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ORIGINAL ARTICLE

Development of a Measure of Fearful Implicit Associations with Dental Stimuli in Youth

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Abstract

Youth with dental anxiety are at an increased risk of poor oral health but current tools used to identify dental anxiety in children in clinical settings are hampered by several limitations. This study assessed the psychometric properties of a measure of implicit associations with dental stimuli, the Affective Misattribution Procedure for dental stimuli (AMP-D) in 68 youth between the ages of 9 and 17 years. Measures of self-reported dental anxiety and parental perceptions of child dental anxiety were also administered. The internal consistency of the AMP-D was high (KR-20 = 0.96) and 1-week test-retest reliability was in the acceptable range ($r = 0.75$). The AMP-D was correlated with self-reported dental anxiety, providing evidence of construct validity. The psychometric properties of the AMP-D suggest it could be a useful tool in identifying youth with dental anxiety, particularly when concerns regarding self-representation may compromise the validity of self-reported anxiety.

Keywords Dental anxiety · Implicit measures · Assessment · Psychometrics · Pediatric dentistry · Behavioral science

Introduction

Dental anxiety and dental phobia in children and adolescents are associated with higher frequency of missed appointments, higher rates of dental caries [1] and poorer social and emotional well-being [2]. Moreover, dental phobia appears to be one of the most prevalent, severe, and stable phobias [3].

Estimates of the prevalence of dental anxiety in adults range from around 12 to 16%. Approximately 1% of adults meet criteria for dental phobia, severe and persistent dental anxiety that engenders significant distress or interference [4, 5]. Data for youth are less consistent, with estimates ranging from 5 to 20% for dental anxiety and no studies reporting on the prevalence of dental phobia in youth [6]. Nonetheless, we can surmise that this figure is higher than that in adults given that studies suggest that most adults with dental phobia develop the fear during childhood or adolescence [5]. Dental anxiety in youth that results in avoidance of necessary preventative care and treatment can begin a vicious cycle that can lead to a full-blown phobia with a significant impact on oral and dental health. Therefore, it is important to identify and address dental anxiety in its earliest stages to interrupt the development of this cycle.

Currently, identification of dental anxiety in children and adolescents is most often achieved through the use of behavior ratings scales and self-report measures, the first of which can be broken down into rating scales for use by trained observers and ratings scales designed to be completed by the treating dentist [6, 7]. The use of behavior ratings scales is likely confined to research settings given that these tools are impractical for use in clinical practice and are of limited use to the practitioner in that they are done in the context of treatment and therefore do not alert the dentist to potential problems before the exam commences. Therefore, these types of measures can help to document the presence of dental anxiety but have limited utility in helping to prevent a negative experience for a child or adolescent attending

Study was completed before author was affiliated with the National Cancer Institute.

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treatment. Existing self-reports are typically brief so they can be completed in the waiting room and most can be scored quickly by computer, enabling results to be available to a clinician before meeting with the patient; additionally, these measures have been shown to have good psychometric properties [7]. Drawbacks, however, include the atheoretical nature of most self-reports of dental anxiety and that, with few exceptions, they are typically developed for use with children of at least 8 years in age without any cognitive limitations [7]. This may be somewhat problematic in that most recommendations are that youth begin visiting the dentist well before age 8 and there is also some evidence that dental fear and phobia may be especially prevalent in atypically developing youth [8], a group that may have particular difficulty completing self-report measures. Additionally, self-reported dental anxiety may be influenced by how willing a child is to disclose anxiety.

Implicit measures can address several of the shortcomings inherent in current assessment methods. For example, self-reports of anxiety require the child to understand the language in which the measure is written, to be familiar with the vocabulary used, and to make sophisticated judgements that require the child to know not just how s/he feels but how those feelings compare with norms or what would be expected in a particular situation. Many implicit measures use pictures and rely on simple good/bad or like/dislike judgements. For example, the Affect Misattribution Procedure (AMP) simply requires the respondent to rate a series of Chinese pictographs as good or bad.

A second advantage of implicit measures is that with their low face validity, implicit measures are useful in evaluating constructs where social desirability plays a role. For example, when racial attitudes were compared using the AMP and self-reports, correlations were moderated by participants' motivation to conceal a racial bias. This effect was driven by self-reported prejudice [9]. Correlations between AMP and self-reported racial attitudes were high for participants with low motivation to conceal their attitudes, but these correlations decreased or disappeared for those who were highly motivated to conceal their attitudes; this was due to performance on self-report measures (i.e., successful concealment) without a corresponding change in the implicit measure (i.e., failure to conceal).

