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Review

# Dental anxiety: An understudied problem in youth

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ABSTRACT

Dental anxiety and dental phobia typically emerge during childhood; the associated avoidance of dental care can result in oral health problems and is associated with lower quality of life. In this review, we discuss the definition of dental phobia and dental anxiety and issues related to their differentiation. We then review the literature on dental anxiety and dental phobia, including its prevalence, assessment, and sequalae. Moreover, we provide a synthesis of findings on the etiology and maintenance of dental phobia and propose a comprehensive cognitive behavioral model to guide further study. We also present a systematic qualitative and a quantitative review of the treatment literature, concluding that although we have made strides in learning how to prevent dental anxiety in youth, the methods effective in preventing anxiety may not be equally effective in treating youth with dental phobia. We propose a multidisciplinary approach, including those with expertise in pediatric anxiety as well as pediatric dentistry, is likely required to move forward.

## 1. Introduction

Dental fear in youth is often considered to be developmentally normative. However, when developmentally appropriate fear gives way to significant dental anxiety or dental phobia, the resulting avoidance has the potential to impact a child's health status. In this review we first define and describe dental anxiety and dental phobia and discuss the classification of dental phobia in DSM 5 (American Psychiatric Association, 2013). We then review the evidence of the prevalence, assessment, and impact of dental anxiety and dental phobia as well as the literature on its etiology and maintenance – presenting an integrated cognitive behavioral model to guide future research. Finally, we provide a systematic qualitative and quantitative review of attempts to treat dental anxiety and phobia, with the aim of elucidating what we know about addressing this important problem and where we need to go to improve the options we can offer youth affected by this condition.

## 2. Definition and clinical picture

Dental phobia is a persistent and excessive fear of dental stimuli and procedures that results in avoidance or significant distress. Children and adolescents with dental phobia may evidence disruptive behaviors when undergoing examinations and treatment – ranging from fidgetiness to full-blown tantrums; in the most extreme cases, youth with dental phobia may refuse treatment even when experiencing significant pain that could be alleviated with appropriate care. In the DSM 5, dental phobia is classified as a specific-phobia and, more precisely, under the blood-injection-injury (BII) phobia type (American Psychiatric Association, 2013). The appropriateness of the BII specifier, however, has been called into question because of several distinctions between those with dental phobias and other BII phobias. For example, anxiety sensitivity seems to be a significant part of the clinical picture for those with BII phobias, but this is not reported to be the case for those with dental phobia (Kılıç, Ak, & Ak, 2014), although it should be noted that the data here are mixed (Liddell & Gosse, 1998; Locker, Shapiro, & Liddell, 1997). In addition, patients with dental phobia often report more anxiety pertaining to other dental stimuli (e.g., the sound of a drill, having a tooth extracted) than to blood and injections per se; in fact, anxiety regarding blood seems to be relatively uncommon or minor in individuals with dental anxiety (de Jongh et al., 1998; van Houtem et al., 2014). Moreover, the onset of dental phobia appears to occur somewhat later than other BII phobias (Öst, 1987) and there is some emerging evidence of different physiological reaction patterns between those with dental phobia and those with other BII phobias (Leutgeb, Schäfer, & Schienle, 2011). Similarly, while there is comorbidity of dental phobia and other BII phobias, it is not as high as would be expected if these were one in the same and, when there is overlap, it seems to be explained by a diagnosis of dental phobia resulting from a fear of injections, but not other dental stimuli, during dental treatment or as part of a more general clinical picture that includes multiple phobias and anxiety disorders (Locker et al., 1997; Öst, 1992). In fact, at least one study suggests that dental phobia is more strongly related to

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fears that center on loss of control rather than medical fears per se (Armfield, 2008).

Often, studies that investigate fear and anxiety related to dental stimuli report on dental anxiety rather than dental phobia. Dental anxiety is a heightened fear of dental procedures that may or may not reach full criteria for diagnosis as a phobia; however, since self-report measures alone are often used to identify dental anxiety, all data required for the determination of a diagnosis are typically not available. Given that much of the literature investigates dental anxiety rather than dental phobia, we use the term dental anxiety throughout, except when we wish to make explicit comparisons between heightened anxiety and a full-blown diagnosis of dental phobia.

## 3. Prevalence

It is difficult to accurately describe the prevalence of dental anxiety as many epidemiological studies do not provide such data; data in youth samples are particularly scarce. However, looking at adult studies may provide some insight as evidence suggests that most adults with dental anxiety developed their fear in childhood or adolescence (Locker, Liddell, Dempster, & Shapiro, 1999). Again, however, data are problematic in that studies report more often on dental anxiety with few studies reporting on dental phobia.

### 3.1. Prevalence of dental anxiety in adult samples

Given this caveat, it seems that around 15% of the adult population suffers from significant dental anxiety. For example, Locker et al. (1999) estimated the prevalence of dental anxiety to be 16.4% and Locker, Poulton, and Thomson (2001) found that 12.5% of their sample of 18 year olds drawn from the Dunedin (New Zealand) Multidisciplinary Health and Development Study (DMHDS) reported moderate to severe dental anxiety on a self-report instrument. Similarly, a study in Australia that included both children and adults found high levels of dental anxiety in 16.1% of the sample (Armfield, Spencer, & Stewart, 2006). Dental phobia in adults, on the other hand, is much less common with about only 1% of the DMHDS sample reporting symptoms consistent with a diagnosis of dental phobia at age 18 years (Locker et al., 2001).

### 3.2. Prevalence of dental anxiety in youth samples

Prevalence estimates of dental anxiety in youth are somewhat more variable, with estimates ranging from approximately 5% to 20%. Baier, Milgrom, Russell, Mancl, and Yoshida (2004) found that 20% of their sample of youth visiting private pediatric dentists evidenced high dental anxiety; however, this would seem likely to be an underestimate in the general population in that children and adolescents with the most severe dental anxiety might be expected to avoid dental treatment altogether or to present at specialty clinics (Bedi, Sutcliffe, Donnan, Barrett, & McConnachie, 1992). However, a study of unselected adolescents in the United States arrived at a lower figure as approximately 10% of the junior high and high school students in the sample reported high levels of dental anxiety (Gatchel, 1989). Investigations of unselected youth in Scotland and the Netherlands found somewhat similar results with about 7% of early adolescents in Scotland and 6% of Dutch youth reporting high dental anxiety (Bedi, Sutcliffe, Donnan, & McConnachie, 1992; ten Berge, Veerkamp, Hoogstraten, & Prins, 2002a). On the other hand, epidemiological studies in youth have found estimates of the prevalence of all simple/specific phobias to range from 0.3% to approximately 5% (Costello et al., 1996; Fergusson, Horwood, & Lynskey, 1993). Of course, only a subset of these youth would be expected to have dental phobia; thus, the prevalence of full-blown dental phobia in youth would be expected to be much lower than the estimates of dental anxiety. Nevertheless, estimates from both youth and adult samples suggest a significant portion of the population experiences significant distress related to dentistry and importantly, both dental anxiety and dental phobia appear to be related to negative consequences in both the short and long term (Eitner, Wichmann, Paulsen, & Holst, 2006; Klingberg, Berggren, Carlsson, & Noren, 1995).

## 4. Clinical significance

The clinical significance of dental anxiety should not be underestimated. Dental anxiety is first and foremost an oral-health problem as it is associated with a lower frequency of dental visits and a higher prevalence of dental caries (Klingberg et al., 1995). Furthermore, as indicated in the diagnostic criteria for any anxiety disorder or phobia by APA (2013), the avoidance or distress associated with the phobic stimulus interferes significantly with the individual's normal routine, occupational or school functioning, and social relationships.

Luoto, Lahti, Nevanperä, Tolvanen, and Locker (2009) found that children who were afraid of dental treatment reported lower social well-being and emotional well-being in comparison to children without fear of dental treatment. Thus, the sequelae of dental anxiety were shown to extend well beyond the actual dental situation itself to life outside the dental setting and to life in general. These findings are not surprising given that quality of life has been shown to be compromised in children with other phobias (Ollendick & Davis, 2001; Ollendick et al., 2009). Additionally, compromised oral health in children, which is related to dental anxiety, has been linked with a host of quality of life issues in youth including pain, social avoidance, and trouble eating (Foster Page, Thomson, Jokovic, & Locker, 2005).

Importantly, emerging research in both children and adults suggests that dental health and, by extension, dental anxiety may also have much broader health implications. For example, Frisbee, Chambers, Frisbee, Goodwill, and Crout (2010) found that parent reported dental health problems was related to markers of systemic inflammation in children, possibly putting children at risk for later cardiovascular disease. Additionally, a recent meta-analysis has shown a link between childhood dental caries and obesity (Hayden et al., 2013). Although the link between dental health, inflammation, and conditions such as cardiovascular disease has been suggested as an etiological pathway, it must be noted that much of the research in this area is cross-sectional and correlational. Thus, whether hypotheses about a casual pathway will be borne out is yet to be seen. However, at this time we do know that dental anxiety is correlated with poorer dental health, poorer quality of life, and may even put children at risk for serious disease in adulthood.

## 5. Etiology and maintenance

Extant research suggests a complex set of factors that lead to the development and maintenance of significant dental anxiety or dental phobia. Here we review these findings and present an integrated cognitive-behavioral model of the development and maintenance of dental anxiety (see Fig. 1).

### 5.1. The role of learning in the etiology of dental anxiety

There is growing evidence to suggest that classical conditioning plays a major role in the development of dental anxiety in a number of sufferers (Fig. 1, panel a) with fewer, but a still significant number of those with dental anxiety, reporting vicarious conditioning experiences. Although much of this work has been done with adults, findings have been supported in the few studies conducted with children and adolescents as well.

