Transient state-dependent fluctuations in anxiety measured using STAI, POMS, PANAS or VAS: a comparative review

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Abstract

Several psychometric instruments can be used to measure state-dependent variations in anxiety, including the State-Trait Anxiety Inventory (STAI), the Profile Of Mood States (POMS), the Positive and Negative Affect Schedule (PANAS) and the Visual Analog Scales (VAS). Each of these instruments rests on specific theoretical assumptions about the construct of State Anxiety, and has been widely used for this purpose in different research domains. However, it remains difficult to determine what may be the specificities of these four instruments, when the goal is to measure transient state-dependent variations in anxiety. In this work, we provide a systematic and comparative literature review of studies which have explored rapid fluctuations (i.e. test-retest intervals not exceeding 24 hours) in state anxiety by means of these specific instruments. Almost 200 studies were eventually included in our review. This comparative review confirms that, despite some disparities and specificities, each of these four instruments provides a reliable measure to capture rapid state-dependent variations in anxiety, although they have been used in non-overlapping research domains or experimental contexts.

Keywords: State anxiety, Self report, STAI, POMS, PANAS, VAS

Total number of words*:* 13,284 (references excluded)

1. State anxiety: construct and measures

The compelling observation that specific unpleasant emotional conditions, characterized by short-lived feelings of tension or apprehension, are actually prone to fluctuations depending on external contingencies in the environment was first put forward by Cattell (1966; Cattell & Scheirer, 1958 & 1963) in the second half of the last century, when he proposed the distinction between *state* anxiety and a more stable personality trait (referred to as *trait* anxiety), the latter being related to the tendency to experience feelings of tension and worrisome thoughts. Since this pioneering work, although no consensus has been reached about the true nature of state anxiety as a psychological or physiological construct, this concept has been further elaborated and refined by Spielberger (1966 & 1976) at a theoretical level, and it has been implicated in a myriad of empirical studies that have helped delineate and better characterize the numerous psychological reactions to stressors in humans (e.g., Moser, Hajcak, & Simons, 2005; Amir, Weber, Beard, Taylor, & Bomyea, 2008; O'Brien, Terry, & Jimmieson, 2008), or the physiological activations of the nervous system triggered by external or internal emotional stimuli (e.g., Swartzman, Edelberg, & Kemman, 1990; Chua, Krams, Toni, Passingham, & Dolan, 1999; Carrillo *et al.*, 2001; Lucas *et al.*, 2006; de Rooij, Schene, Phillips, & Roseboom, 2010).

Levels of trait anxiety are considered crucial for people's successful adaptation to the environment, and have been shown to influence a multitude of core psychological components, including well-being and mental health (e.g., Duncko, Makatsori, Fickova, Selco, & Jezova, 2006; Bruk-Lee, Khoury, Nixon, Goh, & Spector, 2009). Consequently, good instruments for measuring stable inter-individual differences in anxiety proneness, considered as a personality trait, have been developed in the affective sciences literature (e.g., Cattel & Scheirer, 1963; Spielberger, Gorsuch, & Lushene, 1970), with the underlying idea that such trait is long lasting and mostly stable across time and situations. At the same time, a

growing number of studies suggested that trait characteristics of anxiety not always accurately predicted psychological responses in specific situations (e.g., Andrykowski, Redd, & Hatfield, 1985; Andrykowski & Redd, 1987; Perry, Parker, White, & Clifford, 1994), nor did they always show a straightforward relationship with the magnitude of anxiety fluctuations over time in response to external events (see Spielberger, 1983; Caumo *et al.*, 2000). In these cases, a less stable measure of anxiety, able to capture these short-lived variations in the state of the individual would be desirable.

In order to appropriately meet these theoretical and empirical considerations, several instruments have been developed over the years, providing alternative instruments for measuring state-dependent fluctuations in anxiety, or more broadly, in affect or mood. Among these instruments, four self-report measures have been widely used in the affective sciences literature: the State-Trait Anxiety Inventory (STAI, Spielberger *et al,* 1970); the Profile Of Mood States (POMS, McNair, Lorr, & Droppleman, 1971); the Positive and Negative affect Schedule (PANAS, Watson *et al.*, 1988), and various Visual Analog Scales (VAS), among which the Visual Analog Mood Scales (VAMS, Stern, Arruda, Hooper, Wolfner, & Morey, 1997) and the VAS-Anxiety (VAS-A). The aim of our review is to introduce and compare these four dominant measures as they have commonly been used in the literature across various domains and disciplines.

1.1. Goals of the study

As it will become evident from the specific sections concerning each of the aforementioned measures (see here below), they are all characterized by good psychometric properties. More specifically, they all provide rather sensitive estimates of fluctuations in anxiety. Capitalizing on their validity and flexibility of application, their use has rapidly led to the development of many research lines, resulting in an almost countless number of scientific publications available today. Accordingly, an attempt to provide a clear overview of their different fields

of application has become increasingly difficult. Surprisingly, no explicit attempt has been done in this direction so far, and the unique resources summarizing the literature on self-report measures of state anxiety remain the comprehensive bibliographies of the individual instruments (e.g., Spielberger, 1989, for the STAI, and McNair, Heuchert & Shilony, 2003, for the POMS). Moreover, systematically comparing the psychometric properties of each measure seems rather difficult, since they have to be retrieved from various and sometimes scattered sources, such as the manuals and a set of psychometric papers addressing different combinations of instruments, with sometimes a lack of consistency across analysis techniques, sample types and research domains (e.g., Chlan, 2004; Stern *et al.*, 1997; Millar *et al.*, 1995). Ideally, psychometric assessments of the four instruments in the same samples, with systematic variations of the contexts, would need to be carried out in such a way to obtain comparative information at the psychometric level. Alternatively, a meta-analysis comparing the four instruments as used in the existing literature might help to gain insight into their specificity and sensitivity within certain domains. However, to the best of our knowledge, no such attempt has been made or is available in the literature so far. Many practical and/or theoretical reasons may potentially explain this lack of systematic comparison of these four instruments. First, as our systematic review suggests, the number of contributions is overwhelming and their contents heterogeneous, such that any attempt to summarize and integrate concurrently all these individual contributions into, for example, a meta-analysis, remains extremely challenging. Second, another major problem arises, as these instruments have primarily been used in different fields or domains, which renders any systematic or statistical comparison across these instruments almost impossible. Finally, it must be emphasized that it remains highly challenging to directly compare the psychometric properties of these instruments, which are in essence very different from each other (e.g. whereas the VAS-A is a single-item scale, the POMS is composed of 65 mood

adjectives/items). Given these existing difficulties and limitations, the goal of our review is certainly not to carry out a systematic comparison of the psychometric properties of these four instruments. Before such a useful work can be initiated, a rough comparison of these four instruments, as well as their preferred domains of application, is first required. This is precisely the purpose of our systematic and descriptive review, whose potential value is thus to provide a first systematic attempt to acknowledge this inherent complexity, and propose a set of classification variables that may eventually help researchers and clinicians in their selection of an instrument (or combination of instruments) aimed at capturing state-dependent variations in anxiety.

In sum, the goal of our review is threefold: (i) first, we provide brief and consistent descriptions for each of the four instruments, including a careful presentation of their individual psychometric properties in relation to state anxiety. (ii) Second, we review the available psychometric data looking at convergent or discriminant validity as they have been reported in the reviewed studies, keeping in mind that all possible comparisons across the four instruments have not been performed yet in the literature, and hence the strength of the conclusions remains limited. (iii) Finally, our goal is also to provide a clear and transparent reading structure of the existing literature addressing questions related to the *state anxiety* construct, as explored using diverse methodologies and across different domains. Such an effort is worthwhile, as it enables to make more explicit some of the common associations made between specific measures and specific sub-domains within the affective science literature. Accordingly, our review work should provide initial clarifications of the possible reasons explaining some of these strong and common associations. Moreover, we also provide some general guidelines for the use and application of these four different instruments, when they are used to capture state-dependent variations in anxiety. As a result, our systematic review might turn out to be valuable for many researchers interested in

capturing state-dependent fluctuations in anxiety, who are frequently confronted with difficulties when deciding which self-report measure might be the most relevant or appropriate to address a specific research question.

1.2 Methods

As we have already alluded to here above, the extant literature on state anxiety using the aforementioned four measures has become impressively vast and differentiated. Hence, in order to efficiently read transversally across this impressive amount of studies and find some unifying factors or variables, we adopted a standardized and quite restrictive "data-driven" approach to perform our literature review. As a first introductory step, we thoroughly present the exact criteria taken up for selecting these specific self-report measures (and not other ones), along with the criteria adopted for either including or excluding single studies from the large pool of available scientific resources. Furthermore, we list and precisely define the descriptive classification criteria used for the hits retained in our review.

1.2.1 General inclusion criteria for the existing self-rating instruments

As it turns out, a large number of self-report measures are nowadays available in the literature to measure anxiety, both in clinical or healthy populations. However, only a subset of self-rated instruments is actually relevant for assessing *state-dependent changes* in anxious responses, while the majority of the tools are mainly designed and used for measuring the more stable dimension of trait anxiety (for an overview of existing trait anxiety measures, see Elwood & Olatunji, in press). Among the instruments that allow repeated assessments of anxiety with short time frame instructions, the tools that were primarily included in our review were the ones most widely used in the literature, best characterized by very good to excellent psychometric properties, and usually applied for scientific research purposes, both in clinical and non-clinical samples. These tools include the State-Trait Anxiety Inventory (STAI), the Profile Of Mood States (POMS), the Positive and Negative Affect Schedule

(PANAS) and the Visual Analog Scales (VAS). Other self-report instruments often used in the literature to capture state-dependent changes in anxiety are the Hamilton Anxiety and Depression Scale-Anxiety (HAM-A; Hamilton, 1959), and the Hospital Anxiety and Depression Scale-A (HADS-A; Zigmond & Snaith, 1983). However, these two latter scales were excluded from our systematic review because they have been used almost exclusively in clinical settings. Other measures, such as diaries, although extremely useful in clinical and non clinical settings, have been considered not relevant for this review either, mainly because they are not commonly used for repeated assessments using short test-retest intervals. Moreover, additional instruments, such as the Subjective Units of Distress Scale (SUDS; Wolpe, 1958 & 1990), the Tension and Effort Stress Inventory (TESI; Svebak, Ursin, Endresen, Hjelmen, & Apter, 1991) or the Emotion Assessment Scale (EAS; Carlson *et al.*, 1989), have been considered as well, but given their limited dissemination, they were not included in our review[1]. The same restriction has been applied to the different questionnaires designed to assess very specific subtypes of anxiety (as opposed to state anxiety defined as a general/uniform construct), as the Smith Somatic Stress Symptoms Scale-State (SSSSS-S; Smith, 1990), the Competitive State Anxiety Inventory (CSAI-2; Martens, Vealey, & Burton, 1990), the Job Anxiety Scale (JAS; Linden, Muschalla, & Olbrich, 2008), the Dental Anxiety Scale (DAS, Corah, 1969) or similar more specific instruments.

1.2.2 Description of the search strategy and specific selection criteria entailed

To perform our systematic literature review we used multiple and commonly available search engines, including PsychInfo (from 1970), PsychArticles (from 1970), and the databases of ISI Web of Knowledge (namely, Web of Science®, Inspec® and Medline® from 1975). More

[1] When compared to the four dominant self-report measures (STAI: 315 total hits; PANAS: 188; POMS: 196; VAS: 190), it becomes evident that the use of the SUDS (23 hits in Isi Web of Knowledge, 0 hits in PsychInfo and PsychArticles), EAS (0 hits in Isi Web of Knowledge, 5 hits in PsychInfo and PsychArticles) and the TESI (1 hit in Isi Web of Knowledge, 6 hits in PsychInfo and PsychArticles) remains limited.

precisely, we searched these databases (upper time limit was April 2010) for hits containing "state anxiety", when combined with the following expressions or keywords: "STAI-S", "STAI-State", "STAI Y-1", "POMS", "PANAS", "VAS"[2]. Subsequently, we further refined our search in Web of Knowledge to studies falling under the domains "Psychology" and "Neurosciences". During a second stage, once the corresponding relevant contributions were all collected (i.e., 889 hits when collapsing across questionnaires and search engines), another restriction on the basis of the time frame used for the assessments was applied: we included in this review studies using the aforementioned self-report measures in the context of short-term instructions (e.g., *at the moment, in the past few minutes* etc.), as opposed to trait-like instructions (e.g., *in the past few weeks*, or *in general*) since we aimed to study transient state-dependent fluctuations in anxiety. Among them, we considered relevant for this review only studies carried out with repeated measures designs, in which two (or more) testing occasions were separated by short[3] test-retest intervals. This systematic and narrow search of the literature resulted in a total pool of 197 studies using at least one (or sometimes a combination of) the self-report measures described here above (STAI, POMS, PANAS and VAS) and meeting all the aforementioned selection criteria. Among these 197 studies, 130 used the STAI, 70 the VAS, 40 the POMS and 33 the PANAS, either in isolation or in combination with another measure. Eighty-three studies used multiple measures. Clearly, the strength of this search procedure is that this specific outcome can be easily replicated by an independent researcher, if a similar literature search is performed with the same selection criteria, and using the same standard databases. The full bibliographical details of the

[2] Note that for the STAI-S the use of multiple research keys was required to overcome many inconsistencies in the way this specific part of the inventory has been commonly referred to in the literature, while for the three other questionnaires, a more widely accepted consensus regarding the use of the acronyms was found. In general, we adhered to the standard acronym used by the developers of the scales and reported in the published manuals.

[3] 'Short' has been formally operationalized as *within the 24 hours.* Although more longitudinal studies are certainly equally valid from a scientific viewpoint, we wished to focus in this review on "rapid" changes in anxiety and assess the ability of these four instruments to capture these fast and short-lived fluctuations.

references/hits (n = 197) retrieved using the aforementioned search keys and criteria is provided as supplementary material, and thoroughly summarized in Table 1.