Last, a major advantage of the use of implicit measures in the area of anxiety, particularly phobia, is that these measures could be useful not only in detecting anxiety but also in determining whether a treatment is successfully affecting the associations that cause the anxiety. Dental phobia is most frequently caused by a direct conditioning experience in which the pairing of one or more dental stimuli with an unconditioned stimulus (e.g., pain or shame) becomes an established association causing anxiety and fear (i.e., excitatory learning) (see Seligman et al. [6] for a review of the evidence). Exposure therapy, the gold-standard in treatment for anxiety, is thought to work through the development of inhibitory learning, the creation of new non-anxiolytic associations to compete with existing excitatory learning [10]. Several studies show that it is these conditioned associations that cause responses on implicit measures such as the AMP [11, 12]. Thus, psychometrically sound implicit measurers of anxiety could allow for mechanistic investigations of anxiety treatments.

Although the Implicit Associations Test (IAT; 13) is probably the most widely recognized implicit measure, the IAT can be difficult to administer, requires complex instructions, relies on response latencies, which can be affected by children's focus and momentary distractions, and recent studies have called into question its validity (e.g., 14). The AMP [9] is a widely used implicit measure that is simple to complete and brief. The AMP requires respondents to make a simple dichotomous choice in response to ambiguous stimuli, making it accessible even for young children. Scores are based on favorable versus unfavorable responses and not reaction time as with the IAT, making it less likely for artifacts (e.g., distractions in a busy environment such as a waiting room) to affect results. Moreover, the reliability and validity of the AMP has been demonstrated in multiple studies across multiple domains [15]. Furthermore, there is evidence the AMP is a valid measure of implicit associations in children. In a series of studies, Williams et al. [16] demonstrated the validity of the AMP in children as young as 5 years. However, although the AMP has been used to measure health anxiety in adults [17], to our knowledge, no previous research has used the AMP to assess anxiety or phobias in children or adolescents.

The current study reports on the development and testing of a dental specific AMP for use with children and adolescents, hypothesizing the Dental AMP (AMP-D) will demonstrate adequate internal consistency and test-retest reliability. Moreover, it is expected that youths' scores on the AMP-D will be significantly but moderately correlated with explicit (i.e., self-report) measures of dental anxiety, thus providing evidence of construct validity.

Methods

Participants and Procedures

Participants were recruited through schools and summer camp programs in southern Texas, United States in summer 2017 and fall 2018. Information about the study and consent forms were sent to parents of all youth who attended the schools and summer camp programs. Seventy parents provided informed consent and permission for their children to participate. Two children opted out of participating at the

time of the study. The final sample was made up of 68 youth (31% boys) between the ages of 9 and 17 years ($M = 13.48$, $SD = 1.89$) who provided assent before starting study procedures. The majority of the sample (75%) were Hispanic, with the remaining youth reporting their ethnicity as Caucasian/White. The project was reviewed and approved by the Institutional Review Board of the first author's institution before study procedures commenced.

Youth were tested in a private room; all measures were completed on a computer. After the study procedures were explained, the participants completed the AMP-D and a self-report of dental anxiety in a counterbalanced order. Parents completed a questionnaire reporting on their child's dental anxiety. Some parents accompanied the child to the session and completed the measure during this time but in most cases, parent packets were sent home. A second session took place approximately 1 week after the initial testing session in which youth completed the AMP-D a second time to allow for assessment of test-retest reliability.

Dental Anxiety Measure

Youth reported their dental anxiety using the Modified Child Dental Anxiety Scale (MCDAS; 18). The MCDAS is a list of eight items which require the child to indicate the level of worry s/he experiences in various dental situations (e.g., going to the dentist, having a tooth taken out). Due to a clerical error, some youth responded to a version of the MCDAS with a 3-point response scale and some responded to a version with a 5-point response scale; as a result, child scores on the MCDAS were converted to z-scores. Parents reported on their child's dental anxiety using the same measure, modified to ask about the respondents' child. The MCDAS has demonstrated good test-retest reliability and internal consistency and elevated MCDAS scores have been observed for youth referred for dental anxiety and those with a history of receiving general anesthesia for dental procedures, supporting the validity of the instrument [18]. Internal consistency in the current sample was $\alpha = 0.86$ for both the child and parent MCDAS.