#### 5.1.1. Evidence from adult studies

Berggren, Carlsson, Hägglin, Hakeberg, and Samsonowitz (1997) found that 47% of their adult sample high in dental anxiety reported

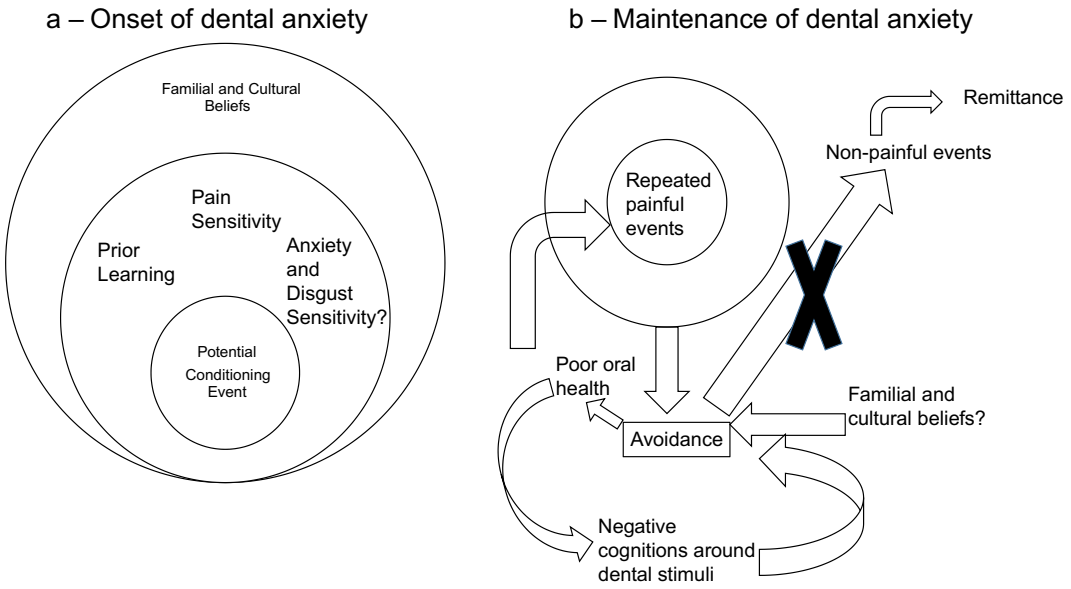


**Fig. 1.** The onset of dental anxiety begins with a conditioning event but whether a dental experience serves as a conditioning event is dependent on the context in which it occurs (panel a). The maintenance of dental anxiety is hypothesized to be influenced by a complex interplay of cognitive behavioral factors influenced by the child's family and cultural beliefs (panel b).

direct conditioning experiences leading to their anxiety and another 26% reported a mixture of both direct and vicarious learning experiences. Similarly, Davey (1989) found that 93% of adults with either current dental anxiety or a history of dental anxiety reported at least one painful dental experience; this proportion was significantly higher than that found in individuals with no dental anxiety. Moreover, there was some evidence from this study to suggest that individuals with high dental anxiety were also more likely to report at least one *very painful* dental experience. de Jongh, Muris, ter Horst, and Duyx (1995) also found that adults with current dental anxiety were more likely to report painful or traumatic dental experiences than those who had never experienced dental anxiety. In fact, they found very few individuals with current dental anxiety who had not experienced a painful or traumatic dental event. Importantly, although these studies were conducted with adults, multiple investigations have found that the conditioning events leading to dental anxiety have typically occurred in childhood or early adolescence (Davey, 1989; de Jongh et al., 1995; Liddell & Locker, 2000), suggesting this period may be critical in the development of dental anxiety. Specific developmental influences may play a role in this phenomenon, although there is little research or theory to suggest how or why this might be the case. On the other hand, increasingly fine-grained analyses of the learning histories of those who develop dental anxiety suggest an alternative hypothesis for why onset typically occurs in childhood or adolescence. Such investigations suggest that latent inhibition – a history of non-fearful learning prior to a fear conditioning event – may play a key role.

More specifically, although it is true that those who develop dental anxiety are more likely to have a dental history that includes dental trauma and pain than those who do not have dental anxiety, a considerable number of those without dental anxiety also have had similar experiences with dental pain or traumatic events at the dentist's office. In fact, studies suggest that as many as 60–80% of people with no history of dental anxiety have had at least one painful dental treatment (Davey, 1989; de Jongh et al., 1995). However, what seems to differentiate those who go on to develop significant dental anxiety from those who do not is that those who do not develop dental anxiety have more *non-painful or non-traumatic* dental experiences (i.e., a greater number of conditioned stimulus presentations without the presence of the unconditioned stimulus) *prior* to their negative dental experience(s) (Davey, 1989; de Jongh et al., 1995). Conversely, those with significant dental anxiety seem to have had fewer non-fearful learning opportunities before their negative dental experience (Davey, 1989; de Jongh et al., 1995). In effect, this means that *early* learning experiences will play a particularly important role in determining dental anxiety. If an individual has several positive experiences with dental treatment before having a painful or even traumatic treatment, the chances of developing significant dental anxiety decrease compared to someone who is naïve or relatively naïve to dental treatment when s/he first has a negative experience. Given that many individuals first visit the dentist during childhood or adolescence, these learning experiences will likely take place during youth, which may explain why many with significant dental anxiety report an age of onset in childhood or adolescence. This also means that early and *regular* dental care should serve to inhibit the development of dental anxiety, barring any very early dental injury or severe disease.

#### 5.1.2. Evidence from child studies

These conclusions with adults are largely supported by studies in youth in that studies with children and adolescents similarly find that learning experiences, particularly direct conditioning, are key to the development of dental anxiety. For example, in a large sample of elementary school-aged children in Taiwan, Lin et al. (2014) found direct conditioning experiences to be the most commonly reported etiological factor for dental anxiety. Modeling was also found to play a role, however, with direct conditioning serving as the best predictor of dental anxiety in high socioeconomic status (SES) youth and modeling experiences serving as the best predictor of dental anxiety in low SES youth. Similarly, Milgrom, Mancl, King, and Weinstein (1995) found that direct conditioning experiences and modeling predicted dental anxiety in low income youth in the United States. However, direct conditioning experiences in this study were inferred from the child's dental health; that is, children with poor dental health (e.g., caries) were presumed to have had more negative conditioning experiences. However, this may not have been the case if the children did not actually experience dental treatment that was perceived as painful or traumatic. Importantly, as we discuss below, what the individual brings with them in terms of their thoughts and beliefs to the dental exam room can significantly affect whether or not a particular dental encounter serves as a conditioning event.

Subsequent research in youth, however, did address this short-

coming by looking at dental health *and* perceptions of treatment as indictors of the direct conditioning pathway to dental anxiety in youth (Townend, Dimigen, & Fung, 2000). Results revealed that youth with dental anxiety did indeed have more dental decay and missing teeth than their non-anxious counterparts *and* that anxious youth had more visits to the dentist that were perceived as traumatic. Importantly, the latent inhibition hypothesis suggested in the adult literature was also examined, revealing that children with dental anxiety first experienced dental trauma at an earlier age than children without dental anxiety. While these data, like those in adult studies, were obtained by retrospective reports, in this case the period of recall was briefer, adding additional credibility to the latent inhibition hypothesis. Interestingly although modeling was also examined, little evidence was found for this type of learning as a pathway to dental fear. So while learning seems to play an important role in the development of dental anxiety, the preponderance of evidence suggests a direct conditioning pathway in most cases with less evidence supporting the role of modeling as a direct pathway to dental anxiety in youth. However, as we allude to above, a dental experience that may serve as a conditioning event for one child may be perceived as relatively benign to another. We have already discussed how prior learning influences the likelihood that a painful or traumatic event serves to condition the child to associate dental stimuli with anxiety; however, so too does the cognitions and characteristics the child brings with him or her to the dental exam.

### 5.2. The role of cognitive and constitutional factors in the etiology of dental anxiety

One's perception of *oneself* in relation to dental stimuli seems to also play an important role, again functioning to moderate the probability that one will experience the early learning events that lead to the initial development of dental anxiety (Fig. 1, panel a). Those with dental anxiety have been found to be more fearful of pain, particularly minor pain, than those low in dental anxiety (Vowles et al., 2005) and to view themselves as having a lower pain tolerance threshold (Davey, 1989). These beliefs may serve to focus the individual on physical sensations during dental treatment; this biased processing of physical stimuli may actually serve to amplify the potentially painful stimuli (Chapman & Kirby-Turner, 2005).[1] Thus, while it is true that the occurrence and pattern of early learning experiences seems to play a critical role in the development of dental anxiety, whether or not one is exposed to these anxiety engendering experiences may not be independent of the individual's perception of those experiences. Pain is a complex phenomenon and it is most certainly not a purely physiological-based response; those individuals who view pain as particularly aversive and who have relatively low self-efficacy for coping with pain may be more likely to experience dental pain as a result of these beliefs.

Additional constitutional factors such as behavioral inhibition, disgust sensitivity, and anxiety sensitivity have often been found to put youth at disproportionate risk for specific phobias. In the case of dental phobia the role of these risk factors is somewhat unclear given the lack of research. However, what data we do have are mixed.