1.2.3. Classification variables

As a final step, we examined all the retained studies, and, in order to organize them in meaningful categories, we and carried out a systematic descriptive classification according to a limited number of variables. Six main classification variables were used: "*construct", "domain", "population", "manipulation", "direction of the effect",* and *"approach*". Note that these variables have been selected after careful consideration of the extreme variability across the retained studies, because, in the authors' opinion, they are good descriptors for the results, enabling comparisons among them despite their large heterogeneity. We have to acknowledge that other classification variables may be possible or acceptable, and were indeed initially considered by the authors (e.g., number of assessments; syndrome subtype in clinical studies; presence of concurrent non self-report measures, and so forth). However, these alternative variables have subsequently been excluded because they did not allow the extraction of any extra relevant information that could be used to better organize the different contributions included in our review. Moreover, we must add that each variable does not necessarily match a clearly identified concept of a putative theoretical model. Instead, the classification variables entailed are mainly descriptive and are based on the need of structuring the result of the search in an objective way, though respecting as much as possible the standpoint and interpretation of the authors of the original contributions.

Here below, we provide a list of the variables used in our review, with their corresponding labels and characteristics.

Construct: "Anxiety", "Affect", "Mood", "Stress", "Distress" or *"Fear"*. This classification variable corresponds to the theoretical or empirical concept that the authors

referred to, when articulating the research question or expected results. In this respect, most of the papers classified with the label "*Anxiety"* refer to a negative emotional state, characterized by a reaction of the organism (usually including changes in the body and the brain) to stressors, undermining the general well-being. Most of the studies did not provide any specific definition for anxiety when they referred to this construct; usually they simply reported the Spielberger's one (Spielberger, 1983). However, in a minority of cases, the authors were more specific in their definition, and they usually referred to anxiety as a physiological reaction to stress, mediated by subcortical circuits in the brain, involving emotional, behavioral, somatic and cognitive components (e.g., entry 145 in Table 1); this physiological reaction, in specific occasions (e.g., patients tested before undergoing surgery) might lead to increased responses to stressors. Obviously, this definition still remains relatively broad, and encompasses different aspects of anxiety. Nonetheless, in order to compare the 197 entries retained in our review, as well as to stick as much as possible to the specificities of the authors' concepts, which not always readily reflected the constructs which the single self-report measures were designed to measure, we had to include, besides "*Anxiety*", other labels reflecting state-dependent fluctuation in emotional response (i.e., "*Mood*", "*Affect*", "*Stress*", "*Distress*" and "*Fear*).

Domain: "Treatment", "Experimental", or "Applied". Under the label *Treatment* we categorized each manipulation that was designed by the authors in order to lower or down-regulate anxiety levels. Examples of "*Treatment"* manipulations are pharmacological trials with anxiolytic drugs, alternative therapies as massage or aromatherapy, cognitive techniques (such as attentional bias or interpretation trainings), or more physical-oriented approaches (such as controlled bouts of aerobic gymnastics). By comparison, "*Experimental"* indicates that the manipulation was designed with the aim of inducing increases in anxiety levels either experimentally (with cognitive tasks, for example) or pharmacologically (with psychoactive

or stress-resilience depressor drugs)[4]. We sometimes encountered studies in which, although the test-retest design criterion was fulfilled, no specific manipulation was visibly implemented. Representative examples are studies tracking affect fluctuations of circadian rhythm in healthy volunteers, or studies modeling the temporal dynamics of anxiety fluctuations in athletes during competitions. They have been included as "*Applied"*.

Population: "Clinical" vs. "Non Clinical". With the *Clinical* label, we included studies that involved patients belonging to different "medical" groups, including cancer patients, anxiety spectrum disorder patients (Generalized Anxiety Disorder, Social Anxiety Disorder, Post Traumatic Stress Disorder, different phobias), depressed patients, psychiatric in- and outpatients, patients scheduled for elective surgery, or, more generally, any hospitalized patient under treatment or observation. Under the "*Non Clinical"* classification, were grouped the studies involving healthy participants, including in the subclinical domain (e.g., Table 1, entries 137, 154 & 156).

Manipulation: "Central", "Peripheral" or "No Manipulation". This fourth variable refers to the content or modalities of the actual experimental manipulation performed by the authors in their study. A manipulation was considered "*Peripheral"* when it primarily targeted the body (or specific segments of the body), and used physical actions to directly intervene on it. Examples of studies meeting this criterion are all the ones involving treatments as massage or physical activities, but also the experimental ones involving manipulations of physical activity characteristics (for example, when acute bouts of gymnastics were manipulated in

[4] In specific cases, when an experimental design combined anxiety down-regulation (e.g., via drugs) with experimentally increased anxiety (by means of stress-inducing tasks, for example), the preferred label was "*Treatment"*, because the experimental induction of tension or stress was meant to be only functional to the testing of the regulatory factor. On the other hand, when the positive outcome of an experimental manipulation was not expected or hypothesized *a priori*, or when both the directions of the effect were tested (for example, when exploring the effect of positive and negative interpretive bias training onto subsequent neutral tasks), the "*Experimental"* label has been chosen consistently.

duration or intensity to model their effects on mood or affect, instead of being applied with the explicit aim to obtain a moderating effect on anxiety). With "*Central"*, we included the studies capitalizing on cognitive processes for either up- or down-regulating state dependent levels of anxiety (such as the implementation of stressful tasks, exposure to threat stimuli, classical conditioning paradigms, attentional bias training and so forth). Noteworthy, common to all these tasks, is that the effect of the manipulation is assumed to be mediated by cognitive/central processes. As it turned out, we encountered special difficulties to ascribe one of these two labels to a group of studies where certain experimental manipulations were applied through one of the sensory modalities of the participants (e.g., music, bright light exposure, olfactory stimulations) or blindly taken in by the volunteers (as any medication in placebo controlled pharmacological trials), hence suggesting a bottom-up/peripheral action or way of delivery. In other words, in all these cases the participant was mainly a passive receiver of the experimental action, with no mediation of any conscious cognitive processes. Nonetheless, and crucially, all these experimental trials assumed that the treatment, or more generally, the manipulation used, actually targeted structures of the central nervous system. For this reason, we decided to ascribe to all the studies involving these types of manipulations the "*Central"* classification label. Furthermore, in another group of studies (mainly the ones classified as "*Applied*" following the variable "*Domain",* see here above) the authors did not use any manipulation in order to test their hypotheses, and accordingly, the label "*No Manipulation"* was ascribed to them.

Direction of the effect: "*Induction" vs. "Regulation".* This variable seeks to identify the direction of the effect evoked by the manipulation onto the levels of state anxiety, here coded on the basis of the expected results. Hence, a study aiming at showing a reduction of state anxiety after completing a given physical treatment (e.g., a sauna session), would be classified as "*Regulation"*. When considering an opposite case, for example a study

purposefully designed to measure the effects of increasing levels of state anxiety on decision making, this study would be classified as "*Induction"*. Note that a combined label "*Induction/Regulation*" is possible for studies exploring the modulatory effects of treatments onto experimentally induced states of heightened anxiety.

Approach: "Descriptive" vs. "Causal". This sixth variable refers to a binary classification. A study is considered "*Causal"* if the manipulation used in the experiment was purposefully designed to change levels of state anxiety. In all the other cases, namely when the manipulations were implemented for other purposes, and the fluctuations in state anxiety were measured only as a side effect, the study was classified as "*Descriptive"*. For example, a study testing the relationship between Acute Tryptophan Depletion (ATD) procedures and amygdala reactivity to emotional stimulation, when the self-rated anxiety measures were eventually used only to control for undesired side-effects of the amino acid drink onto levels of affect (see entry 40 in Table 1), receives this qualification.

2. Self-report measures capturing state-dependent fluctuations in anxiety

2.1 State-Trait Anxiety Inventory (STAI)

2.1.1 General description, main use and psychometric properties

The *State-Trait Anxiety Inventory* (STAI) is a widely used instrument, primarily designed to measure anxiety either when it corresponds to a relatively stable personality disposition, or when it refers to a transitory emotional state, prompted by external or internal stimuli (Spielberger *et al.*, 1970; Spielberger, 1983). Given the scope and aims of this review, here we mainly focus on the latest revised edition of the STAI[5] (Form Y) and, more specifically,

[5] Since scores on STAI Form Y (Spielberger, 1983; Vagg, Spielberger & O'Hearn, 1980) and STAI Form X (Spielberger et al., 1970) are highly correlated (*r* correlation coefficients ranging from .96 to .97 in American students), the use of the unrevised form may, in some cases, be accepted. Nevertheless, the use of the Y version is highly recommended because of its more stable and replicable underlying factor structure, obtained after having identified and replaced some items providing only poor psychometric properties (Spielberger, 1983).

on its state part (STAI Form Y-1). Although a large number of names or abbreviations have been ascribed to this inventory, we will consistently refer to the State-Anxiety scale of the STAI (Form Y) as to the STAI-S. The STAI-S is a 20-item self-rating inventory composed of short verbal statements that participants have to rate using a 4 points Likert scale according to the subjective experienced intensity of each described feeling (1 = *not at all*, 4 = *very much so*). The standard instructions stress the importance to perform the ratings using the intensity of feelings at the moment of the assessment (*right now, that is, at this moment)*[6].

The factor structure of the STAI-S is characterized by two main dimensions (*Anxiety-Present* and *Anxiety-Absent*), which are each loaded by ten of the 20 items belonging to the inventory. The total score, obtained after summing up the scores obtained for the 20 single items, ranges from 20 to 80 points, with higher scores indicating higher anxiety levels. The scores for the 10 items loading the Anxiety-Absent factor are reversed before the sum is computed. Normative data for various English-speaking populations (e.g., students, adults in different age groups, military recruits) are reported in the *Manual* for Form Y (Spielberger, 1983). Noteworthy, translated forms of the STAI are now available in more than 60 languages and dialects (Spielberger & Reheiser, 2009), and norms for the some of the translated versions are available in the literature. Moreover, guidelines for further linguistic adaptations are provided in the *STAI (Form Y) Test Manual* (Spielberger, 1983).

Overall, the STAI-S provides excellent psychometric properties: the internal consistency measured using Cronbach's *alpha* coefficient, ranges from good to excellent across several populations (e.g., between .86 and .95 in Spielberger, 1983; .94 in Creamer, Foran, & Bell, 1995). Noteworthy, *alpha* coefficients are typically higher for the STAI-S when state anxiety is assessed under conditions of psychological distress, due to the peculiar positively skewed

[6] Simple modifications of the instructions enable flexibility, and yield similar assessments based either on previous (and still recent) moments in time (e.g., *during the last block of the task*, or *during the therapeutic session*), or for a future or hypothetical situation (*just before* or *during a very difficult exam*, for example).

distribution of the STAI-S scores in relaxed situations, as compared to a more normal distribution under conditions of psychological stress (Spielberger, 1983; Spielberger & Reheiser, 2009). Further evidence for the good reliability of the STAI-S is provided by relatively high item-remainder correlations (median *r* range from .55 to .63 in several independent normative populations). At the same time, however, the stability of the STAI-S, as measured by test-retest correlations, is low (in the *Manual*'s samples *r* = .34 - .62, depending on the population and on the test-retest interval). Nonetheless, it is worth mentioning that given the transitory nature of the anxiety state that the STAI-S seeks to capture, low test-retest coefficients are actually expected, and even desirable to some extent (Spielberger, 1983). All in all, the reliability of the STAI Form Y-1 is very good. The same conclusion holds for the validity of this inventory. Construct validity is supported by the sensitivity of the STAI-S scores to manipulations of psychological stress: S-Anxiety scores are systematically higher when the inventory is administered just before or after stress-inducing contingencies, or with the instructions to *imagine* being in such cases, as compared to administration in relaxed conditions. Since the evidence for concurrent and discriminant validity provided in the *Manual* mainly refers to the Trait Form of the STAI X, it will not be reported here[7] (for details, see Spielberger, 1983). More relevant for the purpose of this work is the notion that the STAI-S items cover a wide item-intensity specificity range (i.e., the items differ in their sensitivity to diverse degrees and types of stress): because certain statements provide better discriminations at low anxiety levels, while others are more sensitive to variations in higher levels of stress, the STAI-S can be used to measure state anxiety under broadly varying stress conditions. For this reason, the use of the entire scale for

[7] Since the STAI-S was developed chronologically before other instruments measuring state anxiety, this may explain why no concurrent validity scores are provided in the *Manual*. In turn, the STAI-S has been used as reference for the validation of other instruments: for this reason, the correlation coefficients with the POMS, PANAS and VAS are reported in the sections concerning their respective psychometric properties (paragraphs 2.2.1, 2.3.1 and 2.4.1).

measurement of state anxiety is highly recommended (Spielberger,1983). However, when shorter testing protocols are desirable (for either practical or clinical reasons), pruned versions are possible and acceptable. In this case, the single item-remainder correlations reported in the *Manual* should be taken into account when selecting the most optimal items while at the same time, the different item-intensity specificities should be evaluated in relation to the purpose and setting of the test (Bonke, Smorenburg, Vanderent, & Spielberger, 1987).

2.1.2 Practical usage

The STAI-S is a brief and simple self-rating instrument, characterized by items covering a broad item-intensity specificity range. This feature qualifies it as a good measure for state changes in anxiety in a variety of experimental manipulations, both in clinical as well as subclinical populations. It must be noted that the Y form of the STAI was purified from items related to depression, mania or elation more than anxiety, and this version is therefore preferable to the X form (Spielberger, 1983).

