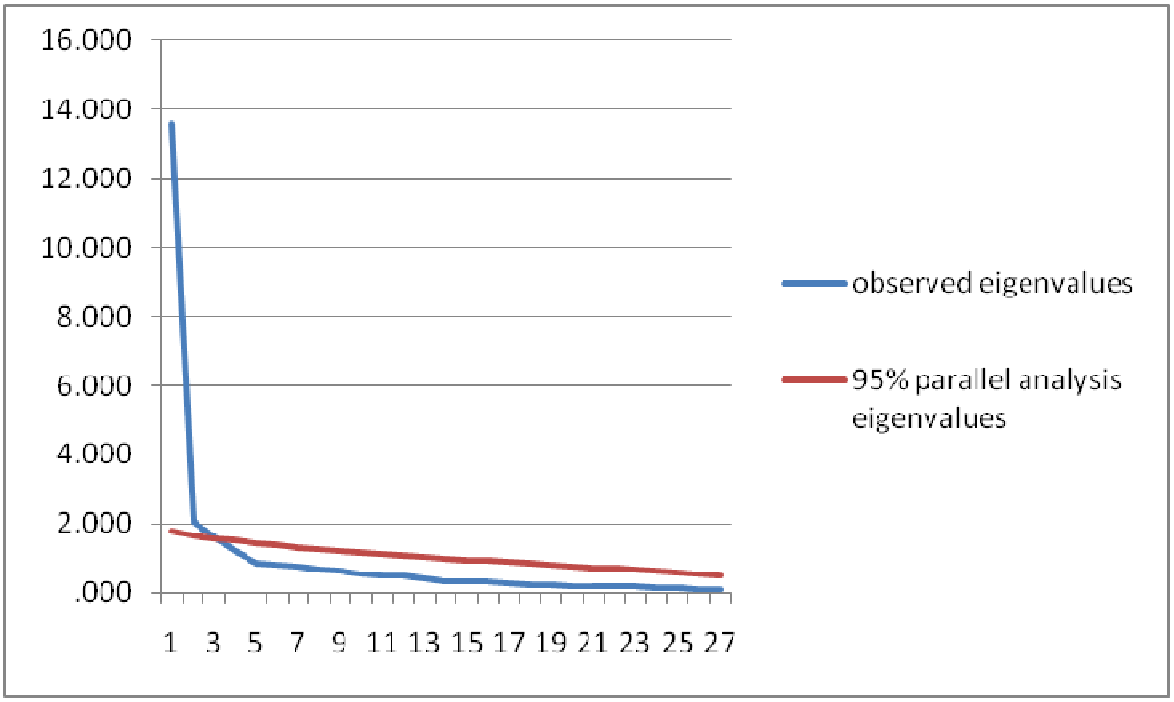


Figure 2.

Scree Plot for Factor Analysis of reduced Sweating Cognitions Inventory in the Hyperhidrosis Sample.

