cally improved. This can be accomplished only by recognizing the problems associated with assessment procedures and obtaining cooperation between the clinicians, pharmacologists, and behavioral scientists.

References

Measurement Issues in Research on Dental Fears and Anxiety
Patricia A. McGrath, Ph.D.
Paediatric Pain Programme, Children's Hospital of Western Ontario, University of Western Ontario, London, Ontario, Canada

In order to evaluate the efficacy of behavioral and pharmacological therapies for reducing dental fears and anxiety, it is first necessary to assess the subjective experience of fear and anxiety in an objective and consistent manner. This article reviews the principal issues that are relevant to the choice of an objective measure for dental anxiety in both adults and children.

Anxiety is a complex emotional reaction that is related to uncertain expectancies about the future, particularly negative expectancies. Anxiety may be defined as a transitory state that is related to a specific situation, or as a relatively stable trait that is a personality characteristic. Fear and anxiety are multidimensional emotions in that they depend on a variety of psychological, social, and situational factors. Consequently, a comprehensive evaluation of dental fear or anxiety requires not only a reliable index of an individual's specific anxiety level, but also a consideration of the multiple factors that can modify anxiety or anxiety behavior in a particular clinical situation. Investors must attempt to assess both the subjective experience of anxiety and also the relevant characteristics of the anxiety-inducing situation. The development of objective methods to measure situational anxiety has been complicated by both the subjective and multidimensional nature of anxiety. As an example, Figure 1 illustrates the interaction between an individual (for example, a five-year-old boy whose older sister has provided him with graphic and
frightening details about a scheduled dental extraction) and a potentially aversive situation (the clinical procedure). Anticipation of the dental visit, arrival at the office, entry into the operatory, all represent a series of stimuli that produce successive interactions between this child and the dentist performing various steps in the procedure. Each interaction produces physiological, cognitive, and emotional arousal that is related to the outcome of each part of the clinical treatment, as these specific outcomes relate to the general uncertainty of treatment outcome. The specific emotional responses for any individual may include anxiety, depression, fear, frustration, anger, relief, or satisfaction. These emotions occur as a consequence of each aspect of the dental procedure (and each behavior of the dentist) in relationship to the patient, his/her desires, goals, expectations, perceived control, and previous experience. In order to understand and control the consequent emotional responses, it is necessary to identify and quantify these relevant situational factors.

There are three general categories of methods that have been evaluated as measures of human anxiety for children and adults: direct self-report measures, behavioral measures, and physiological measures (Table 1).1,9,10,13 In direct self-report methods, patients use standardized scaling techniques, such as visual analog scales, adjective descriptor scales, and inventories to rate their general trait or specific state anxiety. A variety of behavioral rating scales have been developed to assess anxiety in specific dental or medical situations.1,11,12 Trained raters observe an individual's behavior to report either the incidence and frequency of overall anxiety-related behaviors (for example, crying for children) or the incidence of specific fine motor behaviors correlated with a tense or anxious body state. In general, numerical estimates of anxiety scores are obtained by differentially weighing the specific anxiety behaviors that occur, as well as scoring their frequency. Behavioral approaches to anxiety measurement may be operationally and objectively defined and a variety of external raters can be trained to use consistent criteria in assessing patients' distress behaviors. However, individuals differ in both their behavioral responses to anxiety and in the time pattern or sequence in which they may demonstrate the same behavioral responses. Consequently, it is important to sample a patient's behavior at successive intervals throughout a situation to provide a comprehensive reflection of how the distress behavior may parallel anxiety levels.

Physiological parameters, such as the Palmar Sweat Reflex, heart, or respiration rates are also monitored to provide an index of anxiety. However, many studies have failed to show that the changes in the psychological responses are related unequivocally to changes in anxiety, rather than to a general arousing state. Since as yet, there is no one objective physiological or behavioral correlate for anxiety, it is necessary to use multiple measures to provide accurate and comprehensive information about dental anxiety.