An additional feature of this inventory is that it leaves out items reporting bodily correlates of anxious response (e.g. shaky, sweaty) in favor of more psychologically-based statements. As a result, this methodological choice leads to a less spurious measure of psychological states, as compared to other self-report measures (e.g., PANAS-X, which includes items as *Shaky* and *Sleepy*, see here below for detailed presentation).

As a last remark, since the STAI-S is primarily aimed at capturing subtle state fluctuations in anxiety driven by internal or external stimuli, it is recommended to administer it always before the Trait scale (STAI-T) in order to avoid unwanted priming effects of certain emotional states (e.g., tension).

2.1.3 Main domains of utilization

The STAI-S has been widely used for the assessment of state anxiety in response to various experimental manipulations in the context of psychological investigations. When reviewing the impressively large amount of studies using the STAI-S as outcome measure, it becomes rapidly obvious that the ease to administer this questionnaire, as well as the simple and straightforward scoring procedure, combined with the stability of the underlying psychological construct, have led many researchers to use this specific instrument. However, across these studies, a recurrent way of using this self-report measure is to administer it in combination with anxiety-inducing procedures, in order to assess the corresponding changes in levels of state anxiety. Diverse techniques or approaches have been developed for this purpose, among which cognitive and social stressors appear to be the most widely used. For example, a well validated procedure to successfully induce increases in state anxiety and mental stress is the *Trier Social Stress Test* (*TSST*, Kirschbaum, Pirke, & Hellhammer, 1993, see Table 1, entries 4, 5, 28, 33, 90, 92, 106, 109, 171 & 193). In prototypical studies using this paradigm, participants are usually kept blind to the real purpose of the experiment (i.e., their actual response or resistance to the stressor), and are asked to complete the STAI-S, usually when entering the laboratory at the very beginning of the experiment. After obtaining this baseline measure of state anxiety, the experimental manipulation is usually applied, either to a subgroup of participants or to the whole sample. After the targeted manipulation has been performed, participants are typically informed of a stressful speech assignment, and state anxiety is assessed again using the STAI-S at the end of the preparation phase (that is, when anticipatory anxiety has presumably had the time to ramp up). Finally, the STAI-S is usually administered a last time after the end of the public speech task. Besides the *TSST*, several other manipulations have been successfully used to induce increased levels of mental stress, both in clinical and subclinical populations, when these changes were primarily measured using the STAI-S. These manipulations include stressful cognitive tasks involving

mental calculations (entries 100, 123 & 130), highly complex Tangram puzzles (entry 147), or high speed word processing tasks (entry 128), sometimes used in combination with exposure paradigms, in which fearful or phobic volunteers are briefly confronted to their threat-related objects (as in entry 154). Levels of anxiety have also been manipulated in healthy participants by means of exposure to various neutral stimuli which were designed to induce increases in tension (entries 30, 58 & 136). Furthermore, in order to achieve modulations in state anxiety, mood induction procedures with pictures (entry 56), videos (entries 167 & 184) or virtual reality environments (entries 53, 67 & 102) have also been used in combination with the STAI-S as main outcome measure. The main reason or motivation to induce changes in state anxiety levels in these populations is either to study the psychophysiology of state anxiety (as in entries 123 & 130) or to measure the protective effects of treatments in interaction with ecological stressful situations (as in entries 100 & 128). In this context, the high item-intensity specificity of the STAI makes it an extremely useful instrument, since it enables to capture subtle changes in anxiety, even when differences in baseline scores are reported, as in groups differing for their vulnerability to anxiety (see Bonke *et al.*, 1987).

Whereas the majority of studies reviewed in our work and employing the STAI-S as an outcome measure used paradigms designed to *induce* anxiety in various ways (see Table 1, *"direction of the effect"* variable), a subgroup of studies have used the exact same instrument with the aim to explore possible reductions (or absences of change) of levels of state anxiety, in particular in clinical populations of patients undergoing surgery or anesthesia. Among these studies, the most common anxiolytic treatment that has been tested so far when the STAI-S is the main outcome measure, is exposure to music before medical operation (Table 1, entries 26, 36, 42 and 103). These studies demonstrated the high variability in the use of

the STAI-S, usually with good results, even in clinical settings where the administration time must usually be kept as short as possible and the patient's burden limited.

2.2 Profile of Mood States (POMS)

2.2.1 General description, main use and psychometric properties

The Profile Of Mood States (POMS) consists of a list of 65 adjectives (e.g., *Friendly*, *Tense*) describing possible moods or feelings, each to be scored on a 5 points scale (0 = *Not at all*; 4 = *Extremely*) based on its compatibility with the participant's emotional state. Although judgments based on the feeling experienced in the past week (including the day of the test) are considered standard instructions of the POMS, more short-term requests (i.e., *how are you feeling right now*) can be used when investigating fluctuations of mood in relation to situational factors. Evidence was provided for independency of the POMS factor structure from the rating time frame (McNair *et al.*, 1971, Appendix III). However, some caution is needed when comparing scores obtained using different temporal instructions to the general POMS norms provided in the *Manual* (McNair, Lorr, & Droppleman, 1992). Various studies comparing *right now* and *past week* instructions reported inconsistent patterns of differences in all the factor scores for the two instruction sets, therefore it has been suggested that the sensitivity of the single items might be affected by the different temporal frames in certain samples (for details, see McNair & Heuchert, 2005).

Six independent studies addressed the factor structure of the POMS during the development phase of the questionnaire construction (see McNair *et al.*, 1971): they all yielded to a number of factors comprised between 5 and 7, with the most stable dimensions being Tension-Anxiety, Depression-Dejection, Anger-Hostility, Vigor-Activity and Fatigue-Inertia. An independent replication further confirmed the stability of the three subscales of Anger-Hostility, Vigor-Activity and Fatigue-Inertia, with less consensus for the Tension-Anxiety and Depression-Dejection dimensions, which were nonetheless detected in the two

experimental samples (Norcross, Guadagnoli, & Prochaska, 1984)[8]. The factors scores (obtained by adding up the single items scores within each sub-scale) can also be combined, with the Vigor score weighted negatively, in a Total Mood Disturbance Score (TMDS): the TMDS is presumed to be highly reliable because of high intercorrelations among the subscales (in particular in clinical populations), and it has even been proposed as a reliable measure of state anxiety because of its high correlation coefficients with the S-Anxiety scores of the STAI Y Form (Bolmont & Abraini, 2001), at least under conditions of psychophysical stress. These results suggest that the TMDS may actually reflect a complex low mood pattern that could partially overlap with the construct of state-anxiety response, as captured by the STAI-S. Nonetheless, the psychometric properties of the POMS have always been reported separately for the five (or six) factors, and this approach will also be followed here. Furthermore, because of the specific purpose of this review work on fluctuations in levels of state anxiety, the attention will be primarily focused on the Tension-Anxiety dimension of the questionnaire.

Internal consistency of the Tension-Anxiety subscale is adequately high (Cronbach's *alpha* coefficients range between .90 and .92 in clinical populations, McNair & Heuchert, 2005). As was the case for the STAI-S, the POMS test-retest reliability is also somehow low, even when used with the standard (*past week*) instructions. However, and crucially, the test-retest coefficients are higher when no treatment is applied between the test and retest measures (r = .70 for Tension-Anxiety in psychiatric outpatients), and they decrease when external modifications (e.g., treatment) intervene before the retest phase (r = .51). This sensitivity to change is even amplified when the short-term instructions (*right now*) are used, providing good evidence for the construct validity of the Anxiety-Tension *state* subscale (for details on studies using the *right now* instruction set in combination with emotion-inducing paradigms,

[8] A less stable factor of Confusion-Bewilderment and an additional unscored Friendliness dimension were isolated in a subset of populations, but were not always replicated.

see Pillard, Atkinson, & Fisher, 1967, and McNair & Heuchert, 2005). Evidence for external validity has been provided by means of correlations with other measures capable of capturing contingent changes in state anxiety, including the STAI-S and the Positive and Negative Affect Schedule-Extended form (PANAS-X). The POMS Tension-Anxiety scores have been correlated with all the PANAS-X subscales (with *past week* instructions) and evidence was provided for convergent validity with the Fear subscale (correlation coefficient: .85) and for discriminant validity with all the other subscales of the PANAS-X (all $r < .74$).

Several short forms of the POMS have been developed for inclusion in multi-instrument assessment protocols or in order to be suitable for clinical settings in which the stress or pain experienced by the patients require less time-consuming testing procedures. The POMS-Short Form (POMS-SF, Schacham, 1983) consists in 37 items derived from the original version of the instrument, and it allows separate factors scores as well as a TMDS; its psychometric properties are considered good to excellent, and in certain cases (i.e., Tension-Anxiety subscale) even superior to that of the original POMS version containing 65 items (see Curran, Andrykowsky, & Studts, 1995). The Brief POMS (Cella *et al.*, 1987) is composed by only 11 adjectives, and it enables to compute only a global psychological distress index. Despite the good psychometric properties (Cronbach's *alpha* consistently reported above .90), the absence of more detailed information about possible dissociations among subcomponents of the total score is a major disadvantage of this shortened version of the scale. A 30-items POMS (POMS-B) is available since 1989 (see McNair & Heuchert, 2005): this version of the scale is composed by five items for each of the six subscales, and it has been developed pruning from the original self-rating scale, taking into account the loadings of each item on the separate factors. As a result, its psychometric properties are roughly similar to the 65-items POMS (consistency for the Tension-Anxiety scale is .89 in a group of psychiatric male outpatients and .87 in the respective female group). As for the POMS-BF, the POMS-B

maintains the level of specificity of the original version of the instrument due to the possibility of computing separate scores for the different subscales.

2.2.2 Practical usage

The POMS has been initially developed to measure affective states, and more specifically mood states. In this sense, the Tension-Anxiety factor of the scale identifies the tense mood as a possible counterpart of the concept of state anxiety, as directly measured for example by the STAI-S. Regarding the peculiarities of the POMS and its potential advantages over other self-rating scales, the presence of dissociated and very stable scales for Depression-Dejection and Anger-Hostility, besides the Tension-Anxiety scale, might turn out extremely helpful in further addressing the dimension-specific effects of treatments. As an example, given the large overlap of the anxiety and depression constructs (see Spielberger & Reheiser, 2009; Cella & Perry, 1986; Mineka, Watson, & Clark, 1998, or Wolitzky-Taylor, Castriotta, Lenze, Stanley, & Craske, 2010 for recent reviews on the comorbidity of the two disorders), a reduction along the depression dimension might go undetected when addressing possible mood changes using the STAI-S only. Consistent with this idea, evidence has been provided for a substantial overlap of the STAI-S score with the Total Mood Disturbance Score, which is a compound index and comprises all the POMS subscales (Bolmont & Abraini, 2001). This enhanced sensitivity of the POMS towards differences among scales is supported by the broad range of adjectives included. At the practical level, however, the high specificity of the adjective list might be problematic when the scale is administered to patients with impaired language or verbal skills, or to people with limited lexicon; in such cases, it might be preferable to use non-verbal tools, such as the Visual Analog Scale (see here below). However, this drawback may be overcome, since the manual of this instrument also provides two possible alternatives for each of the 65 adjectives, in case the respondent would ask some clarifications concerning the exact meaning of some of the items.

2.2.3 Main domains of utilization

The POMS has been used primarily as a measure of mood. However, our systematic review shows that a number of studies have used the POMS more specifically, to address the role of physical activity or bodily treatments (e.g., Johrei healing method, aromatherapy or massage) specifically onto levels of state anxiety. Typically, the POMS or a combination of different anxiety measures (usually POMS and STAI-S, see Table 1) is administered before the beginning of the treatment, and repeated again after it, seeking evidence for a decrease in state anxiety (see Table 1, entries 45, 54, 57, 62, 69, 70, 71, 84, 100 & 107). Likewise, several studies have also used the POMS to investigate, using controlled designs, the anxiolytic effects of different physical activities, including single bouts of dynamic Taekwondo exercise (entry 183), Qigong exercise (entry 89), treadmill running (entry 132) and cycling (entry 174). Noteworthy, our review suggests that the POMS is rather seldom employed in clinical settings (cf. Table 1, entries 16, 41, 62, 78, 91, 125, 140 & 182), and never, to our knowledge, with patients suffering from acute pain, due its somewhat lengthy duration of administration. The POMS is nonetheless used in pharmacological trials (entries 44, 64, 72, 121, 159, 160 & 185). Additionally, in combination with the STAI-S and/or with Visual Analog Scales, the POMS is sometimes used to test for the effects of procedures of Acute Triptophan Depletion on mood (entries 41, 78 &125 in Table 1).

To sum up, the results of this systematic review show that more than half of the studies meeting our general search criteria for this measure concern the positive influences of physical exercise or physical treatments, in the domains of sports and health psychology. Nonetheless, our review also suggests that the POMS is rather often used in psychopharmacology and, third, in the domain of experimental and applied psychology (roughly 20% of the studies reported in our review and using the POMS, see Table 1).

2.3 Positive and Negative Affect Schedule (PANAS)

2.3.1 General description, main use and psychometric properties

The *Positive and Negative Affect Schedule* (PANAS) was initially developed to provide a reliable estimate of two broad and largely independent factors implicated in emotional experience: Positive and Negative Affect (PA and NA). The original and most widely used version of the PANAS (Watson *et al.*, 1988) is composed of 20 self-rating items corresponding to adjectives (e.g., *Interested, Distressed*) that describe different states, feelings and emotions. Each of the 10 terms linked respectively to NA and PA requires a score on a 5 points Likert scale. Each rating seeks to measure the intensity of that specific feeling or emotion during a given timeframe for the participant (1 = *very slightly or not at all*; 5 = *extremely*). As was the case for the POMS, simple amendments to the original instructions of the PANAS can be implemented to better address state fluctuations in PA and NA (using instructions asking to rate the feelings '*right now, at the present moment'*), or instead, as a more stable measure of trait-like emotional disposition (in this case, the instructions are changed and state '*you generally feel this way, that is, how you feel on the average'*)[9]. Here we will primarily focus on the specific properties of the instrument when used to capture transient *state* variations (and more specifically when these changes in affect primarily concern the NA factor). Accordingly, the psychometric properties will be reported with respect to the instructions requiring ratings of *present* affect.