For example, to our knowledge only one study has investigated the role of behavioral inhibition in youth dental anxiety. Of note, this study investigated dental anxiety in a relatively small sample of young children and relied almost entirely on measures with unknown psychometric properties developed by the author (Hammock, 1999). These caveats notwithstanding, child self-reports of dental anxiety were not significantly related to parent and teacher reports of behavioral inhibition; however, in general, observations of anxiety and distress during dental prophylaxis were related to these indices. Thus, although behavioral inhibition may be a risk factor for the development of dental anxiety, to date there is not enough evidence to conclude this is the case despite its link to other anxiety disorders in youth (e.g., Paulus, Backes, Sander, Weber, & Gontard, 2015).

Anxiety sensitivity and disgust sensitivity, often implicated in the etiology of some specific phobias, would likely function to predispose one for dental phobia in much the same way as pain sensitivity - by focusing the individual on particular stimuli and amplifying their aversive properties. In fact, pain sensitivity and anxiety sensitivity seem as if they should be highly linked and thus it would be expected that anxiety sensitivity would likely play a role in the development of dental phobia. Anxiety sensitivity has been shown to be related to BII phobias more generally (Kılıç et al., 2014); however, as previously noted, the evidence for the link between dental phobia and anxiety sensitivity is mixed (Kılıç et al., 2014; Locker et al., 1997). Interestingly, Liddell and Gosse (1998) found that anxiety sensitivity was related only to specific perceptions of early dental encounters – those involving dental injury. Thus, it may be that anxiety sensitivity plays a role in the development of dental phobia only in cases of a particular type of early learning event; however, it may also be that pain sensitivity is a more precise and relevant construct in relation to dental phobia as opposed to other types of BII phobias. This makes some intuitive sense as other BII phobias often involve fear of more general bodily sensations (e.g., the physiological cues that precede fainting) whereas the physiological sensations that seem to predominate in dental phobia revolve more around the specific sensation of pain; however, very little research has been done in this area, particularly with children, so conclusions at this point are tentative.

Similarly, recognition of the role of disgust sensitivity in the development of specific phobias has been growing and this is true in the case of dental phobia as well. However, the evidence regarding the role of disgust sensitivity in dental phobia is not consistent. For example, de Jongh et al. (1998) found a non-significant correlation between self-reported dental anxiety and disgust sensitivity whereas other studies found mixed results (Merckelbach, Muris, de Jong, and de Jongh, 1999). Findings may be clouded however because the relationship between disgust sensitivity and dental anxiety may not be a straightforward one. For example, Armfield (2008) found that disgust sensitivity and dental fear did covary; however, those with high dental anxiety reported disgust sensitivity similar to those with the lowest levels of dental anxiety whereas those with moderate dental anxiety reported the highest levels of disgust sensitivity. Additionally, Leutgeb et al. (2011) found fear to be more central to dental phobia than disgust; nonetheless, their data showed that individuals with dental phobia rated relevant photos as more disgust inducing compared to controls. This response, however, seemed to be driven primarily by items related to oral disgust. Moreover, this investigation also found that those with dental phobia experienced heart rate acceleration when exposed to relevant stimuli in contrast to the heart rate deceleration that is thought to accompany feelings of disgust. Thus, there is not strong support for the role of disgust sensitivity as a primary driver of perceptions of dental experiences. Nonetheless, these mixed results should not be ignored as they lead to several interesting hypotheses requiring further exploration. It might be that a specific type of disgust sensitivity (related to oral intrusions) plays a role in the development of dental phobia and that this relationship gets obscured when more general measures of disgust are used. Alternatively, there may be a particular subset of those with dental phobia who experience high levels of disgust sensitivity and the representation of this group in a study drives the modest correlations sometimes found. These individuals might be more similar to those with other BII phobias than to those with classic dental anxiety. A final possibility is that the comorbidity of dental phobias with other phobias, particularly other BII phobias, drives the association of dental phobia and disgust sensitivity. However, few studies in this area have been conducted and those that have been have used small sample sizes and have not fully addressed these possibilities. Thus whether disgust sensitivity

[1] Chapman and Kirby-Turner (2005) note that this is similar to the process proposed in the etiology and maintenance of panic disorder.

plays a role in the development of dental phobia and, if so, the specific role it does play, needs to be investigated further before we can conclude that disgust sensitivity contributes to clinically significant dental anxiety.

### 5.3. The role of family and cultural factors in the etiology of dental anxiety

When family members have negative attitudes toward dental stimuli, studies show a link with youth dental anxiety with most of these studies examining this phenomenon in the child and parent dyad. In fact, in a meta-analysis of the relationship between parent and child dental fear, Themessl-Huber, Freeman, Humphris, MacGillivray, and Terzi (2010) found evidence for a significant, albeit moderate, correlation between parent dental anxiety and child dental anxiety. Although it is tempting to speculate that this is due to modeling of dental anxiety by parents, as discussed previously, the evidence for vicarious learning as a major direct contributor to dental anxiety is relatively weak. We suggest then that parental anxiety regarding dental procedures may affect child dental anxiety through a more complex, indirect pathway (see Fig. 1, panel a). First, modeling of dental anxiety and verbal learning transmitted from parent to child may cause decreased self-efficacy for pain and affect perceptions of dental stimuli, in turn increasing hypervigilance in early dental encounters and, as discussed previously, this may alter perceptions of potential conditioning events to make direct conditioning more probable. Additionally, parental anxiety may also impact a child's learning history if it results in avoidance of dental stimuli to the extent that the parent delays taking his/her child to the dentist for early and regular preventative care. Such a pattern increases the likelihood that painful treatment or traumatic interactions occur early in the child's dental history without the type of learning events that would result in latent inhibition of anxious learning. However, we must note that although these are plausible hypotheses given the present data, we know of no studies that directly evaluated these pathways.

We suggest that, at a broader level, cultural beliefs about oral health and dental treatment may play out in a similar fashion to affect a child's early dental experiences and ultimately the child's level of dental anxiety. Although extant research has not yet examined *how* culture influences the development of dental phobia in youth, studies have in fact shown that culture is indeed related to child dental anxiety (Folayan, Idehen, & Ojo, 2004). For example, it has been demonstrated that within a small sample in the United States, Puerto Ricans showed higher rates of dental anxiety than either Caucasians or African Americans (Weisenberg, Kreindler, Schachat, & Werboff, 1975). Again, it is not clear why this was the case, but cultural beliefs and the relationship between race, ethnicity, and economic factors may affect children's early learning about dentistry. For example, compared to Caucasian adults living in the same community, Latino and African American adults have been found to have less positive beliefs about a preventative stance toward dental healthcare (Nakazono, Davidson, & Andersen, 1997). The implications of such a perspective within a culture are underscored by the results of a study exploring dental healthcare use among African American, high and low acculturated Latinos, and White families (Valencia et al., 2012). In this study, less acculturated Latino children were the least likely to have visited a dentist in the previous year; in fact, compared to White children, the odds that a Latino youth from a less acculturated family had been to the dentist in the previous year was 75% lower. The picture for the other minority families was also bleak as the odds for African American and more acculturated Latino youth were 45% and 40% lower respectively. Interestingly, in multivariate models predicting dental attendance, ethnicity/race appeared to exert its influence on dental visits largely through economic factors such as having dental insurance and a regular source of dental care. Of note, this investigation did not include an in depth assessment of health beliefs so the impact of these beliefs could not be determined. Taken together, however, these studies suggest that beliefs about oral health and economic factors related to race and ethnicity are likely to affect a child's pattern of attendance at dental appointments. Latino and African American youth may be less likely to visit the dentist regularly and they may be particularly less likely to visit the dentist for preventative care visits – the types of visits that are more likely to provide an early positive learning history. Such a pattern would be expected to ultimately impact child dental anxiety by increasing the probability of painful and traumatic dental visits when the child does eventually seek care, along with the likelihood that the child will not have positive early learning history to inhibit the anxious learning. On the other hand, there is some evidence that some Asian families are comparatively more concerned about both the social and physical consequences (i.e., pain) of dental health compared to Caucasians (Kiyak, 1981). Such a set of beliefs results in increased preventative behaviors (Kiyak, 1981), which in turn should decrease the possibility of early aversive learning. However, a cultural focus on pain or other constitutional factors that increases hypervigilance during dental treatment could result in aversive learning in response to even a relatively innocuous dental history; thus increasing the probability of dental anxiety. Moreover, these cultural factors are also likely to play a role later in the anxiety cycle, helping to determine whether or not initial dental anxiety remits or results in stable anxiety and phobic behavior.

### 5.4. The role of learning, cognition, and culture in the maintenance of dental anxiety

While early learning history seems to play a role in the initial development of dental anxiety, several other factors including repeated aversive learning, avoidance, the cognitive construal of dental stimuli, and family and cultural values likely contribute to the maintenance of dental anxiety. Moreover, these factors seem to be intertwined in a very complex relationship (see Fig. 1, panel b). For example, when comparing adults who reported stable, persistent dental anxiety to those who reported remitted dental anxiety, Davey (1989) found the experience of multiple painful dental events distinguished the two groups – both groups experienced early negative learning experiences leading to dental anxiety, but those who did not have repeated pain paired with dental stimuli were more likely to remit over time. It seems that multiple painful experiences may function to culminate in stable dental anxiety in several ways. First, multiple UCS/CS pairings make the learning more probable, although it should be noted that some evidence suggests this is not necessary if the UCS is particularly potent (Davey, 1989; de Jongh et al., 1995). Second, importantly, individuals who have multiple painful dental experiences are more likely to avoid dental treatment (Skaret, Raadal, Berg, & Kvale, 1999). This avoidance in turn affects dental anxiety through a direct path - not allowing for non-fearful learning, as well as indirectly- through the impact of avoidance on cognitions regarding dental stimuli (Carrillo-Diaz, Crego, Armfield, & Romero-Maroto, 2012).