AMP-D

The AMP-D consisted of a series of trials in which a dental priming image or a neutral image (e.g., a wooden chair) selected from the International Affective Picture System (IAPS; 19) is briefly presented on a computer screen followed by an ambiguous image (see Fig. 1). The participants are asked to evaluate the ambiguous images. Ambiguous stimuli used here were Chinese pictographs as is common for AMP procedures given that most in the United States are not familiar with the meaning of these characters. The rationale is that one's affective response toward the priming or neutral image will be misattributed to the subsequent ambiguous stimulus and therefore evaluations of the ambiguous images provide an unobtrusive assessment of the primed category [9].

The AMP-D task was completed on a touchscreen computer using DirectRT software [20]. The task began with 10 practice trials followed by a series of trials with dental primes and neutral primes. On each, a prime image (either dental or neutral) appeared in the center of the screen for 75 ms followed by a blank screen for 125 ms. Immediately after the blank screen, a Chinese pictograph appeared for 125 ms. Finally, a black and white "noise" pattern appeared, and participants were asked to judge whether the ambiguous image was pleasant or unpleasant by touching either a happy face (scored as "0") or a sad face (scored as "1") on the screen. Dental primes consisted of 10 pictures of dental equipment and 10 pictures of a child in a dental chair. Each of the dental images were presented 6 times, for a total of 120 dental prime trials. Participants also complete 40 trials with unrelated neutral primes, resulting in a total of 160 randomly ordered trials. The score on the AMP-D was calculated as the difference between the proportion of the pleasant/unpleasant ratings on the 120 dental prime trials and 40 neutral prime trials. Higher scores equate to more unpleasant ratings following the dental primes, or put differently, more negative implicit associations with dental stimuli.

Results

Descriptive Statistics and Preliminary Analyses

AMP-D scores at Time and Time 2 were normally distributed (Skewness < 0.5; Kurtosis < 0.9) with central tendency (M Time 1 = 0.49; M Time 2 = 0.51) and variability (SD Time 1 = 0.56; SD Time 2 = 0.53) similar to other AMPs. Females and males did not have significantly different AMP-D scores at Time 1 or Time 2 (t's < 1., p's > 0.3), and AMP-D scores were uncorrelated with participant age (r's < 0.3, ps > 0.1). Standardized scores on the MCDAS ranged from − 1.67 to 2.66, indicating considerable variability on self-reported dental anxiety within the sample.

Reliability

Internal Consistency

As AMP-D responses are dichotomous, internal consistency was estimated using the Kuder-Richardson 20 [KR-20] coefficient. The internal consistency was high at both Time 1 (KR-20 = 0.97) and Time 2 (KR-20 = 0.96). The KR-20 coefficients were similar for males and females at both Time