The factorial structure of the 20 items version of the PANAS comprises only two orthogonal factors, each related to one of two primary dimensions of mood: Positive Affect and Negative Affect. The two scales exhibit acceptably high internal consistency (Cronbach's coefficient α for NA/present: .85), invariably low intercorrelations (-.15 for *present* instructions) and better test-retest reliability when the timeframe used in the instructions increases (test-retest correlation coefficients: NA/present: .45; NA/general: .71). The NA scale is composed by

[9] Between these two extremes, a wide variety of time frames can be tested, depending on the modifications made to the original task instructions (for details on this topic, see the technical *Manual*; Watson *et al.*, 1988).

items with high loadings on one factor and acceptably low loadings on the other one, providing therefore quite pure markers of one out of two dimensions: for the 10 items in the NA scale, loadings on NA factor are comprised between .52 and .74, while loadings on PA factor are all lower than |.15| (symmetrically, similar values are reported for the items loading the PA dimension, see Watson *et al.*, 1988). Additionally, the internal validity of the scale is high, both for convergent (NA/present: .91) and discriminant (-.15) correlations (obtained with factor analysis: for further details, see Watson *et al.*, 1988). The external validity of the tool has been tested by means of correlation scores calculated with other instruments measuring distress (and psychopathology). For the purpose of this study, the only relevant comparison (i.e., correlations with a measure of *state* NA) is the one performed with the STAI-S (Form X, Spielberger *et al*, 1970), where correlations of .51 were found, indicating mildly good external concurrent validity.

An expanded form of the PANAS (PANAS-X, Watson & Clark, 1994), whose psychometric properties closely resemble the original version (NA/*present*: Cronbach's α: .85; internal convergent validity.89 to .94; internal discriminant correlations: -.05 to -.16; scales intercorrelation: -.06) is also available[10]. Unlike the original version of the instrument, which is based on a conceptualization of the affective structure as a two-dimensional construct (composed by NA and PA, represented as distinctive and orthogonal factors), the PANAS-X is based on a hierarchical structure, which comprises two broad, higher order dimensions (again, NA and PA), each composed by several lower-order sub-scales corresponding to separate affective states. In this expanded scale the higher order constructs indicate the *valence* of the emotional state, while the correlated, and nonetheless distinguishable, lower order dimensions are specifically related to the *content* of the experienced affect. The eleven

[10] The internal validity coefficients provided for the PANAS-X were obtained with correlations between the NA and PA scales (PA scores non reported here) and regression-based scores on the first two Varimax Factors in the samples assessed with the original 60 PANAS-X Mood Descriptors.

sub-scales of the PANAS-X (Fear, Sadness, Guilt, Hostility, Joviality, Self-Assurance, Attentiveness, Shyness, Fatigue, Serenity and Surprise), composed by uneven numbers of items (for a total of 60 adjectives), can be further grouped into three intermediate subcategories on the basis of their intercorrelations and loading values on the two higher order dimensions (NA or PA). The *Basic Negative Emotion Scales* comprise items with highest loadings on Fear, Sadness, Guilt and Hostility, which are in turn intercorrelated and have high loadings on NA (convergent correlations between .69 and .79, discriminant correlations <|.27| for NA/*present*). Particularly relevant in the context of this review work is the Fear subscale, which has some clear resemblance with the STAI-S, and with the Anxiety-Tension scale of the POMS. The internal consistency of the PANAS-X Fear subscale (tested with *present* instructions) is acceptably high (Cronbach's α: .87 in American undergraduate students, Watson & Clark, 1994), and its external validity, as expressed in correlations with the different subscales of the POMS[11], is adequately high (convergent correlation with the anxiety-tension POMS dimension: .85; discriminant correlations with the other dimensions of the POMS: all $r < .74$). Although the psychometric properties of the hierarchical form of the PANAS (PANAS-X) have been reported to be acceptably good and stable across different samples (Watson & Clark, 1991 & 1992), the factorial structure of the NA sub-scales has been questioned (Bagozzi, 1993).

2.3.2 Practical usage

The PANAS Negative Affect scale does not provide a direct and explicit measure of state anxiety *per se*. Nonetheless, both the NA scale and, even more specifically, the Fear subscale of the PANAS-X contain items that are closely related to the definition of anxiety as a

[11] Note that in contrast with the other psychometric properties reported here, which were calculated with *present* instructions, the external validity coefficients of the PANAS-X have been calculated with *past few weeks* instructions. For further details on the PANAS-X psychometric properties with different timeframe instructions, see Watson & Clark, (1991, 1992 & 1994).

'*general or long lasting state of distress, prompted by not explicit or generalized cues'* (cf. Lang, Davis, & Öhmans, 2000). Accordingly, these subscales have consistently been used to address phasic changes in anxiety (or in certain specific cases, stress). In line with this notion, the PANAS and PANAS-X external validity measures provided by the authors (Watson *et al.*, 1988; Watson & Clark, 1994) give acceptably high convergent correlations with the POMS Anxiety-Tension subscale and with the State-Trait Anxiety Inventory-State Form (r = .85 with the POMS Anxiety-Tension subscale and .51 with the STAI-S, both with *Past few weeks* instructions, see Watson & Clark, 1994 & Watson *et al.*, 1988, respectively). The critical items, which are strongly and consistently loading the *Basic Negative Emotion Scales* in the PANAS-X or the NA scale in the 20-item version of the instrument are *Afraid, Scared, Frightened*, *Nervous*, *Jittery*, *Shaky*, *Upset* and *Distressed*. In contrast to the STAI-S, which includes items assessing the Anxiety-Present and Anxiety-Absent constructs independently, the PANAS and PANAS-X scales do not comprise items related to the absence of anxiety. Nonetheless, the PANAS-X Self Assurance scale (comprising items as *Fearless* and *Confident*) and the Serenity subscale, belonging to the *Other Affective States* group and represented by items as *Calm* or *Relaxed*, could be used as measures of the Anxiety-Absent construct.

2.3.3 Main domains of utilization

The PANAS and the PANAS-X scales have been widely used to investigate changes in positive or negative affect states in healthy volunteers, mainly in experimental contexts aimed at either up- or down-regulating stress responses. The PANAS as outcome measure for anxiety has often been used in combination with anxiety-inducing procedures (see Table 1, entries 2, 19, 30, 40, 52, 66, 76, 115, 117, 136, 142, 146, 156, 168, 171, & 192), among which the *TSST* (see also section 2.1.3). As was the case for the application of the *TSST* in combination with the STAI-S, studies using the PANAS as a measure of anxious reactions

have applied experimental designs requiring multiple measurements of positive and negative affect, which were assessed at baseline (i.e., before the primary manipulation), a second time before the *TSST*, and a third time at the end of the speech, in such a way to be able to eventually model the time course of anxious reactions to multiple stressors (see entries 117, 142 and 171 in Table 1). However, our systematic review suggests that, whereas the *TSST* has often been used in combination with the STAI-S to verify changes of the emotional responses in relation to the stressor, the same *TSST* and other anxiety induction procedures (e.g. the presentation of unpleasant pictures or sentences) were used in the literature in combination with the PANAS in order to quantify the *effects* of the induced stress on other cognitive aspects, including decision making processes or patterns of regional brain EEG activity (Table 1, entries 171 & 146). Furthermore, the PANAS has sometimes been used to assess the compensatory effects of cognitive restructuring protocols (entry 156) or positive imagery (entry 75) onto induced stress responses.

Besides this main domain of application, the PANAS has also been used frequently in different fields (e.g., sports and health psychology), in order to assess the positive effects of physical exercise on mood and affect (and more specifically onto negative affect and anxious feelings). In this context, the PANAS has been administered before and after exercises varying in type (Table 1, entry 43), intensity (entries 9 & 20) or duration (entry 152). Interestingly, the PANAS has been also associated with the STAI-S to assess the positive effects of gymnastics on emotional state (entries 86 & 87), and to compare changes in levels of state anxiety caused by bouts of activity in various disciplines, including Yoga, walking, martial arts, cycling and aerobic gymnastics (entries 21, 97 & 129).

In summary, our review shows that the PANAS and PANAS-X scales have mainly been used in experimental paradigms aimed at characterizing factors or conditions able to influence both positive and negative affect (and among the components of NA, state anxiety). By

contrast, it turns out that this instrument has only rarely been used with clinical populations to capture transient state-dependent variations in mood or affect (see entries 21, 136 and 146 in Table 1).

2.4 Visual Analog Scale-Anxiety (VAS-A)

2.4.1 General description, main use and psychometric properties

The *Visual Analog Scales,* or *Graphic Rating Scales*, as they were originally coined, have been introduced in 1923 by Max Freyd, for the purpose of achieving an unbiased judgment of psychological or behavioral characteristics. A VAS is composed by a line whose limits are anchored by two terms representing the extremes of the addressed sensation, and by an introductory question (e.g., *How anxious do you feel right now?*). This form of self-rated measure can be used in combination with several adjectives or statements (e.g., *tense*, *shaky*, *restless*) in order to obtain a measure of these attributes, which is at the same time precise, accurate, sensitive to change, but also not very burdensome in completion for clinical populations. Additionally, due to its intrinsic simplicity, the VAS is a suitable instrument for repeated measurements, also in clinically restraining situations (e.g., directly in the operatory room). The patient is usually requested to mark the point, along the line, that corresponds best to the perceived intensity of the feeling that is mentioned in the question. This procedure has proven to be also suitable for patients with motoric or linguistic problems, or in state of acute stress, where omissions in more burdensome inventories (such as STAI or POMS) are frequent in clinical practice. The most commonly used VAS for the measurement of state changes in anxiety is the so-called VAS-A, composed by one single item proposing the question "*How anxious do you feel right now?"* followed by a line delimited by two anchors "*Not anxious at all"* on one side and "*As anxious as I could be"* on the other side (or similar statements, for example "*No Anxiety at all"* and "*Worst anxiety imaginable"*). With some exceptions (see below the VAMS description) the *null anxiety* anchor is usually positioned at

the far most left of the line, or at its bottom in case of a vertical format, while the *extreme anxiety* anchor is positioned at its right (or top). Scoring of the scale is calculated either with a ruler, measuring the distance in millimeters from the *null anxiety* anchor to the mark, or with stencils, which permit differentiation in the attribution of values to the positions on the basis of distributional properties (Freyd, 1923).

The psychometric properties of the VAS-A have been addressed both for the horizontal and the vertical version of the instrument in several clinical and subclinical populations (Hornblow & Kidson, 1976; Vogelsang, 1988; Gift, 1989; Cline, Herman, Shaw, & Morton, 1992; Millar, Jelicic, Bonke, & Asbury, 1995; Kindler, Harms, Amsler, Ihnde-Scholl, & Scheidegger, 2000; Chlan, 2004). They are quite acceptable, although internal consistency of the scale is not available, since it is composed by one item only. On the other hand, its validity has been addressed by several studies in clinical and nonclinical populations, leading to the conclusion that this instrument is suitable for assessing state changes in anxiety, knowing that the vertical version of the VAS-A seems to be more sensitive to change in affect than the horizontal one (Gift, 1989). The external validity has been reported in numerous populations by means of correlations with STAI-S scores and other measures of anxiety: the correlation scores range from moderately low values[12] (.52 in Cella & Perry, 1986; .50 in Chlan, 2004) to relatively high coefficients (.82 in Vogelsang, 1988). This wide variability somehow suggests that caution is needed when assuming the same psychometric properties for the VAS-A in different populations (see also Hornblow & Kidson, 1976, reporting very different correlation coefficients between STAI-S and VAS-A across several populations). Concurrent validity has also been calculated in respect to the POMS-Tension (*r*

[12] Both the VAS-A and the STAI-S presumably provide an estimate of the same, very specific, construct (namely, anxiety), such that these two instruments should normally share a high portion of variance. Accordingly, correlation coefficients ranging between .34 (Hornblow & Kidson, 1976) and .52 (Cella & Perry, 1986) may be considered moderately low in this context.

= .51), while discriminant correlation coefficients were provided in the same sample with measures of depression (all *r*s < .49, Cella & Perry, 1986)

Test-retest reliability data have been provided both in healthy populations (between .30 and .32 Hornblow & Kidson, 1976; >.50, Cella & Perry, 1986) and in the context of carbon dioxide breathing challenges in panic disorder patients (see entry 189 in Table 1). Pre-challenge VAS-A scores, as well as post-challenge scores and difference/delta scores (obtained after subtracting the pre-challenge scores from the post-challenge, usually higher, ones) were reported for two identical sessions one week apart. Correlation coefficient between scores in the two sessions ranged from .058 for the pre-challenge score to .401 for the delta score and .709 for the post-challenge score, providing evidence for both sensitivity to variable situational factors (pre-challenge low correlations) and for stability in the sensitivity to change (high post-challenge coefficients). This study also pointed out that VAS delta scores might not be the best way to assess anxiety induction, because of their strong dependence to the (unstable) pre-challenge scores.