More specifically, avoidance circumvents the opportunity for competing learning experiences (CS presentations in the absence of the UCS). Moreover, in a particularly perverse turn, avoidance makes it more likely that phobic individuals will experience compromised oral health which (1) increases the likelihood of uncomfortable or painful treatment when the person does eventually seek treatment, thus increasing the probability of additional aversive learning (Armfield, 2013) and (2) is related to the development of cognitive vulnerability schema in which dental stimuli are viewed as uncontrollable, disgusting, and dangerous or harmful (Armfield, 2008; Carrillo-Díaz, Crego, Armfield, & Romero, 2012), which creates a vicious cycle.

However, family and, on a larger scale, cultural beliefs about oral health seem to also be important in determining the course of dental anxiety. For example, when Davey (1989) compared adults with stable dental anxiety to those with remitted dental anxiety, they were similar on many of the variables discussed here (e.g., pain tolerance); however,

those in the remitted group were more likely to have close family members who regularly sought dental care. Davey (1989) postulated that this may lead one to have a positive evaluation of dental stimuli that can serve to compete with the negative evaluation formed from conditioning events. Such a conflict with family or cultural values may mitigate the likelihood of the aversive learning leading to avoidance, putting these individuals on a different development course that ultimately leads to remission rather than maintenance of the fear.

### 5.5. Summary and implications of key findings

There is good evidence that in many cases dental phobia starts with a direct conditioning event. We hypothesize, however, that whether any given dental event results in aversive learning is highly dependent upon multiple factors including characteristics of the event itself as well as learning history, child factors (pain sensitivity and perhaps anxiety and disgust sensitivity), and family/cultural factors. Moreover, family and cultural factors may also serve to help determine the pattern of learning; with parental dental anxiety, cultural beliefs, and economic factors affecting the likelihood that early dental visits will be for preventive care – encounters that are less likely to result in a potential conditioning event – or for treatment – encounters that are more likely to result in a conditioning event. Cultural factors may also play a role in determining a child's perceptions of pain, also influencing the likelihood that a dental event will serve to condition the child. Later in the cycle, we hypothesize that learning and behavioral patterns (repeated aversive events, avoidance) again interact with factors including oral health, cognitions regarding dental stimuli, and family/cultural beliefs to ultimately determine whether dental anxiety remits or begins to result in a true phobia. Thus, we hypothesize that a complex interaction exists between the child and the environment to determine both whether a potential conditioning event takes place and ultimately the effects of such an event. It should be noted, however, that although there is good evidence for some parts of our model, other components of the model are based on a very small number of studies. Clearly more research is needed – particularly into how family and culture affects the onset and maintenance of dental phobia. Nevertheless, we suggest that this research will prove more fruitful if guided by a comprehensive model, such as the one we propose here, given that the extant literature does seem to point to a complex interplay of cognitive, behavioral, and contextual factors in both the development of dental phobia and determination of its course. This research, as well as effective intervention efforts, relies on our ability to properly identify clinically significant levels of dental anxiety; thus, we now turn to the assessment of dental anxiety and dental phobia.

## 6. Assessment

Two methods have been commonly used to assess dental anxiety in youth. These include behavior ratings scales used by trained coders or by dental professionals providing treatment, and self-reports. Below we discuss some of the most widely used measures employing each of these methods.

### 6.1. Behavior ratings scales

Behavior rating scales infer dental anxiety from observations of disruptive behavior displayed by children when undergoing dental treatment. These scales can be grouped into two general categories. The first category examines specific behaviors and is typified by Melamed's Behavior Profile Rating Scale (BPRS; Melamed, Hawes, Heiby, & Glick, 1975a). The BPRS is a list of 27 *specific* behaviors – 25 disruptive child behaviors (e.g., verbal complaints, inappropriate mouth closing) and two dentist behaviors that would likely follow from child disruptive behaviors (using a loud voice and using restraints). Each of the behaviors is weighted by a rating, which the scale's authors obtained from dentists, of the degree of disruption caused, so that the behaviors that interfere most with dental treatment are weighted most heavily. Raters count the frequency of occurrence of each behavior during consecutive three minute intervals. A total score is obtained by multiplying the frequency of each behavior by its weight, summing across all behaviors, and dividing by the number of three minute intervals in the observation (Melamed et al., 1975a).

The second category of behavior rating scales is more subjective and rates behavior on a more macro level. This category includes the Frankl Behavior Rating Scale (Frankl, Shiere, & Fogels, 1962) and the Venham Rating Scales (Venham, Bengston, & Cipes, 1978). In this type of rating system, an ordinal rating is made by the dentist or observer with guidance from descriptors. For example, the Venham Rating Scales consist of a scale to measure anxiety and a scale to measure cooperativeness; in both instances, ratings are made on a 5-point scale with 0 indicating no anxiety ("relaxed, smiling, willing and able to converse") or total cooperation ("total cooperation, best possible working conditions, no crying, or physical protest") and 5 indicating extreme anxiety ("Child out of contact with the reality of the threat. General loud crying…") or lack of compliance ("General protest, no compliance or cooperation. Physical restraint required.").

These rating scales have been widely used to measure dental anxiety, particularly in treatment studies, and research has shown that raters can be trained to use the scales to make reliable ratings (e.g., Sullivan, Schneider, Musselman, Dummett, & Gardiner, 2000). Behavioral ratings have also been shown to correlate with parent reports of children's dental anxiety (Baier et al., 2004). However, very little research has been done to explore the validity of these measures. Moreover, in the case of the BPRS and the Venham cooperativeness scale, dental anxiety is inferred from the level of disruptive behavior displayed by the child, despite the fact that disruptive behavior may indicate fear and anxiety of the dental situation, fear and anxiety of some other stimuli (e.g., social fears, separation anxiety), or it may be reflective of oppositionality that is largely independent of fear. On the other hand, a child could be very anxious but cooperative and, in most cases, these rating scales would miss the child's internal distress (Aartman, van Everdingen, Hoogstraten, & Schuurs, 1996). Thus, although behavior rating scales are certainly an important component of a thorough assessment of dental anxiety in youth, given the nature of anxiety and fear, we recommend a multimethod approach that includes self-report data as well.

### 6.2. Self-reports

The Children's Fear Survey Schedule – Dental subscale (CFSS-DS; Cuthbert & Melamed, 1982) is perhaps one of the most widely used self-reports of dental anxiety in youth. The CFSS-DS is based on the original Children's Fear Survey Schedule (Scherer & Nakamura, 1968) with items added to create a dental fears subscale. The result is a list of 15-items (e.g., "the dentist drilling") that children react to by rating their fear on a 5-point fear thermometer. Although the CFSS-DS is described as a *subscale* of the Children's Fear Survey Schedule, it has typically been administered in isolation from the rest of the original measure. Cuthbert and Melamed (1982) provide some normative data but no evidence of reliability or validity of the measure. However, other investigators have found evidence supporting the reliability of various derivatives of the CFSS-DS (e.g., Folayan, Idehen, & Ufomata, 2003; ten Berge, Veerkamp, Hoogstraten, & Prins, 2002b). In terms of validity, Holmes and Girdler (2005) found scores on the CFSS-DS to be significantly higher in youth chosen for sedation during dental treatment but an investigation in youth referred for dental anxiety showed no relation between CFSS-DS scores and child behavior during treatment (Klaassen, Veerkamp, & Hoogstraten, 2003). Although it could be argued that this finding may be related to range restriction given the nature of the sample, there are other reasons to question the validity and utility of the CFSS-DS. First, more recent versions of measures of

children's fears have moved to a simpler response format due to observations that children often are unable to discriminate between choices on a 5-point scale (Muris & Ollendick, 2002; Ollendick, 1983). Moreover, it is not clear that all items on the CFSS-DS would be equally relevant when assessing children's dental fears (e.g., "having to go to the hospital" or "having a stranger touch you"). In fact, factor analytic studies of the CFSS-DS and a parent version of the CFSS-DS suggest the 15-item measure taps into three or four different underlying constructs. While some of these factors are clearly dental fears, others seem to be made up of more general fears and non-dental medical fears (Alvesalo et al., 1993; ten Berge, Hoogstraten, Veerkamp, & Prins, 1998; ten Berge, Veerkamp, Hoogstraten, & Prins, 2002c). This seems to be particularly problematic given research suggesting that dental phobia may be distinct from other medical phobias (Armfield, 2008; Kılıç et al., 2014).

Some of these issues are addressed in another widely used self-report of dental anxiety: the Modified Child Dental Anxiety Scale (MCDAS; Wong, Humphris, & Lee, 1998). The MCDAS is an eight-item scale; seven items query about a child's anxiety in specific situations related to visiting the dentist (e.g., "having your teeth looked at," "having a tooth taken out," "being put to sleep to have treatment"), while one item asks about overall feelings about going to the dentist ("going to the dentist generally"). Reflecting this specific focus, items appear to be measuring one unified construct (Wong et al., 1998). However, like the CFSS-DS, the MCDAS also uses a 5-point format for responses which may not be appropriate for young children. A more recent version of the MCDAS uses a facial image scale that may ease administration in this population and children with cognitive disabilities (Howard & Freeman, 2007); it should be noted, though, that the scale still requires children to make discriminations among five choices. The faces version of the MCDAS has been tested in a series of studies of youth between 5 and 10 years of age (Howard & Freeman, 2007). Good test-retest reliability was demonstrated in children as young as 8 years; younger children were not included in the sample that was re-administered the measure, so reliability in younger children is unknown. Scores of the Faces MCDAS were found to be higher in (1) children referred for dental anxiety than those referred for other dental problems, (2) youth with greater decay, and (3) youth who had a history of use of general anesthesia during dental procedures, supporting the construct validity of the measure (Howard & Freeman, 2007).