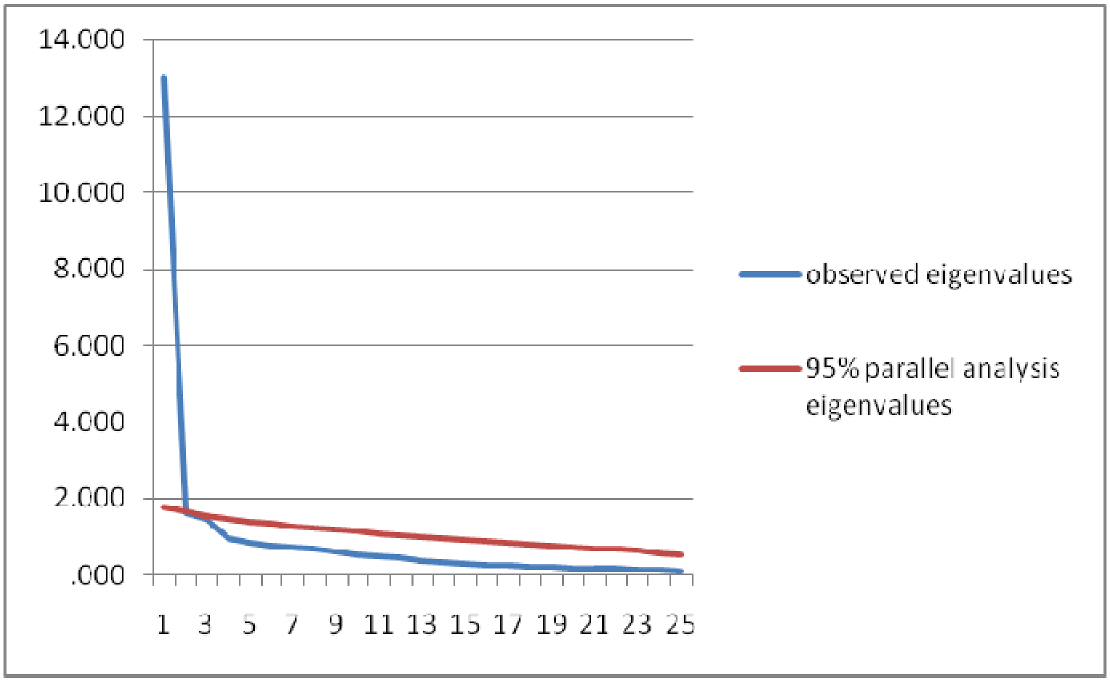


Figure 3.

Scree Plot for Factor Analysis of Sweating Cognitions Inventory in the Student Sample.

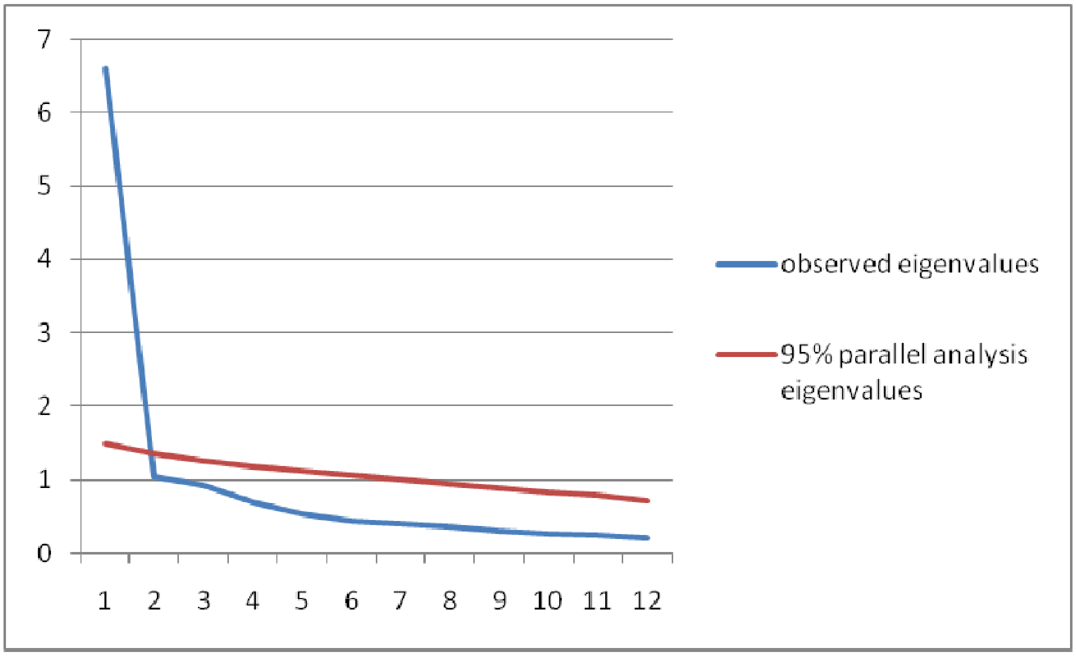


Figure 4.