Several variations in the VAS-A construction and application have been proposed in the past years, leading to instruments with different strengths and weaknesses: the analog scales can be presented in discrete Likert-scale form with verbal instructions (Verbal Anxiety Rating, VAR; entry 18 in Table 1), which leads to smaller omission rates as compared with the visual analog version of the scale, but also to a loss of responsiveness linked to the limited amount of discrete descriptors, as compared to the continuous version (Davey, Barratt, Butow, & Deeks, 2007). Alternatively, the VAS-A has been combined with other scales assessing emotional states, either in vertical Likert-scale format with the null anchor below (as in the Emotion Thermometers: Mitchell, Baker-Glenn, Granger, & Symonds, 2010 & Mitchell, Baker-Glenn, Park, Granger, & Symonds, 2010) or in vertical VAS format, with the neutral anchor above (Visual Analog Mood Scales, VAMS: Stern *et al.*, 1997; Nyenhuis, Stern,

Yamamoto, Lucchetta, & Arruda, 1997). The VAMS version of the VAS-A showed good convergent and discriminant validity, as expressed in the correlation coefficient of the separate VAMS with the different POMS subscales (convergent validity coefficients of the *Afraid* VAMS with the Tension-Anxiety scale of the POMS: .34 to .54 in different samples; mean discriminant validity with non-homologous scales: .16 to .35; mean inter-correlation among VAMS: .14 to .29); acceptable psychometric properties have also been reported for the *Anxiety* Emotion Thermometer (sensitivity measured using the cutoffs of the Hospital Anxiety and Depression Scale: .92; specificity: 0.61).

2.4.2 Practical usage

All in all, systematic research has shown that the VAS-A, in its different declinations, generally performs well in capturing dynamic changes in experienced anxiety state, and can easily be used in clinical contexts. Nonetheless, some recommendations should be made in constructing, standardizing and even simply using VAS scales. First, a very specific unipolar construct should be used in the introductory question and in the verbal anchors. Since many feelings and states can have multiple opposites, only one dimension should be tested in each VAS (Freyd, 1923). The VAS-A (Hornblow and Kidson, 1976), and several other adjectives have been used to assess various constructs. Since the scale is not bound to specific questions, the experimenter or clinician has the freedom to adjust the question and the anchors at his own convenience. However, certain scales have been tested and standardized or validated in the literature, and the recommendation is to adhere as much as possible to one (or more) of them. Some examples of the items used in previous studies addressing the changes in anxiety in diverse clinical populations are the adjectives *afraid* and *tense* (used in the VAMS), and statements regarding the amount of perceived *fear* (entry 73 of table 1), or the possible *correlates of preoperative anxiety* (Kindler *et al.*, 2000). Since the scale has been developed in order to match the needs of clinical populations, the instructions and the

introductory questions should be as simple as possible, in order to minimize omission rates, and contain examples of possible scores (Freyd, 1923; Davey *et al.*, 2007). Moreover, unless a Likert discrete format is used, the VAS line should be continuous and not too long, since it should be perceived as a whole by the participant (Freyd, 1923). Nowadays, automatically scored electronic versions of the VAS-A are commonly available for clinical and non-clinical use, and evidence has been provided for their equivalence with the paper version (van Duinen, Rickelt, & Griez, 2008).

Importantly, some caution is needed when assessing state anxiety levels using combinations of instruments including the VAS-A. This latter measure contains the word *anxious*; hence it is very overt or explicit to participants. Accordingly, it might be good practice to assess the VAS-A after the other measures, in order to prevent any biasing of the responses to the following measures due to the explicit mention of the word *anxious*. However, it must be noted that even questionnaires that are somehow more covert might prime anxious feelings, influencing the subsequent responses to the VAS-A. This problem is crucial in designs involving multiple instrument assessments, and, unfortunately, there is no 'gold standard' rule to deal with this problem in the literature (e.g., Millar *et al.*, 1995).

Although the strengths of the VAS are the quick administration, the relative simplicity of the instructions and the smaller impact that language has on the comprehension and completion of the scale, some potential drawbacks of this way of assessing transient changes in state anxiety should be pointed out. First of all, as previously noted (Gift, 1989), some participants experience problems and uncertainty when translating a sensation into a spatial dimension, as required for the distance between a pre-defined anchor and an arbitrary mark on a straight line. These problems sometimes lead to clustering of the responses at the extremes and at the center of the scale, a phenomenon that might be partially attributed to the *central tendency bias*, a well known psychological phenomenon (Millar *et al.*, 1995). Additionally,

accumulating evidence obtained by the use of the VAS-A in different populations seems to suggest that the distribution of the scores is not always consistent, nor are the correlations with other state anxiety measures (as the STAI-S or the POMS Tension-Anxiety subscale). These observations suggest that norms and cutoffs for high anxiety categories should be obtained separately for different clinical population, and that additional research on the matter is highly desirable.

2.4.3 Main domains of utilization

The VAS-A is a tool that has explicitly been developed to be administered in clinical settings. Hence, it is not surprising to find out in our review that a majority of the relevant studies have used the VAS-A with patients. Consistent with this specificity, several authors have used the VAS-A to explore changes in state anxiety occurring directly within the operatory theater, mainly in patients undergoing surgery or painful dental treatments. The choice of measuring anxiety with a single VAS, or a cluster of them, allows multiple repetitions of the assessment, even during the peri-operative period, when the patients have already received partial sedation (Table 1, entries 1, 73, 95 & 110). In these cases, an experimental manipulation is usually applied immediately preceding or instead of the pre-operatory medication, and the VAS-A is therefore used to test for the efficacy of the target manipulation to eventually reduce levels of state anxiety (e.g., entries 1, 32, 61, 95, 103, 110, 187 & 195). At the same time, our systematic literature review suggests that a second main domain of utilization of the VAS-A, concerns the psychopathology and neuropharmacology of disorders belonging to the anxiety spectrum, as Generalized Anxiety Disorder (GAD), Post-Traumatic Stress Disorder (PTSD), Phobias and Panic Disorder (See entries 4, 10, 12, 24, 41, 63, 78 112 and 189 in Table 1). Moreover, several studies have explored the modulation of anxiety levels in other patient populations as a function of anxiety induction procedures (see entries 22, 85, 99 and

153 in table 1) or dedicated pharmacological manipulations (e.g., entries 41, 78, 125, and entry 79 for a validation study on healthy participants.

3. Comparative evaluation of the four instruments

3.1. Overlap vs. differences for the six classification variables

When carefully looking at Table 1 and the way the six variables (section 1.2.3) account for the heterogeneity found across the 197 retained studies, we can identify some overlap, as well as interesting differences among the four instruments in the way they have been used in the literature to capture transient state-dependent fluctuations in anxiety. Most striking is their selective repeated association with different contexts or situations, as clearly reflected when considering the variables "*Domain*" and "*Population*" concurrently (see Fig. 1d). In this section, for each grouping variable separately, we first discuss the most evident similarities and differences between the four instruments, before we turn to some general conclusions and recommendations.

Construct: "Anxiety", "Affect", "Mood", "Stress", "Distress" or *"Fear"*. This variable corresponds to the theoretical or empirical concept embraced by the authors in their original contribution: it always relates to the state anxiety domain, but sometimes inclusion of more specific or more general constructs was necessary. Based on our systematic review (see Table 1), it becomes obvious that the STAI-S and the VAS-A were the most widely used instruments when the underlying construct was clearly and transparently defined as "anxiety". Presumably, this relates to the unambiguous definition underlying the construct in case of the STAI, and the high specificity allowed by a single-item instrument for the VAS-A. Interestingly, our review shows that the most common multiple assignment is the combination of *"anxiety"* and *"mood"*, whose measurements have been usually achieved by using the POMS in combination with the STAI-S. Interestingly, in several studies the concept of state anxiety closely resembles the concept of "negative mood" or "negative state", and in

these specific case either the POMS alone (cf. Table 1, entries 14, 131, 135, 158 & 174) or the PANAS alone (entries 30, 40, 97 & 156) was used. Conversely, the STAI, initially designed to selectively measure state anxiety, has been used sometimes to measure other constructs such as "negative affect" (see entry 25 in Table 1) "positive affect" (entry 114) "stress" (entries 123 and 175) or "mood" (see entries 87 & 185).

Domain: "Treatment", "Experimental", or "Applied". At first sight, our review suggests an uneven distribution of the studies along these three categories for the four instruments. Whereas three of the four instruments (namely the STAI, the PANAS and the VAS) have primarily been used in studies focusing on experimental designs aimed at modeling changes of the phasic anxious responses, the POMS is distinctive as it has mainly been used in studies designed to treat anxiety states. This difference becomes even more obvious when plotting the four instruments onto a bi-dimensional axis taking into account two independent descriptive variables concurrently, namely "*Domain*" and "*Population*" (Fig. 1d). Figure 1d suggests non-overlapping mean positions for the different instruments along these two axes with a marked shift for the POMS towards the treatment direction, relative to the three other instruments.

Population: "Clinical" vs. "Non Clinical". For this variable as well, differences are visible across the four pre-selected instruments. As can be seen from Figures 1b & 1d, the PANAS has mostly been used in non-clinical samples while the VAS has been used equally in clinical and non-clinical samples to measure state-dependent variations in anxiety. The STAI-S and the POMS occupy relatively intermediate positions as compared to these two "extreme" cases (see Fig. 1b).

Manipulation: "Central", "Peripheral" or "No Manipulation". With respect to this grouping variable, again, dissociations are evidenced for the four instruments. As it turns out

based on our review work, the POMS is distinctive as many studies that have used this instrument focused on manipulations targeting the body ("*Peripheral*"). By comparison, a majority of studies using the VAS (and to a lesser degree either the STAI-S or the PANAS) actually involved manipulations acting on the cognitive or central nervous system ("*Central*", see Figure 2a).

Direction of the effect: "Induction" vs. "Regulation". Figure 2b shows the relative distribution of studies for this variable, separately for each self-report instrument. As can be readily seen, a strong difference is observed between the POMS and the VAS: while most of the studies using the POMS were primarily designed to assess down-regulatory affective processes, a majority of studies using VAS were set up to measure the reactivity of the organism in response to stress or anxiety induction. Interestingly, our review also shows that the highest proportion of studies including a combination of up- and down-regulatory processes actually had the STAI-S as outcome measure (Table 1).

Approach: "Descriptive" vs. "Causal". Our review suggests that this variable was the one providing the lowest discrimination power among the four instruments (see Fig. 1c). Although the number of studies included in our review varies substantially from one instrument to the other (ranging from N = 130 for the STAI-S to N = 33 for the PANAS), most of the studies were classified as "*Causal*" (i.e., the study was designed with the aim to influence levels of state anxiety), relative to "*Descriptive*" (i.e., the study was not set up for this goal), regardless of the instrument used (see Fig. 1c).

Based on this systematic evaluation of the four instruments using our six variables, a main conclusion that can be drawn is the observation of asymmetries or imbalances in the domains of utilization of these four instruments (STAI, POMS, PANAS and VAS). Based on our systematic review, it becomes apparent that these four instruments are used in different

research domains, even if they are all applied to obtain a measure of state-dependent fluctuations in anxiety. When the testing takes place in a clinical environment, VASes clearly dominate, and are the most commonly used instruments, while by comparison, the use of the PANAS, for example, remains extremely limited (see Figures 1b & 1d). On the other hand, our review also indicates that when fluctuations in anxiety are measured and experimental designs are explicitly used, the STAI-S is the dominant instrument, and seems to be the 'gold standard' measure. In these cases, it must be emphasized that the construct under study is usually strictly and clearly characterized as "*anxiety*", as opposed to "*affect*", "*mood*", or "*stress*". Likewise, our review shows that when the research question involves measuring changes in anxiety (or mood) in response to specific treatment conditions administered to non-clinical samples, a majority of studies have used the POMS, which often appears to be considered the most valid instrument in these cases, because of its enhanced specificity in capturing and disentangling discrete effects of the manipulation on putative orthogonal factors (e.g., anxiety, depression or anger).

As anticipated in the introduction section, our review work did not aim, however, at establishing whether these differences found for the domains of utilizations of these four instruments actually result from their non-overlapping intrinsic characteristics (including at the psychometric level, as reviewed here above), rather than a simple tradition to use a specific instrument within a specific domain of investigation. To the best of our knowledge, this is still an empirical question, and no previous work has directly compared the sensitivity of all these four instruments in capturing fine-grained fluctuations in anxiety, when they occur within a short time period. Importantly, it must be noted that systematic comparisons between these instruments have been made (e.g., Davey *et al.*, 2007; Chlan, 2004; Cella & Perry, 1986), but these comparative efforts were mainly carried out to better characterize these instruments when considered only in a very specific domain at a time, as opposed to a

systematic comparison of the sensitivity of these instruments across several or multiple domains. However, as a first attempt towards more systematic comparisons of these four instruments, we have extracted from the studies included in our review (when available), the reported psychometric properties, and summarized them in a Table (Table 2, supplementary material). From Table 2 it becomes obvious that certain properties of the measures match rather well with the ones provided in the manuals (see for example the internal consistency scores). However, it is also clear that other properties (such as test-retest reliability and inter-measure correlations) are not always reported. Moreover, when that is the case, inter-instrument comparisons are often only partial, and moreover generalization across domains remains very difficult, due to the limited use of certain measures in certain domains. Nonetheless, with respect to basic psychometric properties, these four instruments are highly comparable and they provide reliable tools to measure state-dependent changes in anxiety. However, it is clear that more psychometric and comparative work is needed to precisely determine the respective sensitivity (and specificities) of each of these four instruments in relation to a specific domain of application.