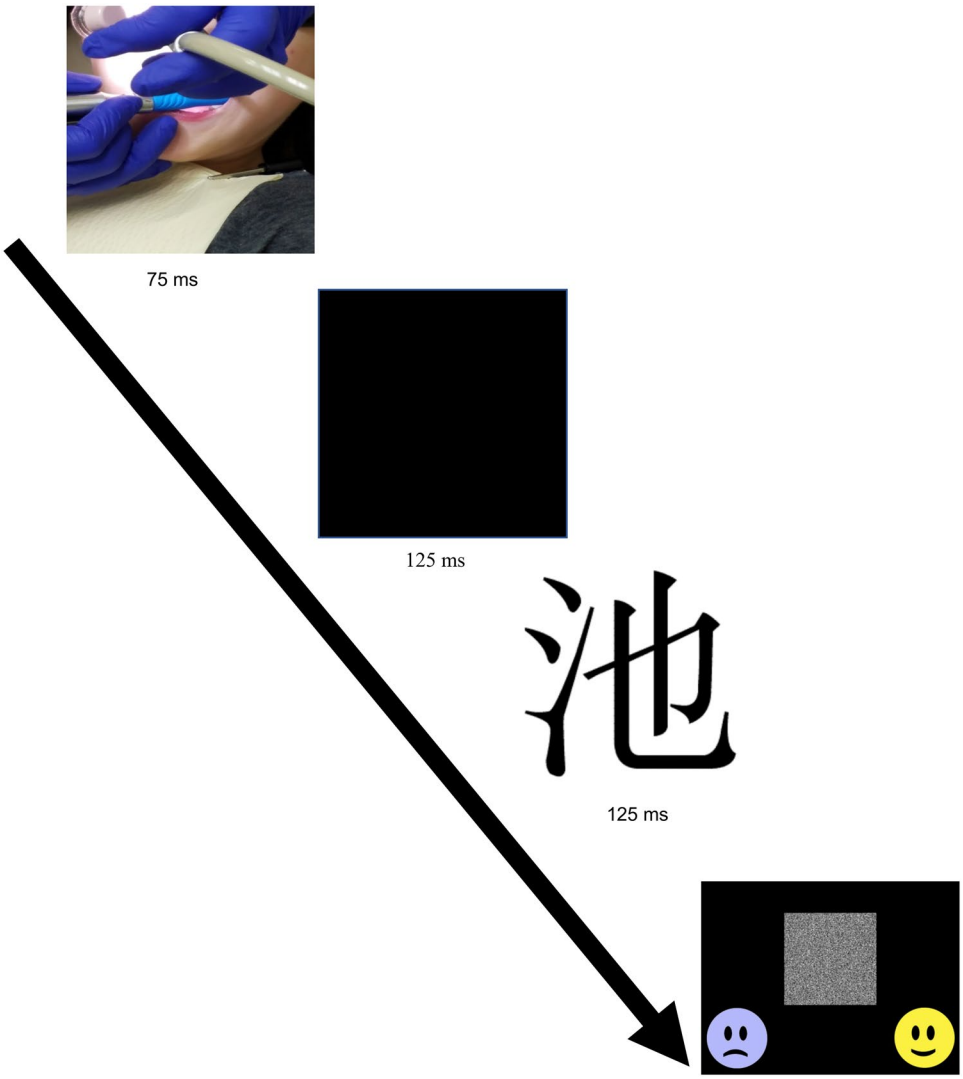

Fig. 1 Example dental prime trial

1 (males: KR-20=0.95; females: KR-20=0.96) and Time 2 (males: KR-20=0.96; females: KR-20=0.96).

Test-Retest Reliability

Scores on the AMP-D at Time 1 and Time 2 were significantly correlated, $r = 0.75$, $p < 0.001$, indicating acceptable test-retest reliability.

Construct Validity

Providing evidence for construct validity, AMP-D scores were associated with MCDAS scores at Time 1 ($r = 0.48$, $p < 0.001$) and at Time 2 ($r = 0.38$, $p < 0.005$). The associations between MCDAS scores and the AMP-D at Time 1 and Time 2 were not significantly different for males (Time 1: $r = 0.38$, $p = 0.09$; Time 2: $r = 0.40$, $p = 0.10$) and females (Time 1: $r = 0.51$, $p < 0.001$; Time 2: $r = 0.40$, $p < 0.05$). Parent ratings of child dental anxiety did not correlate with AMP-D scores (ps > 0.19) or child MCDAS scores (p > 0.45).

Discussion

Our findings provide initial support for the reliability and validity of the AMP-D. In a sample of children and adolescents, the AMP-D showed high internal consistency, good test-retest reliability, and evidence of concurrent validity.

The high reliability found for the AMP-D is consistent with a meta-analysis of the internal consistency of AMP measures [15]. More specifically, Payne and Lundberg [15] found an average internal consistency of 0.81 (95% CI 0.77 to 0.85) across 45 studies and 11,002 participants. Reliability was found to be positively correlated with the number of trials, with AMP measures consisting of 120 trials or more associated with reliability estimates at the higher end of this confidence interval, as we found here with the internal

consistency of the AMP-D. Unlike many previous studies, reliability was also assessed by examining short-term stability of scores. In this regard, the AMP-D exhibited 1-week test-retest reliability in the acceptable range and similar to that of self-reports of dental anxiety [18]. This suggests that at least in the short-term, the AMP-D is tapping into a relatively stable construct as would be expected absent any significant dental experiences.

We also found that the AMP-D was correlated with children's self-reports of dental anxiety, providing strong evidence of concurrent validity. Across 46 studies in various domains, the average correlation of the AMP with explicit measures has been estimated to be $r = 0.30$ [21]. Our findings suggest a somewhat larger association between the AMP-D and explicit reports of dental anxiety, likely owing to the high reliability of our measure. Nonetheless, consistent with current theory [22], the relationship between explicitly assessed dental anxiety and implicitly assessed dental anxiety was modest; suggesting that the AMP-D may yield unique information instead of representing a redundancy with self-reports. The potential utility of implicitly measured dental anxiety is bolstered by evidence showing that implicit measures are often more predictive of behavioral manifestations of anxiety than explicit measures and that they provide incremental validity beyond explicit measures [11, 23, 24].

The AMP-D provides several advantages over existing methods of measuring dental anxiety in youth. As discussed previously, current methods can be impractical for use in clinical practice or with certain subsets of patients. The AMP-D overcomes the shortcomings of explicit self-report measures in that it is less susceptible to attempts at conscious manipulation of responses and the effects of gender-based norms [9, 25]. Moreover, the AMP does not require the child to engage in complex introspection around his/her emotional reactions as is required by self-report questionnaires. Given the brief nature of the AMP-D and that it can be administered and scored easily by computer in the waiting room, the AMP-D could be administered to patients prior to treatment so that the clinician can be alerted to a child's anxiety, a significant advantage over behavior ratings scales.