The criteria for an accurate, objective anxiety measure are identical to those essential for any measurement instrument: (1) reliability, that the method yield consistent results over time; (2) validity, that the method measure unequivocally a specific dimension of anxiety (for example, the intensity of the emotion); (3) that the method is relatively bias free, independent of procedural bias or patient/investigator responses biases; (4) that the method is versatile, applicable for both clinical and laboratory use and practical in a variety of different dental settings; and (5) that the method yield numbers on an identifiable number scale (nominal, ordinal, interval, or ratio), so that the appropriate statistical analyses can be conducted. When these five criteria are satisfied, a measure can be used to evaluate the efficacy of any therapeutic modality for reducing dental anxiety.

Controlled studies, in which investigators may induce different levels of anxiety in a well-defined situation, are useful for determining the reliability and validity of any anxiety measure (behavioral, physiological, or self-report). Validity can be determined by comparing the relationship between anxiety

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**Table 1. Anxiety Measures**

<table>
<thead>
<tr>
<th>Behavioral</th>
<th>Self-report</th>
<th>Physiological</th>
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<tbody>
<tr>
<td>Overt distress</td>
<td>Direct scaling</td>
<td>Palmar sweat index</td>
</tr>
<tr>
<td>General behavior</td>
<td>Interview</td>
<td>Respiration</td>
</tr>
<tr>
<td>Specific motor acts</td>
<td>Inventory</td>
<td>Pulse</td>
</tr>
</tbody>
</table>
scores derived from the proposed anxiety measure to those obtained with a standardized measure. Pharmacological or behavioral manipulations that decrease anxiety can be used to determine if the proposed measure reflects a change in anxiety proportional to the manipulation. The reliability of the measure may be evaluated both across subjects and between sessions. Method bias can be minimized by comparing the anxiety responses obtained using different investigators’ instructions or in different contexts.

Relevant attributes of the anxiety-producing situation can also be manipulated (for example, subject’s expectation or perceived control) in a strict manner to enable investigators to determine the perceptual correlates. As an example, Price, Barrell, and Barrell7,8 conducted a series of psychophysical studies on emotional responses to both real and hypothesized situations. They derived mathematical formulas to describe the relationships between different human emotions such as anxiety, depression, frustration, satisfaction, and excitement based on relationships between three primary components, subjects’ expectations, desire for different goals, and whether the subjects’ goals were positive or negative (Table 2). Their subsequent research demonstrated that the quality and intensity of emotional responses observed in different situations, conformed to those predicted.

Subjects used visual analog scales to rate different emotional experiences as a function of the subject’s goals, expectations, and desires for different situations. Situations included both positive, defined by a positive approach goal (such as, I want to have my tooth “fixed”) and negative, defined by a negative avoidance goal (such as, I don’t want to feel pain during drilling). Table 2 shows a portion of their results for the five emotions. Values are standardized to a 0 to 1 scale for Desire, Expectation, and Feeling. As you can see, the values for Desire are approximately equal across emotions, while those for Expectation decrease consistently from a high of .96 for satisfaction to a low of .08 for depression. Feeling intensity (positive or negative feeling is depicted by the sign preceding the value) varies as a consequence of expectation, desire, and quality of the goal (positive approach or negative avoidance). The authors conclude that anxiety is a negative emotional feeling based on an uncertain expectation (E = .50) of suffering negative consequences (that is, in 91% of situations in which subjects experience anxiety, they report that they have negative avoidance, rather than positive approach, goals). The body feeling associated with anxiety was described as inner tension or disturbance often concentrated in the stomach area or chest.

Although the usual procedures for validation and reliability determinations on the suitability of a measure of anxiety may be difficult to achieve in a regular clinical situation, correlative laboratory and clinical studies can provide valuable information on which of the available anxiety measures are most appropriate in a particular situation.