3.2. General recommendations for the use of the STAI, POMS, PANAS and VAS

Our systematic review is also informative, as it enables to raise a few recommendations for the use of these four instruments in the context of rapid state-dependent fluctuations in anxiety. First of all, it seems particularly important to provide a clear, good and appropriate operationalization of the construct or variable under study, prior to the actual selection of a given instrument. Does the state-dependent changes under study concern anxiety *per se*, or instead negative mood, affect, stress or any other underlying construct? It seems relevant to clarify this issue from the outset, before using a specific instrument. If the core of the research question concerns "state anxiety", and the definition of anxiety most likely adheres to the one put forward by Spielberger (1983), the use of the STAI-S may be preferred,

because of its wide item-intensity sensitivity, which makes it especially suitable tool to test state-dependent fluctuations in a variety of situations and samples (as shown in this review, see Table 1). If the study is performed with clinical patients and the protocol includes more restrictions or constrains (e.g. limited time to fill out a given questionnaire), the VAS-A stands as a the most optimal instrument to measure state-dependent variations in anxiety, keeping in mind the good correlation of the VAS-A with the STAI-S. Nonetheless, as directly pointed out by authors who compared the performance of the two instruments in clinical settings, some caution is needed when comparing results obtained using these two instruments, due to their different discriminant validity and sensitivity (Davey *et al.*, 2007, and entries 18 & 103 in table 1; see also Table 2). Furthermore, our review also suggests that the PANAS or PANAS-X has explicitly been used in the literature not only as a measure of affect, but also of anxiety or negative mood (e.g., entries 25, 87, 97, 142 and 169 in Table 1). In particular, when the construct entailed is "fear" (rather than pure anxiety), the PANAS-X or a single VAS (e.g., entry 24 or 73) have been the preferred measures. Obviously, when more complex changes in affective state (as opposed to changes in the specific anxiety subcomponent), are targeted by the manipulation, the PANAS remains the most relevant instrument, although occasionally Positive Affect has been measured by using the STAI as well (e.g., entry 114 in table 1). Finally, the POMS remains the most suitable instrument in case not only the tension component of anxiety is under interest, but also the mood condition in a broader sense, and when specific effects onto diverse components of mood are hypothesized, also in light of the strong comorbidity between anxiety and depression. However, our systematic review also shows that, besides the POMS, other measures capturing changes in levels of state anxiety have been used when the construct under investigation was mood (e.g., entry 52, 86, 87, 97, 169 or 185), and might therefore be considered for future use.

Obviously, our review work represents only a first, probably imperfect, attempt, aimed at classifying mostly at a descriptive level a large set of studies published across many different domains in the affective science literature, but which all share measurements of state anxiety using standard self-report measures. Based on the results of this first effort, it becomes clear that more research (including psychometric work) aimed at directly comparing these instruments (not so much with the aim to find similarities, but instead to better delineate the subtle differences and reciprocal strengths among them) would be desirable at this point. As such, our review may be a valuable first step for further research which will eventually help researchers selecting the most appropriate instrument (or combination of instruments) in light of their specific research question and domain.

3.3 Added value of multiple measures?

We have to acknowledge, based on our review work, that various combinations of these measures have been made in the literature, although it does not always appear clear why a combination, instead of a single instrument, was actually preferred. Among the studies using multiple assessment instruments for measuring state changes in anxiety, it must be noted that a few inconsistencies were noted, and as such, they may be informative. Hence, in a small number of studies (i.e., 11/83 where more than one instrument was used in the study), different results were obtained for the different instruments, suggesting some discrepancy. Although these inconsistencies remain overall limited (i.e., 13% of the studies in which multiple assessment tools were used), it is interesting to note that this ratio is comparable for the different combinations used: it ranges from 11% (when combining STAI-S and VAS-A) to 13% (when associating STAI-S and POMS). Notably, the authors often used multiple measures presumably in order to increase the number of variables tested at a specific time: for example, de-Paris *et al.* (2003) used a cluster of VASes to test anxiety, while the POMS-BI was also used concurrently, but to assess state-dependent changes in mood. Nonetheless,

in this study, results for the POMS Tension-Anxiety scale showed no effect of the manipulations (i.e. the implementation of the *TSST* while two different doses of Gabapentine were administered, relative to a placebo condition), although results for the VAS-Tension showed significant increases in response to the stressor. This type of dissociation between different instruments that are nonetheless assumed to tap into the same construct was also acknowledged by other authors, in the context of very diverse experimental designs, and with the use of different combinations of instruments (entries 21, 25, 72, 108, 110, 113, 140, 144, 149, 190). Obviously, in these cases where inconsistencies for the different instruments are reported, the question could be raised as whether a genuine effect of the manipulation in changing state anxiety levels could be assumed. Related to this fundamental question, is also the interrogation about how to deal with such inconsistencies when they appear, and whether the use of multiple measures (for example, using both STAI-S and VAS-A to assess changes in levels of anxiety provoked by a given manipulation) is truly desirable. It is difficult to make any recommendation about the use of a single, as opposed to multiple measures, as this question would need to be answered formally both at the empirical and theoretical levels, and to the best of our knowledge, no study has tackled this specific issue so far. As a caveat, we can add that if the two (or more) measure inform about the same construct ("state anxiety"), then using them in combination would not bring any additional information, as these measures would be merely redundant. Alternatively, if capitalizing on the differences between the instruments is the elective strategy to be eventually able to better describe the composite effects of a manipulation, then inconsistencies for these measures are actually informative and desirable, because in this latter case, they enable to rule out generic effects, and allow revealing more specific modulations. Thus, when using multiple measures and obtaining inconsistencies in the results for changes in state anxiety, this may be perceived as either as a positive outcome or not, depending on the way the added value for using multiple

measures is articulated by the authors, as well as the way these inconsistencies are thoroughly discussed in the study. Therefore, we can only formulate here a prudent recommendation, which is to use a single measure to capture "rapid" state-dependent changes in anxiety, unless specific conditions are met, and the added value of multiple measures has been clarified.

3.4 Conclusions

The main goal of our review was to provide a clear and accessible reading structure for the numerous scientific reports that have explored across diverse domains "rapid" state-dependent variations in anxiety using a limited set of self-report measures (STAI, POMS, PANAS or VAS). A total of 197 studies that fulfilled these specific criteria were eventually included in our review. The rationale was then to perform a systematic "data-driven" classification of this large pool of studies, using descriptive grouping variables providing the potential to better structure and delineate boundaries in this large set of heterogeneous studies. This work enables to show that these four different dominant instruments actually map onto different research domains, where the intrinsic specificities of each tool in capturing these state-dependent variations in anxiety seem to have been exploited and maximized. As such, our review work may be valuable for future research, as it provides a coherent and reproducible framework to assess the specificities and overlap between the four instruments (STAI, POMS, PANAS and VAS), which have been most commonly used in the literature to assess rapid changes in state anxiety in various situations and contexts.

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.N	Reference	STAI State	POMS	PANAS	VAS	Other	Construct	Domain	Population	Manipulation	Direction of the Effect	Approach
1	Abdul-Latif *et al.*, 2001	x			x		Anx	Tr	Clinical	Central	Regulation	Causal
2	Abercrombie, Kalin, & Davidson, 2005			x		x	Aff	Exp	Non clinical	Central	Induction	Descriptive
3	Abrams *et al.*, 1987	x			x		Anx	Exp	Non clinical	Central	Induction	Causal
4	Abrams *et al.*, 2002	x			x		Anx	Exp	Clinical	Central	Induction	Causal
5	Amir *et al.*, 2008	x					Anx	Tr	Non clinical	Central	Ind/Reg	Causal
6	Andrykowski, & Redd, 1987				x		Anx	Applied	Clinical	No manipulation		Descriptive
7	Andrykowski, Redd, & Hatfield, 1985				x		Anx	Applied	Clinical	No manipulation		Descriptive
8	Aragon, Farris, & Byers,2002				x		Anx	Tr	Clinical	Central	Regulation	Causal
9	Arent *et al.*, 2005	x		x			Aff	Exp	Non clinical	Peripheral	Regulation	Causal
10	Argyropoulos *et al.*, 2004	x			x		Anx	Exp	Clinical	Central	Induction	Causal
11	Arizono *et al.*, 2000	x			x		Anx	Tr	Clinical	Central	Regulation	Causal
12	Arntz, Merckelbach, & de Jong, 1993				x		Anx	Exp	Clinical	Central	Ind/Reg	Causal
13	Auquier *et al.*, 1995	x					Anx	Applied	Clinical	No manipulation		Descriptive
14	Baker, & Guttfreund, 1993	x					Anx/Mood	Exp	Non clinical	Central	Induction	Causal
15	Baron, Logan, & Hoppe, 1993	x			x		Anx	Tr	Non clinical	Central	Regulation	Causal
16	Bartholomew, Morrison, & Ciccolo,2005		x				Mood/Aff	Tr	Clinical	Peripheral	Regulation	Causal
17	Benedetti *et al.*, 2003	x					Anx	Exp	Clinical	Central	Regulation	Descriptive
18	Benotsch *et al.*, 2000	x			x		Anx	Exp	Clinical	No manipulation		descriptive
19	Bernat *et al.*, 2001	x		x			Anx	Exp	Non clinical	Central	Induction	Descriptive
20	Bixby, Spalding, & Hatfield, 2001			x	x		Mood/Aff	Exp	Non clinical	Peripheral	Regulation	Causal
21	Bodin, & Martinsen, 2004	x		x			Anx	Tr	Clinical	Peripheral	Regulation	Causal
22	Bogaerts *et al.*, 2010				x		Anx	Exp	Clinical	Peripheral	Induction	Causal
23	Bond, Shine, & Bruce, 1995	x			x		Anx	Exp	Non clinical	Central	Induction	Causal
24	Bowen *et al.*, 2006				x		Anx	Applied	Clinical	No manipulation		Descriptive
25	Bradley *et al.*, 2009	x		x			Anx	Tr	Non clinical	Peripheral	Regulation	Causal
26	Bringman *et al.*, 2009	x					Anx	Tr	Clinical	Central	Regulation	Causal
27	Bringuier *et al.*, 2009	x			x		Anx	Applied	Clinical	No manipulation		Descriptive
28	Britt *et al.*, 2001	x				EAS	Anx	Exp	Non clinical	Central	Ind/Reg	Causal
29	Bruera *et al.*, 2008	x					Anx	Tr	Clinical	Central	Regulation	Causal
30	Bruning, & McMahon, 2009	x		x			Anx/Mood	Exp	Non clinical	Central	Induction	Causal
31	Buckelew *et al.*, 1992	x			x		Anx	Applied	Clinical	No manipulation		Descriptive
32	Campeau *et al.*, 2007				x		Anx	Tr	Clinical	Peripheral	Regulation	Causal
33	Carrillo *et al.*, 2001	x	x				Anx	Exp	Non clinical	Central	Induction	Causal
34	Carter *et al.*, 1995	x					Anx	Exp	Clinical	Central	Ind/Reg	Causal
35	Caumo *et al.*, 2000	x					Anx	Exp	Clinical	No manipulation		Descriptive
36	Chan *et al.*, 2003	x					Anx	Tr	Clinical	Central	Regulation	Causal
37	Chua *et al.*, 1999	x			x		Anx	Exp	Non clinical	Central	Ind/Reg	Causal
38	Cinciripini *et al.*, 2006					x	Aff/Mood	Exp	Non clinical	Central	Induction	descriptive
39	Clark, & Golshan, 2008	x					Anx	Tr	Clinical	Peripheral	Regulation	Causal
40	Cools *et al.*, 2005			x	x		Anx/Mood	Exp	Non clinical	Central	Induction	Descriptive
41	Corchs *et al.*, 2009	x	x		x	HAM-A	Anx	Exp	Clinical	Central	Induction	Causal
42	Cruise *et al.*, 1997	x					Anx	Tr	Clinical	Central	Regulation	Causal
43	Daley, & Maynard, 2003			x			Aff	Exp	Non clinical	Peripheral	Regulation	Descriptive
44	de-Paris *et al.*, 2003		x		x		Anx	Exp	Non clinical	Central	Ind/Reg	Causal
45	Diego *et al.*, 1998	x	x		x		Anx	Tr	Non clinical	Peripheral	Regulation	Causal
46	Donoyama, Munakata, & Shibasaki, 2010	x					Anx	Tr	Non clinical	Peripheral	Regulation	Causal
47	Duka *et al.*, 1988	x					Anx	Exp	Non clinical	Central	Regulation	Descriptive
48	Durkin, & Paxton, 2002				x		Anx	Exp	Non clinical	Central	Induction	Causal
49	Edwards, Burt, & Lipp, 2010					ARQ	Anx	Exp	Non clinical	Central	Induction	Causal
50	Ekwall, Gerdtz,& Manias, 2009				x		Anx	Applied	Non Clinical	No manipulation		Descriptive
51	Erb *et al.*, 1998	x					Anx	Tr	Clinical	Central	Regulation	Causal
52	Eubank, Collins, & Smith, 2002			x			Anx	Exp	Non clinical	Central	Induction	descriptive
53	Ferrer-Garcia, & Gutiérrez Maldonado, 2005	x					Anx	Exp	Clinical	Central	Induction	Causal
54	Field *et al.*, 1996	x	x				Anx	Tr	Non clinical	Peripheral	Regulation	Causal
55	Focht, & Koltyn, 1999	x	x				Anx	Tr	Non clinical	Peripheral	Regulation	Causal
56	Fox *et al.*, 2001	x					Anx	Exp	Non clinical	Central	Induction	Causal
57	Fumoto *et al.*, 2004	x	x				Anx	Tr	Non clinical	Peripheral	Regulation	Causal
58	Garvin, & Damson, 2008	x	x				Anx	Exp	Non clinical	Central	Induction	Descriptive