Distribution of SCI scores by group.

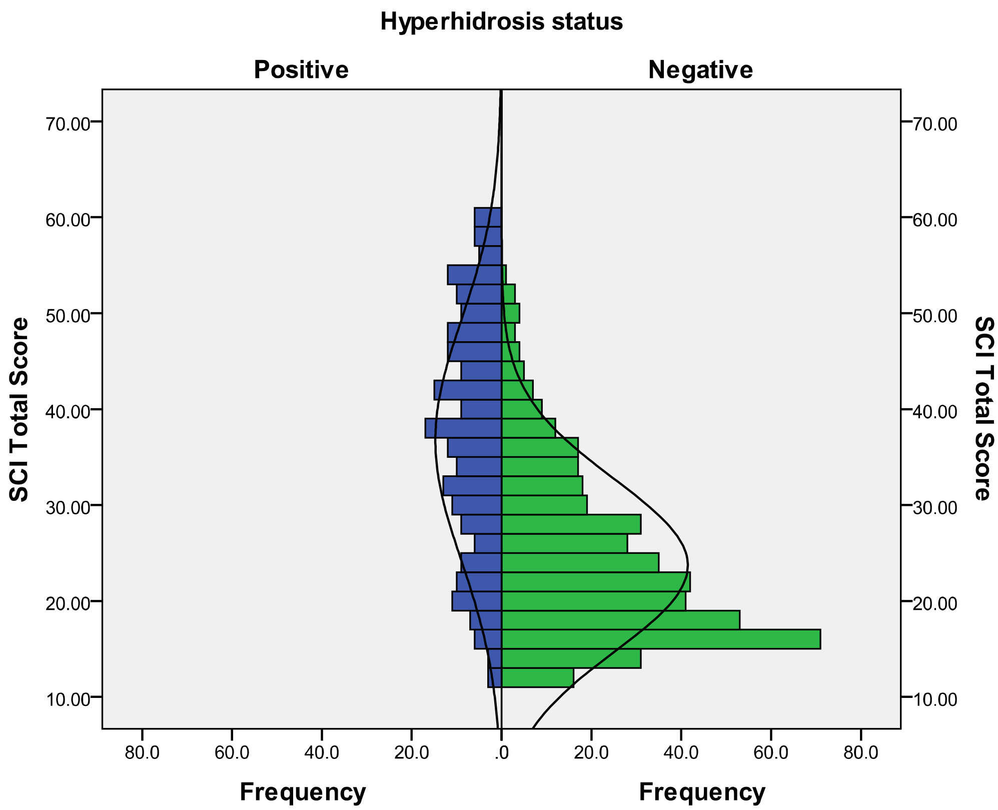
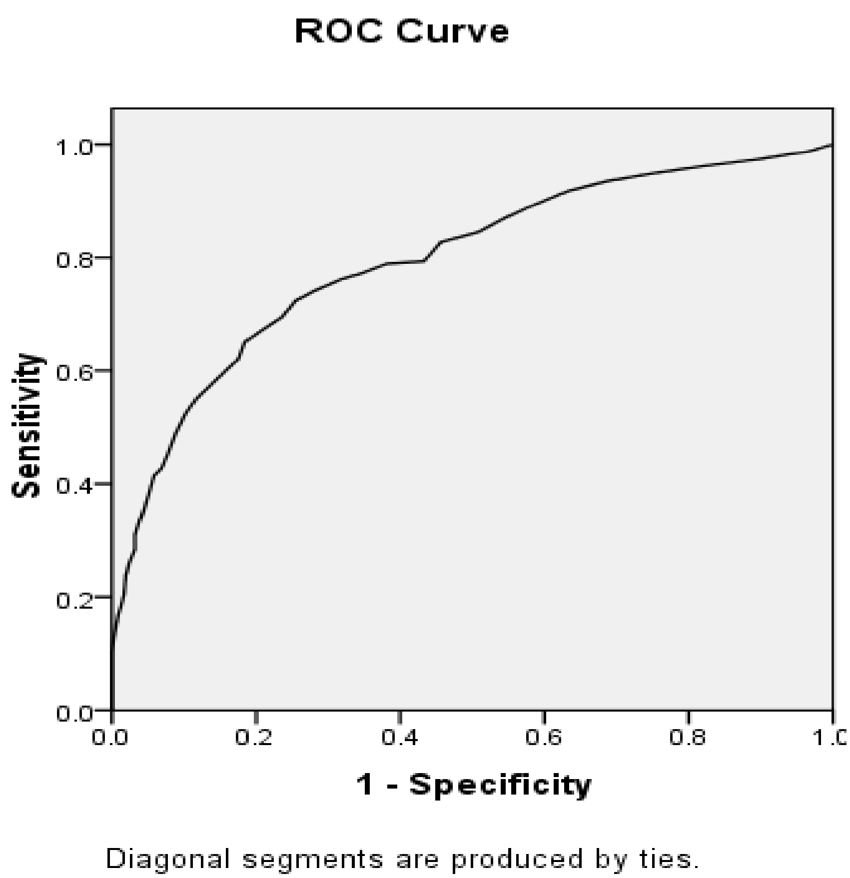