Again, however, a simpler scale may be more appropriate for use with younger children or those with cognitive limitations. The Venham Picture Test (VPT; Venham & Gaulin-Kremer, 1979) may be appropriate for such samples. This measure consists of eight items with each item consisting of two pictures – one in which a young boy displays a positive or neutral emotion and one in which he displays a negative emotion or behavior (in one he runs away!). The measure can be administered in 2 min or less, even with children as young as three years (Venham & Gaulin-Kremer, 1979). Good internal consistency ($\alpha = 0.84$) of the VPT has been demonstrated in children between three and eight years of age (Venham & Gaulin-Kremer, 1979) and some evidence for concurrent validity has been found (Klorman, Ratner, Arata, King, & Sveen, 1978). Interestingly, Buchanan and Niven (2002) have found a one item facial image scale – a row of five pictures of a face ranging from very happy (a face with a big smile) to very sad (big frown) – to correlate 0.70 with the VPT, suggesting that a very quick, simple, and easy to administer measure may be able to capture much of the information supplied in the VPT. Of course, while these instruments may be ideal for use with young children or routine use by dentists before a dental examination and even for ongoing monitoring of the effect of treatment of dental anxiety or dental phobia, their simplicity may limit their utility for treatment planning because these measures give a sense of how positive or negative a child feels when attending a dental appointment, but, unlike the CFSS-DS and MCDAS, they do not provide any information on the types of situations the child fears.

The Smiley Faces Program (SFP) and the revised Smiley Faces Program (SFP-R) are more recently developed alternatives that are brief – the original measure is only 4 items, while the revision is 5 – but still query about *some* specific dental stimuli (Buchanan, 2005, 2010). The SFP queries about anticipatory anxiety (how the child would feel if she had a dental appointment the next day and how the child would feel in the waiting room of the dental office) as well as fear of having a tooth drilled and an injection in the gum tissue. The SFP-R also queries about fear of having a tooth extracted, based on pilot data suggesting that even children as young as four years can understand this item (Buchanan, 2010). The measures are computerized and children respond to each item by either clicking on a happy face that they can make happier or a sad face that they can make sadder. A total of 7 different facial expressions are available to the child, including a neutral choice. Both scales have demonstrated good internal consistency and test-retest reliability (Buchanan, 2005, 2010). Concurrent validity with the MCDAS and CFSS-DS has also been established (Buchanan, 2005, 2010). Of note, the psychometric study of the original SFP included children as young as six years.

As indicated above, increasing research in both children and adults suggests a link between poor oral health and a plethora of negative social and health consequences that affects a child's quality of life. Given the barrier that dental anxiety and dental phobia present to obtaining adequate oral health care (as depicted in Fig. 1), it seems likely that many youth with dental anxiety do experience compromised quality of life as a result of avoidance behaviors. Thus, assessment of quality of life related to oral health is an important part of obtaining a complete picture when evaluating youth with dental anxiety. The Child Perceptions Questionnaire (CPQ11-14; Foster Page et al., 2005; Jokovic et al., 2002) is a 35-item self-report survey designed to assess the domains of quality of life that may be impacted by poor dental health in children between 11 and 14 years of age. The $CPQ_{11–14}$ consists of four subscales: oral symptoms (e.g., pain), functional limitations (e.g., difficulty eating), emotional well-being (e.g. avoiding smiling because of dental appearance), and social well-being (e.g., being asked about teeth). The scale developers provide evidence of both reliability and validity (Foster Page et al., 2005; Jokovic et al., 2002). The length of the $CPQ_{11–14}$ may be prohibitive in many settings, especially when quality of life is being measured in conjunction with dental anxiety. More recently, however, several brief versions of the measure have been developed, including an 8-item version that appears promising (Foster Page, Thomson, Jokovic, & Locker, 2008).

## 7. Treatment

The first systematic attempts we could find to treat dental anxiety in children date back to the 1970s. Given this, we conducted a search of MEDLINE, PsychINFO, CINAHL, Science Direct, and PsycARTICLES using the search terms 'dental anxiety treatment,' 'dental phobia treatment,' 'dental phobia therapy,' 'dental anxiety, therapy,' 'children and dental anxiety,' 'treating childhood dental fear,' and 'dental fear, management' from January 1970 through December 2016. All databases, with the exception of Science Direct, were searched simultaneously to minimize duplicates; we were unable to include Science Direct in this type of search as the system used did not allow for simultaneous searching with Science Direct. We applied the methodology limiters 'clinical trial,' 'treatment outcome,' 'randomized controlled trials,' 'clinical trial phase I,' 'clinical trial phase II,' 'clinical trial phase III,' 'clinical trial phase IV,' 'controlled clinical trial,' 'randomized controlled trial,' and 'empirical study' and narrowed results down to published studies written in English that implemented a psychosocial treatment designed to reduce anxiety, fear, distress, or disruptiveness during dental treatments in youth up to 17 years of age (one study also included a small number of 18 and 19 year old participants). The reference sections of articles meeting these criteria were also searched. Initial screening of articles was done by the first author (LDS) - at this point articles were excluded if they were clearly not germane to the

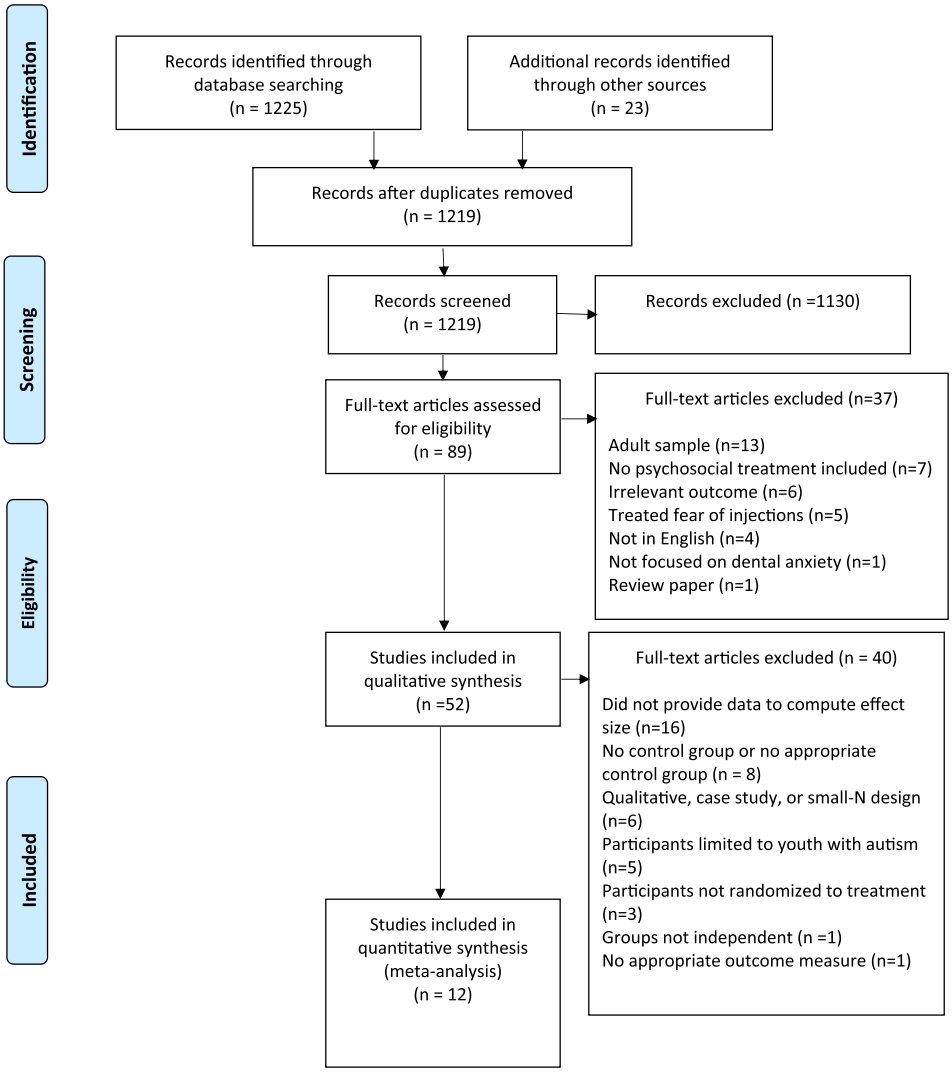


**Fig. 2.** Study search and selection process.

topic of dental anxiety and/or did not study a child or adolescent population. A full-text review conducted by the first author was then reviewed by the second author (JDH). Disagreements were resolved through discussion until a consensus was reached. The results of this search and subsequent screening are depicted in Fig. 2. Of note, we excluded studies that examined dental anxiety related to injections only because, as we discussed previously, it is unclear that this type of anxiety should be grouped with more general dental anxiety. Studies that addressed dental anxiety generally – in the treatment and assessment – but included fear of injections as part of the treatment or assessment of the treatment were included. Combined, these processes resulted in a total of 52 relevant articles. We summarize key characteristics of these studies in Table 1. Although we included only papers published in English and the majority of the investigations took place in the United States ($n$ = 24), findings from several areas of the world were represented in this literature, including England ($n$ = 5), Iran ($n$ = 4), Israel ($n$ = 3), the Netherlands ($n$ = 3), Australia ($n$ = 2), Nigeria ($n$ = 2), Scotland ($n$ = 2), Sweden ($n$ = 2), Canada ($n$ = 1), Brazil ($n$ = 1), India ($n$ = 1), Lebanon ($n$ = 1), and Spain ($n$ = 1). Interestingly, as can be seen in Table 1, many of these studies are probably best conceptualized as preventive interventions, as the children receiving treatment were not selected to be high in dental anxiety; in fact, a key feature in several of these studies is that children were (dental) treatment naïve. Of the investigations that did select participants based on some indicator of dental anxiety, none selected children formally diagnosed with a specific phobia – although it is likely that in at least some instances, some participants would have met diagnostic criteria. Commonly, children were included in these studies because of past disruptive behavior during dental treatment or because of parent or dentist ratings of dental anxiety or disruptiveness. With some exceptions, the treatment used both in prevention and treatment studies was based on learning theory and, more specifically, some variation on a modeling approach was often used.