.N	Reference	STAI State	POMS	PANAS	VAS	Other	Construct	Domain	Population	Manipulation	Direction of the Effect	Approach
59	Gaudreau, Blondin, & Lapierre, 2002			x			Aff	Applied	Non clinical	Peripheral	No Manipulation	Descriptive
60	Geeraerts *et al.*, 2005	x			x		Anx	Exp	Non clinical	Central	Induction	Causal
61	Gejervall *et al.*, 2005	x			x		Anx	Tr	Clinical	Peripheral	Regulation	Descriptive
62	Gilbert, Parker, & Claiborn, 1978		x				Anx	Tr	Clinical	Central	Regulation	Causal
63	Goldin *et al.*, 2009				x		Aff	Exp	Clinical	Central	Induction	Causal
64	Grasing *et al.*, 1996	x	x		x		Anx/Mood/Aff	Exp	Non clinical	Central	Induction	Descriptive
65	Grassi, Gaggioli, & Riva, 2009	x		x	x		Anx	Tr	Non clinical	Central	Regulation	Causal
66	Grillon *et al.*, 2003	x		x	x		Anx	Tr	Non clinical	Central	Ind/Reg	Causal
67	Gutierrez-Maldonado *et al.*, 2006	x					Anx	Exp	Clinical	Central	Induction	Causal
68	Hale, & Raglin, 2002	x					Anx	Tr	Non clinical	Peripheral	Regulation	Causal
69	Hatayama *et al.*, 2008	x	x				Anx/Mood	Tr	Non clinical	Peripheral	Regulation	Causal
70	Hayasaka *et al.*, 2008	x	x				Anx/Mood	Tr	Non clinical	Peripheral	Regulation	Causal
71	Hayasaka *et al.*, 2009	x	x				Anx/Mood	Tr	Non clinical	Peripheral	Regulation	Causal
72	Head *et al.*, 1996	x	x				Anx/Mood	Exp	Non clinical	Central	Ind/Reg	Causal
73	Heikkila *et al.*, 1998	x			x	HADS-A	Fear	Applied	Clinical	No manipulation		Descriptive
74	Hofer *et al.*, 2003	x					Anx	Exp	Clinical	Central	Regulation	Descriptive
75	Holmes, Lang, & Shah, 2009	x		x			Anx	Tr	Non clinical	Central	Ind/Reg	Causal
76	Holmes, & Mathews, 2005	x					Anx	Exp	Non clinical	Central	Induction	Causal
77	Holmes *et al.*, 2008	x					Anx/Aff	Exp	Non clinical	Central	Ind/Reg	Causal
78	Hood *et al.*, 2010	x	x		x		Anx	Exp	Clinical	Central	Induction	Causal
79	Hood *et al.*, 2006	x			x		Anx	Exp	Non clinical	Central	Induction	Causal
80	Hopko, Hunt, & Armento, 2005				x		Anx	Exp	Non clinical	Central	Induction	Causal
81	Hughes, & Kendall, 2008					SUDS	Anx	Exp	Clinical	Central	Regulation	Descriptive
82	Ihme, & Mitte, 2009	x					Fear	Exp	Non clinical	Central	Induction	Descriptive
83	Iizawa *et al.*, 2004	x					Anx	Tr	Clinical	Central	Regulation	Causal
84	Imura, Misao, & Ushijima, 2006	x	x				Anx/Mood	Tr	Non clinical	Peripheral	Regulation	Causal
85	Jacobsen *et al.*, 1995				x		Anxiety/Distress	Exp	Clinical	Central	Induction	Causal
86	Järvekülg, 2005	x		x			Anx/Aff	Exp	Non clinical	Peripheral	Regulation	Descriptive
87	Järvekülg, Neissaar, & Viru, 2001	x		x			Anx	Exp	Non clinical	Peripheral	Regulation	Descriptive
88	Jerabek *et al.*, 1998	x					Anx	Exp	Non clinical	Central	Induction	Causal
89	Johansson, Hassmén, & Jouper, 2008	x	x				Anx/Mood	Tr	Non clinical	Peripheral	Regulation	Causal
90	Juliano, Brandon, & Moffitt, 2002	x					Anx	Exp	Non clinical	Central	Ind/Reg	Descriptive
91	Kagaya *et al.*, 2001		x				Anx	Tr	Clinical	Central	Regulation	Descriptive
92	Kassel, & Unrod, 2000	x					Anx	Exp	Non clinical	Central	Ind/Reg	Causal
93	Kennedy, & Newton, 1997		x				Mood	Tr	Non clinical	Peripheral	Regulation	Causal
94	Kerr *et al.*, 2005					TESI	Anx	Applied	Non clinical	No Manipulation		Descriptive
95	Kimberger, Illievich, & Lenhardt, 2007	x			x		Anx	Tr	Clinical	Peripheral/Central	Regulation	Causal
96	Koukounas, & McCabe, 2001				x		Anx	Exp	Non clinical	Central	Induction	Descriptive
97	Kraemer, & Marquez, 2009	x		x			Anx/Mood	Tr	Non clinical	Peripheral	Regulation	Causal
98	Kreutz *et al.*, 2004			x			Aff	Tr	Non clinical	Central	Regulation	Causal
99	Krueger *et al.*, 2005	x			x		Anx	Exp	Clinical	Central	Induction	Descriptive
100	Laidlaw *et al.*, 2006	x	x				Anx	Tr	Non clinical	Central	Ind/Reg	Causal
101	Law, Logan, & Baron, 1994	x			x		Anx	Tr	Non clinical	Central	Regulation	Causal
102	LeBlanc *et al.*, 2008	x					Anx/Stress	Exp	Non clinical	Central	Induction	Descriptive
103	Lepage *et al.*, 2001	x			x		Anx	Tr	Clinical	Central	Regulation	Causal
104	Li *et al.*, 2000	x	x				Anx/Mood	Exp	Non clinical	Central	Induction	Causal
105	Liotti *et al.*, 2000				x		Anx	Exp	Non clinical	Central	Induction	Causal
106	Litvin, & Brandon, 2010	x				x	Anx	Exp	Non clinical	Central	Induction	Descriptive
107	Liu *et al.*, 2005		x				Mood	Tr	Non clinical	Peripheral	Regulation	Causal
108	Lu *et al.*, 2004	x			x	BAI	Anx	Tr	Non clinical	Central	Ind/Reg	Causal
109	Lucas *et al.*, 2006	x					Anx/Stress	Exp	Non clinical	Central	Induction	Causal
110	Man *et al.*, 2003	x			x		Anx	Tr	Clinical	Central	Regulation	Causal
111	Martelli *et al.*, 1987	x					Anx	Tr	Clinical	Central	Regulation	Causal
112	Masdrakis *et al.*, 2009	x			x		Anx	Exp	Clinical	Central	Induction	Causal
113	Masters *et al.*, 2003	x	x				Anx/Aff	Exp	Non clinical	Peripheral	Regulation	Causal
114	Mathews,& Mackintosh, 2000	x					Anx	Exp	Non clinical	Central	Induction	Causal
115	McDermut, & Haaga, 1998			x			Aff	Exp	Non clinical	Central	Induction	Causal
116	Meinberg, & Yager, 1985	x					Anx	Exp	Non clinical	Central	Regulation	Descriptive?
117	Mendonca-de-Souza *et al.*, 2007			x			Anx/Stress	Exp	Non clinical	Central	Induction	Causal

.N	Reference	STAI State	POMS	PANAS	VAS	Other	Construct	Domain	Population	Manipulation	Direction of the Effect	Approach
118	Mercer, Warson, & Zhao, 2010	x		x			Anx	Tr	Non clinical	Central	Regulation	Causal
119	Merckaert *et al.*, 2009	x					Anx	Exp	Clinical	Central	Induction	Descriptive
120	Miller, Bartholomew, & Springer, 2005			x			Aff	Tr	Non clinical	Peripheral	Regulation	Causal
121	Miller, Taylor, & Tinklenberg, 1988		x		x		Mood	Exp	Non clinical	Central	Regulation	Descriptive
122	Mitchell, MacDonald, & Knussen,2008	x					Anx	Tr	Non clinical	Central	Ind/Reg	Causal
123	Modena *et al.*, 1989	x					Anx	Exp	Clinical	Central	Induction	Causal
124	Moser, Hajcak, & Simons, 2005					SUDS	Anx	Exp	Clinical	Central	Induction	Descriptive
125	Munafo, Hayward, & Harmer, 2006		x		x		Anx	Exp	Clinical	Central	Induction	Causal
126	Muzzarelli,Force, & Sebold, 2006	x					Anx	Tr	Clinical	Peripheral	Regulation	Causal
127	Nainis *et al.*, 2006	x					Anx	Tr	Clinical	Central	Regulation	Causal
128	Nakane *et al.*, 2002	x					Anx/Stress	Tr	Non clinical	Central	Ind/Reg	Causal
129	Neissaar *et al.*, 2002	x		x			Anx	Tr	Non clinical	Peripheral	Regulation	Descriptive
130	Noto *et al.*, 2005	x					Anx/Stress	Exp	Non clinical	Central	Induction	Descriptive
131	O'Brien, Terry, & Jimmieson,2008		x				Anx/Mood/Aff	Exp	Non clinical	Central	Induction	Causal
132	O'Halloran, Murphy, & Webster, 2004		x				Mood	Tr	Non clinical	Peripheral	Regulation	Causal
133	Okawa, Ichinohe, & Kaneko, 2005				x		Anx	Exp	Non clinical	Central	Induction	Causal
134	Oldman, Moore, & Collins, 2004	x			x		Anx	Exp	Clinical	Central	Regulation	Descriptive
135	Oliveira, Gouveia, & Oliveira, 2009		x			MRT	Anx/Mood	Applied	Non clinical	No Manipulation		Descriptive
136	Park *et al.*, 2009	x		x			Anx	Exp	Clinical	Central	Induction	Causal
137	Parr, & Cartwright-Hatton, 2009	x					Anx	Tr	Subclinical	Central	Ind/Reg	Causal
138	Perry *et al.*, 1994				x		Anx	Exp	Clinical	No manipulation		Descriptive
139	Perry *et al.*, 1990				x		Anx	Applied	Clinical	No manipulation		Descriptive
140	Petruzzello *et al.*, 2009	x	x		x		Anx/Mood	Tr	Clinical	Peripheral	Regulation	Causal
141	Philippot, Baeyens, & Douilliez, 2006	x					Anx	Tr	Non clinical	Central	Regulation	Causal
142	Phillips, & Giancola, 2008			x			Anx	Exp	Non clinical	Central	Induction	Causal
143	Polman *et al.*, 2007		x		x		Mood	Applied	Non clinical	No Manipulation		Descriptive
144	Poma *et al.*, 2005	x			x		Anx	Exp	Non clinical	Central	Induction	Causal
145	Prabhu *et al.*, 2009	x			x		Anx	Tr	Clinical	Central	Regulation	Descriptive
146	Rabe *et al.*, 2006			x			Anx	Exp	Clinical	Central	Induction	Causal
147	Raes *et al.*, 2003	x			x		Anx	Exp	Non clinical	Central	Induction	Descriptive
148	Raglin, & Wilson, 1996	x					Anx	Tr	Non clinical	Peripheral	Regulation	Causal
149	Rausch, Gramling, & Auerbach, 2006	x				SSSSS-S	Anx	Tr	Non clinical	Central	Regulation	Causal
150	Redd *et al.*, 1987				x		Anx	Tr	Clinical	Central	Regulation	Causal
151	Reinecke, Rinck, & Becker, 2006	x					Anx	Exp	Clinical	Central	Induction	Descriptive
152	Rejeski *et al.*, 1995			x			Aff	Tr	Non clinical	Peripheral	Regulation	Causal
153	Ren *et al.*, 2009				x		Anx	Exp	Clinical	Central	Induction	Causal
154	Rinck *et al.*, 2005	x					Anx	Exp	Subclinical	Central	Induction	Descriptive
155	Robb, 2000	x			x		Anx	Tr	Non clinical	Central	Regulation	Causal
156	Rodebaugh *et al.*, 2009	*x*		x			Anx/Mood	Tr	Subclinical	Central	Ind/Reg	Causal
157	Rogers, & Revelle, 1998					MSQ-R	Mood	Exp	Non clinical	Central	Ind/Reg	Descriptive
158	Rosa *et al.*, 2004		x				Anx/Mood	Exp	Non clinical	Peripheral	Regulation	Descriptive
159	Ruijter *et al.*, 2000	x	x				Anx/Mood	Exp	Non clinical	Central	Induction	Descriptive
160	Ruijter, Lorist, & Snel, 1999	x	x				Anx/Mood	Exp	Non clinical	Central	Induction	Descriptive
161	Sablowski, & Herrmann, 1986	x					Anx	Applied	Clinical	No manipulation		Descriptive
162	Schmid-Leuz *et al.*, 2007					SUDS	Anx	Tr	Non clinical	Central	Ind/Reg	Causal
163	Schneider *et al.*, 2003	x					Anx	Tr	Clinical	Central	Regulation	Causal
164	Schunck *et al.*, 2008	x			x	HAM-A	Anx	Exp	Non clinical	Central	Induction	Causal
165	Schwerdtfeger, Schmukle, & Egloff, 2006				x		Aff	Exp	Non clinical	Central	Induction	Causal
166	Scott, McNaughton, & Polman, 2006		x				Anx	Exp	Non clinical	Sleep deprivation		Descriptive
167	Shioiri *et al.*, 2006	x					Anx	Exp	Clinical	Central	Induction	Descriptive
168	Sideridis, 2008			x			Anx	Exp	Non clinical	Central	Induction	Descriptive
169	Simpson *et al.*, 2008			x			Mood/Aff	Applied	Non clinical	No manipulation		Descriptive
170	Slaven, & Lee, 1997		x				Mood	Exp	Non clinical	Peripheral	Regulation	Descriptive
171	Starcke *et al.*, 2008	x		x			Anx/Stress/Aff	Exp	Non clinical	Central	Induction	Descriptive
172	Startup, & Davey, 2001				x		Anx/Mood	Exp	Non clinical	Central	Ind/Reg	Causal
173	Steinberg *et al.*, 1998					x	Mood	Tr	Non clinical	Peripheral	Regulation	Descriptive
174	Steptoe, & Cox, 1988		x				Anx/Mood	Tr	Non clinical	Peripheral	Regulation	Causal
175	Strentz, & Auerbach, 1988	x					Anx/Stress	Exp	Non clinical	Central	Induction	Causal
176	Strigo *et al.*, 2002	x					Anx	Exp	Non clinical	Central	Induction	Descriptive