Figure 5.

ROC Curve Differentiating Hyperhidrosis Patients from Non-clinical Participants.



References

Amir, M., Arish, A., Weinstein, Y., Pfeffer, M., & Levy, Y. (2000). Impairment in quality of life among patients seeking surgery for hyperhidrosis (excessive sweating): Preliminary results. *International Journal of Psychiatry Related Sciences, 37*(1), 25-31.

Beck, A. T. (1976). *Cognitive therapy and the emotional disorders*. New York: International Universities Press.

Boschen, M. J. (2007). Paruresis (psychogenic inhibition of micturition): Cognitive behavioral formulation and treatment. *Depression and Anxiety, 0,* 1-10.

Campbell-Sills, L., Liverant, G. I., & Brown, T. A. (2004). Psychometric evaluation of the Behavioral Inhibition/Behavioral Activation Scales in a large sample of outpatients with anxiety and mood disorders. *Psychological Assessment, 16*, 244-254.

Carver, C. L., & White, T. L. (1994). Behavioral inhibition, behavioral activation, and affective responses to impending reward and punishment: The BIS/BAS scales. *Journal of Personality and Social Psychology, 67,* 319–333.

Cina, C. S., & Clase, C. M. (1999). The Illness Intrusiveness Rating Scale: A measure of severity in individuals with hyperhidrosis. *Quality of Life Research, 8*, 693-698.

Clark, D. M. (1986). A cognitive approach to panic. *Behaviour Research and Therapy, 24,* 461-470.

Clark, D. M. (1999). Anxiety disorders: Why they persist and how to treat them. *Behaviour Research and Therapy, 37*, 5-27.

Cohen, J., & Cohen, P. (1983). *Applied multiple regression and correlational analysis for the behavioral sciences*. Hillsdale, NJ: L. Erlaum Associates.

Connor, K. M., Davidson, J. R., Churchill, L. E., Sherwood, A, Foa, E. & Weisler, R. H. (2000). Psychometric properties of the Social Phobia Inventory (SPIN). New self rating scale. *British Journal of Psychiatry, 176*, 379-386.

Davidson, J.R.T., Foa, E.B., Connor, K.M., & Churchill, L.E. (2002). Hyperhidrosis in social anxiety disorder. *Progress in Neuro-Psychopharmacology & Biological Psychiatry, 26,* 1327-1331.

DeVellis, R. F. (1991). *Scale Development: Theory and Applications*. Newbury Park: Sage.

Devins, G. M., Mandin, H., Hons, R. B., Burgess, E. D., Klassen, J., Taub, K., et al. (1990). Illness intrusiveness and quality of life in end-stage renal disease: comparison and stability across treatment modalities. *Health Psychology, 9*, 117-142.