An early example of such an approach was a case study of a 3.5 year old girl who had never been to the dentist before, but her shy temperament resulted in anticipation that her first examination would prove difficult (Adelson & Goldfried, 1970). The intervention involved having the girl observe the dental treatment of a similar aged non-fearful child who the dentist was treating immediately prior to her scheduled appointment. After the observation, the target child was able to complete her dental treatment with no uncooperative behaviors observed. A similar approach was also used in early group intervention studies. For example, White, Akers, Green, and Yates (1974) reported an investigation of a modeling treatment in a sample of girls between the ages of four and eight years who evidenced disruptive behavior during past dental treatment to the degree that all required general anesthesia for dental procedures. The girls assigned to the treatment observed a confederate for six sessions of 5 min each. Their behavior during a dental exam was compared to that of two control groups – a group that saw a dentist and dental assistant identify and manipulate

**Table 1**
Study characteristics.

| Authors | Country | Age | N | Selected due to anxiety | Previous dental treatment experience | Psychosocial treatment(s) investigated and length of treatment | Outcome measures coded |
|---|---|---|---|---|---|---|---|
| Adelson and Goldfried (1970) | United States | 3.5 years | 1 | Yes | No | Modeling | – |
| Aitken et al. (2002)* | United States | 48–83 months | 45 | No | Yes | Distraction with upbeat music<br>Distraction with relaxing music<br>No music | Venham Picture Scale<br>North Carolina Behavior Rating Scale |
| Al-Namankany, Petrie, and Ashley (2014)* | England | 6–12 years | 80 | Yes | Not Specified | Video model<br>Control video | Visual analogue scale of anxiety |
| Aminabadi et al. (2011)* | Iran | 6–7 years | 80 | No | No | Picture story about going to dentist<br>Control story | Modified Child Dental Anxiety Scale<br>Sound, Eye, and Motor Scale |
| Arnrup, Broberg, Berggren, and Bodin (2003) | Sweden | 4–12 years | 94 | Selected due to behavior management problems at dentist | Yes | Individuated treatment including motivational interviewing, behavior management techniques, and nitrous oxide | – |
| Bird (1997) | England | 9 years | 1 | Yes | Yes | Hypnosis | – |
| Campbell, Hosey, and McHugh (2005) | Scotland | 3–10 years | 198 | No | No[a] | Computerized preparation<br>Cartoon preparation<br>Control - Standard verbal preparation | – |
| Cermak, Stein Duker, Williams, Dawson, et al. (2015) | United States | 6–12 years | 44 | No | Yes | Regular dental environment<br>Sensory adapted dental environment | – |
| Cermak, Stein Duker, Williams, Lane, et al. (2015) | United States | 6–12 years | 44 | No | Yes | Regular dental environment<br>Sensory adapted dental environment | – |
| Chertock and Bornstein (1979) | United States | 5–13 years | 25 | No | Yes | Covert modeling<br>Attention control<br><br>Number of models (1 or 2) was manipulated as was type of model (mastery v. coping) | – |
| Farhat-McHayleh, Harfouche, and Souaid (2009) | Lebanon | 5 to 9 years | 155 | No | Not reported | Live modeling by mother<br>Live modeling by father<br>Tell-show-do (1session) | – |
| Fazli et al. (2014) | Iran | 2 to 10 years | 255 | No | Not reported | Distraction – reading by mother | – |
| Folayan, Ufomata, et al. (2003) | Nigeria | 8–13 years | 81 | No | Not reported | The number and types of interventions dentists used with the children during their first visit were recorded. | – |
| Folayan and Idehen (2004) | Nigeria | 8–13 years | 84 | No | No | Source and type of information about dental treatment was recorded and coded. | – |
| Fox and Newton (2006)* | England | 5–17 years | 38 | No | Mixed | Positive dental imagery<br>Neutral images | Venham Picture Test |
| Green, Meilman, Routh, and Thomas McIver (1977) | United States | 2 to 6 years | 145 | No | Mixed | Two different preparatory films<br>Control film<br>No treatment | – |
| Greenbaum et al. (1990) | United States | 3.5–7 years | 40 | Yes | Yes | Loud voice contingent on noncompliance<br>Normal voice contingent on noncompliance<br>Control - Children with no noncompliant behavior | – |
| Guinot Jimeno et al. (2014) | Spain | 6–8 years | 43 | No | Yes | Distraction - cartoon<br>No treatment control | – |
| Heitkemper, Layne, and Sullivan (1993)* | United States | 8–11 years | 45 | No | Not reported | Paced respiration<br>Cognitive coping<br>Attention control | Unstandardized dentist ratings of disruptiveness |
| Herbertt and Innes (1979) | Australia | 5–11 years | 422 | No | Yes | Familiarization<br>Preparation<br>Attention control | – |
| Hermecz and Malamed (1984) | United States | 6–12 years | 20 | No | Not reported | Stimulus imagery<br>Response imagery | – |
| Howard and Freeman (2009)* | Scotland | 5–10 years | 73 | No[b] | Not reported | After dental treatment children performed dental | Modified Child Dental Anxiety |

*(continued on next page)*

**Table 1** *(continued)*

| Authors | Country | Age | N | Selected due to anxiety | Previous dental treatment experience | Psychosocial treatment(s) investigated and length of treatment | Outcome measures coded |
|---|---|---|---|---|---|---|---|
| | | | | | | procedures on a puppet then got reinforcement<br>Reinforcement only | Scale |
| Isong et al. (2014) | United States | 7 to 17 years | 80 | Yes | Not reported | Peer modeling<br>Distraction with movie<br>Peer modeling + distraction<br>Usual care | – |
| Johnson and Machen (1973) | United States | 36–65 months | 58 | No | No | Desensitization<br>Modeling<br>No treatment control | – |
| Kebriaee et al. (2015)* | Iran | 3–6 ½ years | 45 | Yes | Yes | Cognitive behavioral therapy<br>Conscious sedation<br>Treatment as usual control | Venham Picture Test |
| Klesges et al. (1984) | United States | 4 year old | 1 | Yes | Yes | Modeling (by mother) and graded exposure with some relaxation training, reinforcement and positive expectancy statements | – |
| Klingman et al. (1984) | United States | 8–13 years | 38 | Yes | Mixed | Participant modeling<br>Symbolic modeling | – |
| Klorman et al. (1980) *<br>Experiment 1 | United States | No age range given. Average age across groups was between 7 and 8 years | 60 | Yes | Yes | Mastery model<br>Coping model<br>Attention control | Unstandardized dentist ratings of child's nervousness during dental session<br>Behavior Profile Rating Scale |
| Klorman et al. (1980)*<br>Experiment 2 | United States | No age range reported | 46 | No | Yes | Mastery model<br>Coping model<br>Attention control | Frankl Scale<br>Behavior Profile Rating Scale |
| Klorman et al. (1980)*<br>Experiment 3 | United States | No age range reported | 30 | No | No[c] | Mastery model<br>Coping model<br>Attention control | Frankl Scale<br>Behavior Profile Rating Scale |
| Machen and Johnson (1974) | United States | 36 and 65 months | 31 | No | No | Desensitization<br>Modeling<br>No treatment control | – |
| Marwah, Prabhakar, and Raju (2005) | India | 4 to 8 years | 40 | No | No | Instrumental music distraction<br>Nursery rhyme music distraction<br>Control | – |
| McMurray, Bell, Fusillo, Morgan, and Wright (1986) | Australia | 9–12 years | 80 | Yes | Yes | Rehearsal of coping skills<br>Attention control | – |
| Melamed et al. (1975) | United States | 5–11 years | 16 | No | No | Coping model<br>Attentional control | – |
| Melamed et al. (1975) | United States | 5 to 9 years | 14 | No | Mixed | Coping model<br>Attentional control | – |
| Melamed et al. (1978) | United States | 4–11 years | 80 | No | Mixed | Modeling<br>Demonstration of procedures without model<br>Attention control<br><br>Length of film used in modeling and demonstration conditions was also manipulated. | – |
| Olumide, Newton, Dunne, and Gilbert (2009)* | England | 8–12 years | 50 | No | Mixed | Preparation<br>Control information | Facial Image Scale |
| Paryab and Arab (2014) | Iran | 4 to 6 years | 46 | No | No | Filmed modeling<br>Tell-show-do | – |
| Peterson, Schultheis, Ridley-Johnson, Miller, and Tracy (1984) | United States | 2 to 11 years | 44 | No | No[d] | Puppet presentation of information<br>Two version of film with child presenting information<br>Information preparation by hospital staff | – |
| Pickrell et al. (2007)* | United States | 6 to 9 years | 45 | No | Mixed | Memory restructuring + Usual care | Children's Fear Survey Schedule – |