**Conclusion**

After reviewing research on anxiety measurement, several issues must be addressed in order to establish accurate and objective measures of dental anxiety. First, anxiety must be defined from a clear and consistent, theoretical perspective that will enable investigators to compare and integrate results from many laboratory and clinical investigations. Second, the requirements for an objective measure of anxiety, similar to the requirements for any measuring instrument, must be met. These are reliability, validity, minimal inherent bias, and versatility. These criteria can be evaluated in psychophysical studies of anxiety which provide precise control over many factors that may modify anxiety and, therefore, provide a unique opportunity to vary systematically the attributes of an anxiety-inducing stimulus to identify the perceptual correlates. Third, since neither an individual’s behavioral responses nor physiological responses are sufficient indices for human anxiety, it is necessary to also assess subjective experience. The most comprehensive methods for anxiety measurement combine behavioral, self-report, and physiological measures. Direct scaling or self-report techniques can provide qualitative and quantitative estimates of anxiety expressed in terms of the perception of the individual. Behavioral and physiological techniques could be used in a repeated time sampling sequence throughout a clinical session to provide a comprehensive pattern of how anxiety parameters change throughout the situation, as well as to provide valuable information on how self-report measures correlate with these indices. Fourth, in order to provide accurate interpretations of the data analysis of anxiety responses, calibration studies should be conducted on different assessment techniques to define the type of measurement scale that is produced.

**TABLE 2.** Mean Desire, Expectation, and Feeling Characteristics of Emotions

<table>
<thead>
<tr>
<th>Emotions</th>
<th>Desire</th>
<th>Expectations</th>
<th>Feeling</th>
<th>Predicted feeling</th>
</tr>
</thead>
<tbody>
<tr>
<td>Satisfaction</td>
<td>.82 ± .24</td>
<td>.96 ± .10</td>
<td>+.81 ± .15</td>
<td>+.79</td>
</tr>
<tr>
<td>Excitement</td>
<td>.82 ± .22</td>
<td>.87 ± .16</td>
<td>+.80 ± .19</td>
<td>+.74</td>
</tr>
<tr>
<td>Anxiety</td>
<td>.79 ± .11</td>
<td>.50 ± .20</td>
<td>-.36 ± .34</td>
<td>-.40</td>
</tr>
<tr>
<td>Frustration</td>
<td>.77 ± .15</td>
<td>.22 ± .16</td>
<td>-.63 ± .26</td>
<td>-.63</td>
</tr>
<tr>
<td>Depression</td>
<td>.84 ± .17</td>
<td>.08 ± .19</td>
<td>-.79 ± .23</td>
<td>-.83</td>
</tr>
</tbody>
</table>

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Statistical treatment of numerical estimates of anxiety should conform to mathematical permutations that are permissible to that scale type. When two measurement scales may be available, the more powerful scale should be used. Fifth, since anxiety represents a complex multidimensional perception, it is necessary to begin to quantify and identify in a rigorous fashion the components that comprise anxiety as well as quantify the response of an anxious individual. Correlative studies from the laboratory and the clinic could provide information on the relevant components of an anxiety-inducing situation as a function of age, sex, or previous experience, thereby providing objective information as to how to select the most appropriate therapeutic modality (behavioral, pharmacological, or both) to reduce an individual's fears and anxiety in a particular dental situation.

References

Methodological Needs and Behavioral Research with Adult Dental Patients

Norman L. Corah, Ph.D.

Department of Behavioral Sciences, State University of New York at Buffalo, School of Dental Medicine, Buffalo, New York

Though issues discussed in this paper are generally applicable to most areas of research, the focus will be on methodological issues as they relate primarily to behavioral research with adult dental patients. The examples which are used to amplify various issues should be regarded as illustrative, no attempt has been made to be exhaustive or even representative in selecting these examples.

Design and Control

The Research Context and Problems of Generalizability

There are three major dimensions in research which are confounded with methods of study: control, context, and generalizability. Control is best exercised in the experimental laboratory. However, the context or setting in which the behavior of interest occurs may be a very important factor—for instance, Dworkin2 found important differences in pain response between laboratory and dental office settings. When context is important, the appropriate research strategies are the field experiment and