.N	Reference	STAI State	POMS	PANAS	VAS	Other	Construct	Domain	Population	Manipulation	Direction of the Effect	Approach
177	Sukegawa *et al.*, 2008	x					Anx	Applied	Clinical	No manipulation		Descriptive
178	Swartzman, Edelberg, & Kemmann, 1990	x			x		Anx/Stress	Exp	Non clinical	Central	Induction	Causal
179	Swendsen, 1998				x	MAACL	Anx	Applied	Non clinical	No manipulation		Descriptive
180	Tang, & Gibson, 2005				x		Anx	Exp	Non clinical	Central	Induction	Causal
181	Thompson, Altmann, & Davidson, 2004	x					Anx	Exp	Non clinical	Central	Induction	Causal
182	Tornek *et al.*, 2003	x	x				Anx/Mood	Tr	Clinical	Central	Regulation	Causal
183	Toskovic, 2001		x				Mood	Tr	Non clinical	Peripheral	Regulation	Causal
184	Tovilovic *et al.*, 2009	x					Anx	Exp	Non clinical	Central	Induction	Causal
185	Tulen *et al.*, 1993	x	x				Anx/Mood	Exp	Non clinical	Central	Induction	Descriptive
186	Urech *et al.*, 2010	x					Anx	Tr	Non clinical	Peripheral	Regulation	Causal
187	Vadalouca *et al.*, 2009	x			x		Anx	Tr	Clinical	Central	Regulation	Causal
188	van der Bij *et al.*, 2003	x					Anx	Exp	Non clinical	Central	Regulation	Descriptive
189	Verburg *et al.*, 1998				x		Anx	Exp	Clinical	Central	Induction	Causal
190	Villani, Riva,& Riva, 2007	x		x	x		Anx	Tr	Non clinical	Central	Regulation	Causal
191	Vujanovic, & Zvolensky, 2009					SUDS	Anx	Exp	Non clinical	Central	Induction	Descriptive
192	Weisberg *et al.*, 2001			x			Anx	Exp	Non clinical	Central	Induction	Descriptive
193	Werner *et al.*, 2009	x					Anx	Exp	Non clinical	Central	Induction	Causal
194	Wilson, MacLeod, & Mathews, 2006				x		Anx	Exp	Non clinical	Central	Ind/Reg	Causal
195	Wolanskyj *et al.*, 2000	x			x		Anx	Tr	Clinical	Central	Regulation	Causal
196	Yiend *et al.*, 2008	x					Anx	Exp	Non clinical	Central	Regulation	Descriptive
197	Youngstedt, & Kripke, 2007	x					Anx	Tr	Non clinical	Central	Regulation	Causal

Table caption

Table 1: 197 studies (in alphabetical order) included in our literature review and organized as a function of the main variables (Construct; Domain; Population; Manipulation; Direction of the Effect; Approach; see section 1.3 in the main text for exact definitions). All these studies were carefully selected based on specific and strict criteria (repeated measures design, test-retest interval shorter than 24 hours; see section 1.2).

Abbreviations:

Other column: EAS (Emotion Assessment Scale; Carlson *et al.*, 1989); HAM-A (Hamilton Anxiety and Depression Scale-Anxiety; Hamilton, 1959); ARQ (Arousal Rating Questionnaire; Edwards, Burt, & Lipp, 2010); HADS-A (Hospital Anxiety and Depression Scale-A; Zigmond & Snaith, 1983); SUDS (Subjective Units of Distress Scale; Wolpe, 1958 & 1990); TESI (Tension and Effort Stress Inventory; Svebak *et al.*, 1991); BAI (Beck Anxiety Inventory; Beck, Epstein, Brown, & Steer, 1988); MRF (Mental Readiness Form; Krane, 1994); SSSSS-S (Smith Somatic Stress Symptoms Scale-State; Smith, 1990); MSQ-R (Motivational State Questionnaire-revised form; see Rogers & Revelle 1998); MAACL-r (Multiple Affect Adjective Check List-Revised, "Today" Form; Zuckerman & Lubin, 1985). When no name is provided for the measurement in this column, a compound measure created *ad hoc* was reported in the study.

Construct column: Anx = Anxiety; Aff = Affect

Domain column: Exp = Experimental; Tr = Treatment

Direction of Effect Column: Ind/Reg = Induction/Regulation

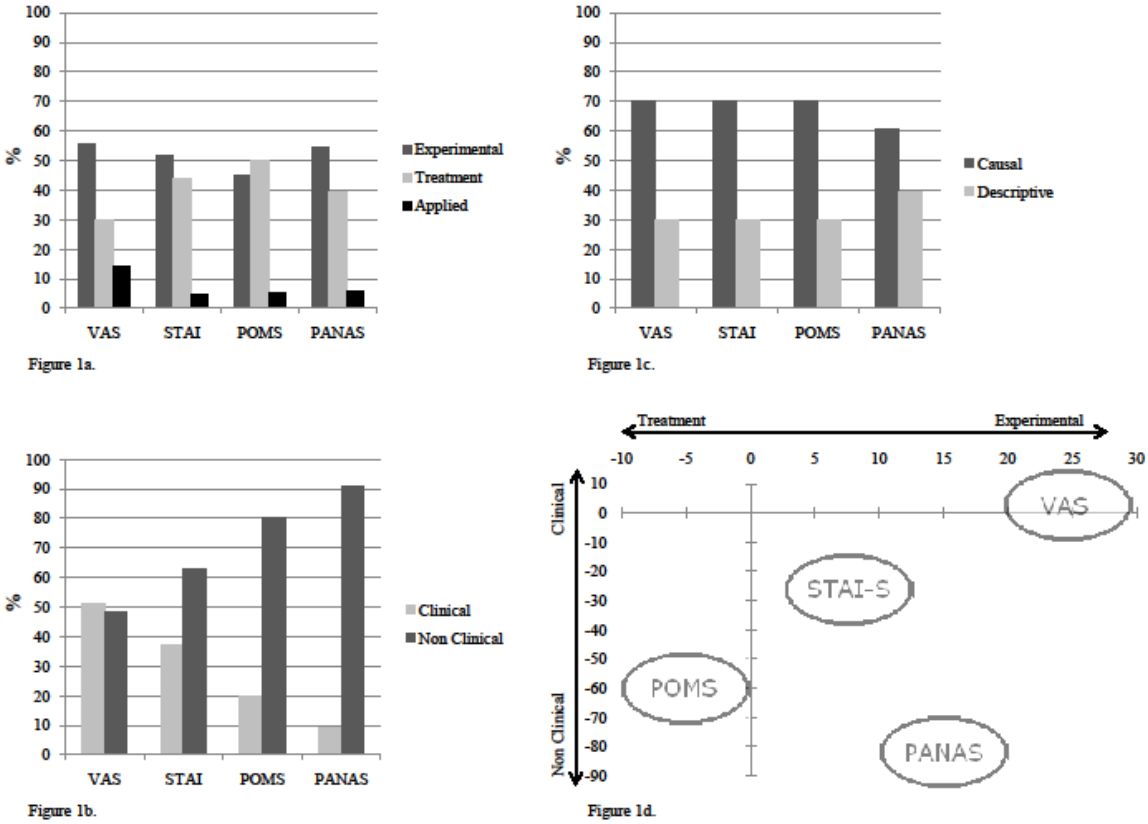

Figure 1: (**a**) Classification of studies (expressed in percentage) separately for each questionnaire (STAI, POMS, PANAS, and VAS) as a function of the *Domain* variable (Experimental, Treatment or Applied). (**b**) Classification of studies (expressed in percentage) as a function of the *Population* variable (Clinical vs. Non-clinical). (**c**) Classification of studies (expressed in percentage) as a function of the *Approach* variable (Causal vs. Descriptive). (**d**) A mapping of the studies using two orthogonal axes/variables (*Domain* vs. *Population*) suggests that the four instruments occupy non-overlapping mean positions, consistent with their use in different domains or contexts. For each instrument, the actual numerical value corresponds to the center of the ellipse. The horizontal axis codes the difference (in percentage) between *Experimental* and *Treatment* studies. Along this axis, a negative number indicates that the percentage of studies classified as *Treatment* for the given tool outnumbers the amount of studies classified as *Experimental*. Conversely, a positive number indicates an opposite effect (in favor of *Experimental*). The vertical axis codes the difference (in percentage) between *Clinical* and *Non Clinical* studies. A negative number indicates that the number of studies labeled as *Non Clinical* for the given tool outnumbers the amount of studies classified as *Clinical*. Conversely, a positive number indicates an opposite trend (in favor of *Clinical*).

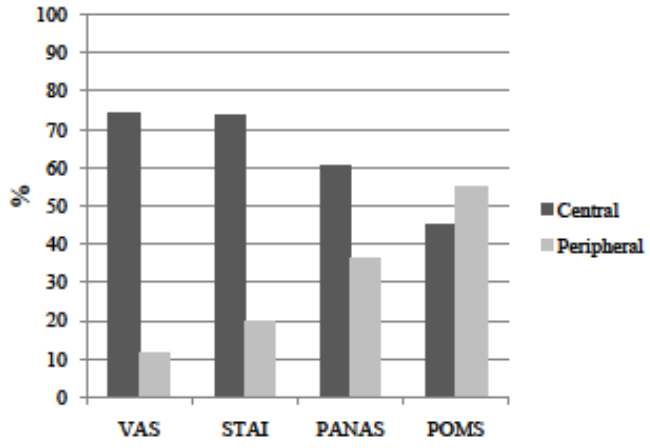

Figure 2a.

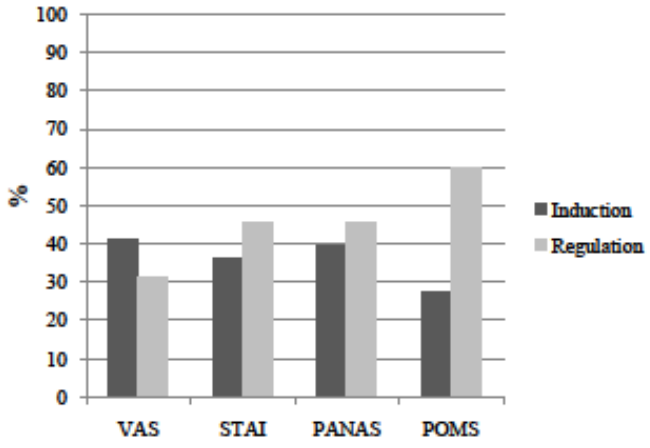

Figure 2b.

Figure 2: (**a**) Classification of studies (expressed in percentage) separately for each questionnaire (STAI, POMS, PANAS, and VAS) as a function of the *Manipulation* variable (Central vs. Peripheral). (**b**) Classification of studies (expressed in percentage) as a function of the *Direction of the effect* variable (Induction, Regulation or Combined).

Supplementary material: Table 2

Entry	Measures	Cronbach 's alpha	Correlations	Test-retest Reliability
1	STAI-S VAS		STAI-S VAS *r* = .58	
15	STAI-S VAS	STAI-S .55		STAI-S *r* = .49 VAS *r* = .82
16	POMS	POMS .93 to .95		
18	STAI-S VAR	STAI-S .92	STAI-S VAR *r* = .69 to .73	VAR *r* = .55 to .66
30	STAI-S PANAS		STAI-S PANAS *r* = .82	
46	STAI-S	STAI-S .77 to .94		
59	PANAS	PANAS .81 to .88		
73	STAI-S VAS	STAI-S .89	STAI-S VAS *r* = .52 to .55	VAS *r* = .59 to .71
74	STAI-S	STAI-S .85		
90	STAI-S	STAI-S .93		
92	STAI-S	STAI-S .90 to .96		
97	STAI-S PANAS	STAI-S .88 to.90 PANAS .79 to .82		
100	STAI-S POMS-BI		STAI-POMS-T(bipolar) *r* =-.81	
102	STAI-S	STAI-S .87		
103	STAI-S VAS		STAI-S VAS *r* = .53 to .68	
106	STAI-S Mood Form	STAI-S . 95 to .96 Mood Form >.80		
113	STAI-S POMS		STAI-POMS-T *r* =.79 STAI-POMS TMDS *r* =.78	
131	POMS (compound)	POMSc .96		POMSc *r* = .74
140	STAI-S POMS	STAI-S .86 to .94 POMS .54 to .82		
145	STAI-S VAS		STAI-S VAS *r* = .31 to .33	
146	STAI-S(once) PANAS	STAI-S .94 PANAS .80 to .92		
156	STAI-S (brief) PANAS	STAI-S .87		
158	POMS	POMS .70		(Split-half *r* = .73 to .78)
161	STAI-S			STAI-S *r* = .42
163	STAI-S	STAI-S .94		
165	VAS (compound)	VASc .86 to .95	VASc & Neuroticism *r* = .41 to .50	
168	PANAS-X PANAS	PANAS-X *fear* . 89 PANAS .79		
181	STAI-S PANAS (once)	STAI-S .89 to .90 PANAS .90		
184	STAI-S PANAS (trait)	STAI-S .90 PANAS .84		
188	STAI-S STAI-S (short)	STAI-S (short) .83	STAI-S STAI-S (short) *r* = .95	
189	VAS			VAS *r* = .06 to .70

Table Caption

Table 2: Comparative psychometric data across the four instruments, as could be retrieved in some of the studies (N=197) included in our review. Entry number corresponds to an arbitrary number used to sort the studies (see Table 1).

Abbreviations:

STAI-S (State-Trait Anxiety Inventory-State Form); POMS (Profile of Mood States); POMS-BI (POMS-Bipolar form); POMS-T (POMS, Tension subscale); PANAS (Positive and Negative Affect Schedule); VAS (Visual Analog Scale); VAR (Verbal Anxiety Rating)

Supplementary material: Bibliographical details for studies included in Table 1

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