*(continued on next page)*

**Table 1** *(continued)*

| Authors | Country | Age | N | Selected due to anxiety | Previous dental treatment experience | Psychosocial treatment(s) investigated and length of treatment | Outcome measures coded |
|---|---|---|---|---|---|---|---|
| | | | | | | Usual care + attention control | Dental Subscale |
| Ramos-Jorge, Ramos-Jorge, Vieira de Andrade, and Marques (2011)* | Brazil | 4 to 11 years | 70 | No | Mixed | Positive imagery<br>Neutral imagery | Venham Picture Test |
| Schwartz and Albino (1983) | United States | 3–4 years | 45 | No | No[e] | Play session unrelated to hospital or surgical procedures<br>Play session related to hospital or surgical procedures<br>No treatment control | – |
| Shahnavaz, Rutley, Larsson, and Dahllöf (2015) | Sweden | 9–19 years | 12 | Yes | Yes | Cognitive behavioral therapy package | – |
| Shapiro, Melmed, Sgan-Cohen, Eli, and Parush (2007) | Israel | 6–11 years | 19 | No | Mixed | Sensory adapted environment<br>Regular dental environment | – |
| Shapiro, Melmed, Sgan-Cohen, and Parush (2009) | Israel | 6–11 years | 16 | No | Mixed | Sensory adapted environment<br>Regular dental environment | – |
| Shapiro, Sgan-Cohen, Parush, and Melmed (2009) | Israel | 6–11 years | 35 | Not reported | Not reported | Sensory adapted environment<br>Regular dental environment | – |
| Siegel and Peterson (1980)* | United States | 42–71 months | 42 | No | No | Coping skills<br>Sensory information<br>Attention control | Behavior Profile Rating Scale |
| Srai, Petrie, Ryan, and Cunningham (2013) | England | 10–16 years | 90 | Not reported | No[f] | DVD demonstration of procedure + verbal information<br>Verbal information only | – |
| Stokes and Kennedy (1980) | Canada | 7 year olds | 8 | Yes | Yes | Baseline – instructions were given to child, information was given about procedures, praise was given for cooperative behavior and whenever possible uncooperative behavior was ignored, noncontingent reinforcement was given.<br><br>Treatment – All baseline activities plus contingent reinforcement, observation of child in prior appointment (including observing whether or not the child received reinforcement), child was then observed by a peer that was coming next | – |
| ter Horst, Prins, Veerkamp, and Verhey (1987) | Netherlands | 5-12 years | 24 | Half were anxious, half were not | Not specified | Treatment by dentist with experience treating fearful children<br>Treatment by dentist without experience treating fearful children | – |
| Veerkamp, Gruythuysen, Hoogstraten, and van Amerongen (1995) | Netherlands | 6–11 years | 55 | Yes | Yes | Behavioral management<br>Behavioral management + nitrous oxide sedation | – |
| Veerkamp, Gruythuysen, van Amerongen, and Hoogstraten (1993) | Netherlands | 6–11 years | 55 | Yes | Yes | Behavioral management<br>Behavioral management + nitrous oxide sedation | – |
| White et al. (1974) | United States | 4–8 years | 15 | Yes | Yes | Modeling<br>Familiarization with treatment equipment<br>No treatment control | – |
| Williams, Hurst, and Stokes (1983) | United States | 4–9 years | 5 | Yes | Yes | Baseline – Treatment as usual<br>Treatment – Observation of a peer followed by observation by a peer. | – |

Studies included in the meta-analysis are marked with a *.

[a] Treatment was addressing anxiety in children undergoing dental general anesthetic; participants were required to have no previous experience with any type of general anesthesia.

[b] Sample consisted of consecutive admissions. Children were not selected because of anxiety but some in the sample were referred due to anxiety.

[c] Participants required a filling but had no previous experience with dental restoration or extractions.

[d] Children were undergoing oral surgery, none had previous experience with surgery.

[e] Children were being treated for a dental restoration or extraction under general anesthesia; they had no previous surgical experience.

[f] Participants were receiving orthodontic treatment; none had history of prior orthodontic treatment.

the same equipment that was used in the modeling condition (attention control) and a second group that received no treatment. Results were partially supportive in that the modeling group evidenced more cooperative behavior than the no treatment group; however, their behavior did not significantly differ from that of the girls in the attention control group. In fact, few significant differences were observed between the modeling group and the attention control group with one notable exception - the girls receiving the modeling treatment were less likely to request that a significant other be present during treatment when compared to *both* control groups. It should be noted, however, that the sample studied here was very small ($n$ = 15), particularly given that there were three treatment groups; this likely resulted in very low power to detect effects – even those of the magnitude that would be considered clinically meaningful.

Other studies have looked more specifically at manipulating the parameters of modeling treatments to determine the optimal method for treatment delivery, but these efforts have been largely unsuccessful. For example, Melamed, Yurcheson, Fleece, Hutcherson, and Hawes (1978) examined whether length of time a child observed the model (10 min vs. 4 min) affected treatment outcome. Although both modeling treatments were more effective than the control treatments included in the study – a long and short demonstration presenting information on dental procedures – no significant differences were found in the two modeling treatments. Similarly, the use of coping and mastery models and the number of models used have been compared, but again, no differences between the treatments have been found (Chertock & Bornstein, 1979; Klorman, Hilpert, Michael, LaGana, & Sveen, 1980, experiment 3); however, it should be noted that in the Chertock and Bornstein (1979) investigation, the active treatments did not outperform the control treatment which might suggest the modeling treatments were not implemented properly.

Another early investigation by Klingman, Malamed, Cuthberg, and Hermecz (1984), however, does suggest that actively encouraging children to use the skills they see demonstrated by models may enhance the effects of modeling treatments. In this study, 38 youth between the ages of eight and 13 years with scores in the moderate range of a dental anxiety self-report measure were randomized to receive either a participant modeling treatment or a symbolic modeling treatment before undergoing a simple dental restoration. In both treatments, the children observed a filmed model using imagery techniques and controlled respiration during a dental exam. Children in the participant modeling group were encouraged to practice the techniques demonstrated and to choose mental imagery that would be personally relevant; children in the symbolic modeling condition observed the same model using the same techniques and were told the film would present some ideas to help them overcome their anxiety of the dentist but they were not actively encouraged to practice or use the techniques. Across measures, the children in the participant modeling treatment showed a greater reduction in anxiety and less disruptive behavior during the exam. Of course, it is not clear from this investigation whether the vicarious conditioning component was necessary or effective – the study did not include a comparison with simple instruction in the coping techniques (i.e., paced respiration and imagery). This last point is important given that other studies have shown instruction in coping techniques to be effective (Siegel & Peterson, 1980). In fact, although distraction treatments tend not to yield impressive outcomes (Aitken, Wilson, Coury, & Moursi, 2002; Fazli, Kavandi, & Malekafzali, 2014) and there are some other notable exceptions (see for example, Howard & Freeman, 2009), overall, studies have found that any treatment – even those performed regularly by dentists without specific training in the treatment of anxiety (Folayan, Ufomata, Adekoya-Sofowora, Otuyemi, & Idehen, 2003; Greenbaum, Turner, Cook, & Melamed, 1990) tend to be effective.

One possible reason for this finding, and one glaring shortcoming in the literature, however, is that very few studies have treated severely phobic youth or even youth with any significant level of dental anxiety. The one group study that included participants most likely to be classified as phobic and in need of treatment – girls who had evidenced disruptive behavior that had interfered with dental treatment on at least two occasions, all of whom required general anesthesia for dental procedures on at least one occasion, found that the modeling treatment tested was better than no treatment, but not significantly more effective than an attention control condition which involved simple exposure to the (dental) treatment environment (White et al., 1974).

This finding brings up a second significant shortcoming in our extant knowledge of treatments for youth with dental anxiety; exposure treatments, currently thought to be a first-line treatment for children with anxiety disorders, including phobias (Davis, Ollendick, & Öst, 2009), are largely missing from the literature on dental anxiety in youth. An interesting exception is a case study of a four year old girl who was refusing dental treatment due to anxiety (Klesges, Malott, & Ugland, 1984). The child's mother also had a history of dental anxiety. A multicomponent treatment package that included graded exposure but also relaxation training, modeling (by the mother), reinforcement strategies, and some cognitive interventions was effective in reducing the child's anxiety and gaining treatment compliance. Interestingly, however, despite the widespread use of exposure treatments for youth with anxiety disorders more generally and specific phobias in particular, and the positive outcome for this case published over 30 years ago, we found no other examples focused on testing exposure treatment for pediatric dental anxiety.

In sum, it seems that there is some evidence that treatment for dental anxiety can be effective, but that this evidence comes largely from investigations of modeling treatments and from samples that were not diagnosed with a dental phobia. When youth with significant dental anxiety were included in studies, results were more equivocal. In hopes of providing some additional clarity, however, we undertook a brief meta-analysis of these findings. More specifically, the goals of the meta-analysis were to examine (1) whether there is evidence of efficacy of psychosocial treatments for dental anxiety, (2) if there is evidence of efficacy, does this hold true for youth with dental anxiety or only for prevention of dental anxiety in non-anxious youth, and (3) is there evidence of differential effects for different treatments. Additionally, given the limitations in the literature on assessment of dental anxiety we discussed previously, the varied focus of self-reports measures and observer rating (disruptiveness vs. anxiety), and the fact that several treatment studies used non-standardized observer ratings of anxiety, we wanted to explore whether treatment response varied with the type of outcome measure used.