Significantly, psychometrically sound measures of implicit associations with dental stimuli may also be useful in examining the efficacy of exposure therapy in the treatment of dental phobia and more specifically, in testing hypotheses regarding the mechanism for exposure therapy. Exposure is a critical component of most evidence-based treatments for childhood phobic and anxiety disorders [26]. Current theory suggests inhibitory learning, the creation of non-fearful associations with phobic stimuli that can compete with existing fearful associations, as the underlying mechanism for these treatments. To date, however, inhibitory learning has been inferred from indirect assessments (e.g., expectation ratings). However, psychometrically sound measures of implicit associations may provide a direct measure of inhibitory learning, key to the experimental medicine approach to furthering treatment research in this area. This hypothesis is supported by previous research that has shown that individuals undergoing exposure therapy for spider phobia showed reduced implicit fear-associations with spiders after treatment [11] and that implicit associations post-treatment predict risk of relapse [12].

Limitations and Future Directions

Interestingly, parents' reports of their child's dental anxiety was not related to child self-reports nor the child's implicit associations with dental anxiety as assessed by the AMP-D. Assessments of mental health symptoms by different informants, such as those by a parent and child, typically show a low-to-moderate concordance [27]. Moreover, poor concordance among informants is particularly true for internalizing disorders as evidenced by a recent meta-analysis of 372 studies that found an effect size of 0.26 between parent and child measures [28]. Our findings, suggesting a concordance between child reported anxiety and implicit associations suggest that child reports may yield better information on dental anxiety than parent-reports. Future research examining the relationship between implicitly measured dental anxiety and child dental behavior and oral health is needed however, to examine this hypothesis.

Given the current findings, an important additional avenue of future inquiry is the examination of the AMP-D in individuals with autism spectrum disorder (ASD). Children with ASD have higher rates of anxiety than children without ASD, with prevalence estimates of 40% in community samples [29]. In addition, children with ASD exhibit uncooperative behaviors during dental visits more frequently, compared to children without ASD [30] but commonly used anxiety measures may not be appropriate with this population. For example, the Spence Children's Anxiety Scale-Parent version, was found to have a different factor structure among children with ASD than in typically developing children [31]. Also, complicating the diagnosis of an anxiety disorder in youth with ASD, children and adolescents may lack the skills to report on their affective states, a skill not required to complete the AMP. Given these potential advantages and the applicability in this population, future research should investigate the suitability of the AMP-D to identify dental anxiety and phobia in children and adolescents with ASD.

The current study was conducted with a majority Latino sample; there is evidence that oral health is poorer in this population relative to non-Latino whites in the United States [32], making this population ideal for the study of dental anxiety measures. Nonetheless, additional research with diverse samples may be needed to confirm the suitability

of the AMP-D with youth. However, although research in non-Western, and non-Caucasian samples is limited, our findings and at least one additional study [33] suggest the AMP performs similarly across ethnic groups.

In addition, the current sample was small and predominantly femaleand did not include young children. We found no evidence that the psychometric properties of the AMP-D differed between males and females and scores were not correlated with age. Moreover, there is ample evidence the AMP is valid in children as young as 5 years [16], suggesting the AMP-D could be useful for both boys and girls across young childhood and adolescence. Nonetheless, future studies with larger samples including younger children with more boys and should be done to confirm.

Summary

The current study examined the reliability and validity of a measure of implicit associations with dental stimuli in children and adolescents. The measure demonstrated high internal consistency and 1-week test-retest reliability in the acceptable range. Moreover, evidence of construct validity was provided by moderate correlations with child-reported dental anxiety. The findings from the current study suggest that the AMP-D could provide a psychometrically sound and efficient method to assess children and adolescents' dental anxiety. The AMP-D could be easily used to assess dental anxiety in the waiting room of a dental clinic, or the measure could be completed at home before a dental visit. This type of assessment could alert the treating clinician to possible problems and is likely less influenced by a patient's (un)willingness to report anxiety. Additionally, the AMP-D could be used during anxiety treatment to assess whether a child evidences the predicted changes in implicit associations expected by cognitive behavioral theory, allowing for advances in research into a hypothesized mechanism for exposure therapy and possibly, allowing for greater precision in future treatment development.

Declarations

Conflict of interest The authors declare no conflict of interest concerning authorship or publication of this article.

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