Edlund, M.J. (1989). Social phobia secondary to pathological sweating. *British Journal of Psychiat*ry, 155, 403-405

Eisenach, J.H., Atkinson, J.L.D., Fealey, R.D. (2005). Hyperhidrosis: Evolving therapist for a well-established phenomenon. *Mayo Clinic Proceedings, 80*(5), 657-666.

Glaser, D. & Benson, S. (2007). Hyperhidrosis. In, A. B. Ward & M. P. Barnes (Eds.), *Clinical Uses of Botulinum Toxins* (pp. 175-200). Camdridge: Cambridge University Press.

Glorfeld, L. W. (1995). An improvement on Horn's parallel analysis methodology for selecting the correct number of factors to retain. *Educational and Psychological Measurement, 55,* 377-393.

Gorsuch, R. L. (1983). *Factor Analysis.* Hillsdale, NJ: Erlbaum.

Guadagnoli, E. & Velicer, W. F. (1988). Relation of sample size to the stability of component patterns. *Psychological Bulletin, 103,* 265-275.

Haider, A. & Solish, N. (2005). Focal hyperhidrosis: Diagnosis and management. *Canadian Medical Association Journal, 172*, 69-75.

Kowalski, J., Ravelo, A., Glaser, D., & Lowe, N. (2003). Quality-of-Life effect of botulinum toxin type A on patients with primary axillary hyperhidrosis: Results from a North American clinical study population. *American Academy of Dermatology Annual Meeting.*

Lear, W., Kessler, E., Solish, N., & Glaser, D. A. (2007). An epidemiological study of hyperhidrosis. *Dermatological Surgery, 33,* S69-S75.

Nunnally, J., & Bernstein, I. (1994). *Psychometric theory.* New York: McGraw-Hill.

Radloff, L.S. (1977). The CES-D Scale: A self-report depression scale for research in the general population. *Applied Psychological Measurement, 1*, 385-401.

Reiss, S., & McNally, R. J. (1985). Expectancy model of fear. In S. Reiss & R. R. Bootzin (Eds.), *Theoretical issues in behavior therapy* (pp. 107-121). San Diego, CA: Academic Press.

Scholing, A., & Emmelkamp, P. M. (1993). Cognitive and behavioural treatments of fear of blushing, sweating or trembling. *Behavioral Research and Therapy, 31*, 155-170.

Stanton, J. M. (2000). Empirical distributions of correlations as a tool for scale reduction. *Behavior Research Methods, Instruments & Computers, 32*(3), 403-406.

Strutton, D.R., Kowalski, J.W., Glaser, D.A., & Stang, P.E. (2004). US prevalence of hyperhidrosis and impact on individuals with axillary hyperhidrosis: result from a national survey. *Journal of the American Academy of Dermatology, 51*, 241-248.

Taylor, S. (ed.) (1999). *Anxiety sensitivity: Theory, research, and treatment of the fear of anxiety*. Mahwah, NJ: Lawrence Erlbaum Associates.

Taylor, S., Zvolensky, M. J., Cox, B. J., Deacon, B., Heimberg, R. G., Ledley, D. R., et al. (2007). Robust dimensions of anxiety sensitivity: Development and initial validation of the anxiety sensitivity index-3. Psychological Assessment, 19, 176–188.

Thurstone, L. L. (1947). *Multiple factor analysis*. Chicago, IL: University of Chicago Press.

Velicer, W. F. (1976). Determining the number of components from the matrix of partial correlations. *Psychometrika, 31,* 321-327.

Vetrugno, R., Liguori, R., Cortelli, P., & Montagna, P. (2003). Sympathetic skin response: basic mechanisms and clinical application. *Clinical Autonomic Research, 13*, 256-270.

Zwick, W. R., & Velicer, W. F. (1986). Comparisons of five rules for determining the number of components to retain. *Psychological Bulletin, 99,* 432-442.