### *7.1. A quantitative analysis of treatment for dental anxiety in children and adolescents*

In addition to the criteria mentioned above, we applied the following inclusion criteria. Studies needed (1) to compare an active treatment to a wait list or attention control condition – given that our goal was to examine the effects of treatment, studies comparing two active treatments were excluded, (2) treatments needed to be clearly defined with children assigned to a specific treatment condition, (3) a quantitative self-report, observer measure, or dentist rating of dental anxiety, distress, and/or disruptiveness needed to be included, and (4) either means, standard deviations, and samples sizes or an independent samples $t$-test needed to be reported for posttreatment comparisons. Case studies and small-n designs were not included nor were studies that reported outcomes only on measures of general anxiety but not dental anxiety. Additionally, we decided to include only studies that looked at dental anxiety in a general pediatric sample, as it may be that dental anxiety in certain populations (e.g., those with developmental disorders) may require specialized treatment. Outcomes were coded at posttreatment only. A summary of the literature search and review is presented in Fig. 2. In total we were able to code 12 articles with one

article reporting on three separate studies; thus our search ultimately yielded 14 studies (see Table 1). These studies yielded a total of 37 effect sizes because some studies reported on multiple outcomes or multiple treatment/control comparisons. This resulted in enough data to conduct analyses; however, given the small number of studies included in this analysis and that three investigations were conducted by the same research team, conclusions must be considered tentative.

We used Comprehensive Meta-Analysis version 3.3 to perform all analyses. Due to the heterogeneity in methods and, to some degree, treatments used across studies, a random effects model was used. To calculate the overall mean effect size for treatment, the mean effect size for each study, across treatments and outcome measures, was calculated so that each study contributed one effect to the overall mean. This resulted in an overall mean effect comparing treatment for dental anxiety to control treatment of Hedges g = 0.98, z = 2.91, $p$ = 0.004, 95% CI [0.32, 1.64], suggesting that, in general, treatment for dental anxiety was effective; however, across individual studies both positive and negative effects were found. Of note, there is some evidence that this effect size may be somewhat biased. For example, both Kendall's tau b and Egger's test both yielded a significant $p$-value, suggesting the presence of bias. However, the fail-safe N was 170. Given that we were able to find only 14 studies it is unlikely that 170 studies with effect of 0 were missed due to search errors or publication bias; thus, although the true effect of treatment may be smaller than we estimate here, it is unlikely to be zero.

However, no studies selected youth based on a diagnosis of dental phobia and only three studies included youth selected to be anxious – the overall effect size in these studies (g = 0.34) was not significant ($p$ = 0.105). Thus, although our analysis was based on only a very small number of studies, these findings are consistent with our impressions from the broader body of literature; it may be that the treatments that are effective for youth without significant dental anxiety do not necessarily transfer to those with dental phobia.

#### 7.1.2. Outcome measure

To investigate further, effect sizes (across all studies) were calculated separately for each category of outcome measure. A mean effect size for each study for each category of outcome measure was calculated first so that each study contributed one effect size to each analysis. Nine studies provided self-reported dental anxiety on some type of dental anxiety instrument. The overall effect size of treatment on self-reported anxiety was g = 1.46, z = 2.86, $p$ = 0.004, 95% CI [0.46, 2.46], suggesting that treatment did have a significant effect on self-reported dental anxiety. Again, however, analysis suggests this estimate may be biased, with both Kendall's tau b and Egger's test significant. However, a fail-safe N of 110 again suggests that while the actual effect may be somewhat different than the estimate obtained here, it is not likely 0.

A different picture emerged when examining dentist ratings of anxiety distress and/or disruptiveness as an indicator of treatment outcome. Analysis of the five studies that included dentist ratings of behavior suggested no effect for treatment, g = 0.35, z = 0.76, $p$ = 0.445, 95% CI [−0.54, 1.23]. Interestingly, however, when an observer other than the treating dentist was used to assess outcome a significant effect was found. Five studies included ratings by an observer; the overall effect for these studies was g = 2.26, z = 2.05, $p$ = 0.040, 95% CI [0.10, 4.35]. Although this result represents a group of studies with a wide range of effects and statistical indicators of publication bias again indicate that our estimate may be biased, the fail-safe N of 61, given that we were able to find only five studies in an exhaustive search, suggests that the full population of studies would not result in an effect of 0. Thus, taken together these results suggest that the effects of treatment on children's behavior during dental procedures may not have been clinically significant enough to impact the perceptions of the treating practitioner despite the differences picked up by the micro-level instruments used by objective raters. As such, the results underscore the importance of a multimethod assessment of dental anxiety as we suggest above.

#### 7.1.3. Type of treatment

Only modeling treatments and distraction methods were investigated in enough studies to justify the computation of a combined effect. A coping model treatment was investigated in three studies, but it should be noted that all three investigations were conducted by the same research team (Klorman et al., 1980). The mean effect size across type of outcome (i.e., self-report, dentist rating, observer rating) within study was used to calculate the overall combined treatment effect. The result was not significant, g = 0.18, z = 0.84, $p$ = 0.401 95% CI [−0.23, 0.58]. Four studies examined a modeling treatment using a mastery model, although again, three of these studies were conducted by Klorman and colleagues (Klorman et al., 1980). In this case, the overall effect was significant, g = 3.70, z = 2.46, $p$ = 0.014, 95% CI [0.75, 6.65]. At first glance, these results seem to suggest the superiority of modeling treatments that use a mastery model; however, the combined effect size of mastery modeling treatments is largely driven by one study (Aminabadi, Vafaei, Erfanparast, Oskouei, & Jamali, 2011) that produced much larger effects than any other of the studies coded. In fact, if this study is excluded and the effect for mastery modeling treatments is based on the three studies conducted by Klorman et al. (1980), the overall effect is not significant. Examining the differences between these studies, it is notable that two of the three Klorman et al. investigations included children who had previous experience with dental treatment and one included children who had been selected based at least a moderate level of dental anxiety, whereas Aminabadi et al. (2011) did not select participants based on dental anxiety and children were naïve to dental treatment. Thus again, this finding seems to point less to a difference between mastery model and coping model approaches than it highlights questions about whether findings from studies of non-anxious youth can be generalized to the population of youth likely to seek treatment for dental anxiety - those with dental phobia. The only other type of intervention to be investigated in at least three studies was distraction techniques. The overall effect size across the three studies using various types of distraction methods was, g = 0.63, z = 1.12, $p$ = 0.263 95% CI [−0.47, 1.74]. Thus, to date, the data do not support the use of these types of interventions.

## 8. Conclusions and future directions

Although we have learned a good deal about the development, maintenance, and assessment of dental anxiety and dental phobia, our review suggests several gaps in our knowledge. First, although dental anxiety in youth seems to be linked with oral health and emerging research is beginning to suggest a link between pediatric oral health and a host of significant diseases and disease processes, whether or not dental anxiety serves as a risk factor for later health complications such as cardiovascular disease and obesity has not been directly investigated. Given the great personal and public health costs inflicted by these diseases, research into early predictors that can be modified is sorely needed. We do have some evidence that dental anxiety in youth is related to compromised social and emotional well-being, but this work is in its infancy; much more research is needed to understand both the physical and psychological consequences of dental anxiety. Second, and relatedly, although there is a clinical sense that dental anxiety and even dental phobia in youth is fairly common, we really know very little about their prevalence in youth. Moreover, we do not know whether prevalence has changed with advances in dental practice or public oral health efforts that offer better preventative measures and less painful treatment procedures. In particular, it will be important to investigate the rates and phenomenology of dental anxiety in particular subsets of youth – such as those with developmental disorders – as these youth may require specifically tailored interventions (Cermak, Stein Duker, Williams, Dawson, et al., 2015). Third, although there are several tools

with adequate psychometric properties to assess the symptoms associated with dental anxiety, some of which are brief enough to be feasible for use in routine dental practice, little research has been done to determine the core processes that drive this anxiety. We suggest that one problem hampering research in this area is that the current classification of phobia subtypes in the DSM does not map onto current research (Armfield, 2008). Although much more research is needed in this area, grouping phobias by the apparent similarity of the phobic stimulus (e.g., dogs and bees, dental procedures and injections) may result in heterogeneous groups that obscure core vulnerabilities in affected individuals (e.g., disgust sensitivity, fear of loss control). Identification of these vulnerabilities could lead to more targeted theory driven treatment. This last point is particularly important as the treatment literature suggests that the treatments studied thus far may be effective in *preventing* anxiety in youth if they are implemented prior to the first dental appointment, but less effective for youth with clinically significant concerns. Despite the gaps in our knowledge regarding effective treatment of dental phobia, very little recent, rigorous research has been conducted to investigate alternative psychosocial treatments for dental anxiety. This may be because it has become more feasible to use chemical restraint procedures in youth; however, these interventions are not without complication and in the long run, they circumvent opportunities for non-fearful learning and may even reinforce the types of cognitions related to the dental treatment experience (loss of control) that exacerbate dental anxiety. Another possible reason for the lack of recent developments in treatment is that investigations into the application of promising treatments such as in vivo exposure would require a multidisciplinary approach – involving both experts in psychological approaches to anxiety disorders in youth and pediatric dentistry. Although such endeavors can be challenging, we suggest that these are exactly the types of efforts needed to move forward in our ability to treat youth with dental anxiety and phobias and to prevent the long-term avoidance and concomitant oral health and quality of life problems observed in adults with dental anxiety.

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