Distraction versus training attention away from threat: How to best wait for the dentist?

Journal:	*Australian Journal of Psychology*
Manuscript ID	Draft
Wiley - Manuscript type:	Special Issue
Keywords:	Attention bias modification training, Dental anxiety, Non clinical sample, RCT, Threat-related attention bias
Abstract:	Objective: Attention Bias Modification Training (ABMT) is a promising novel treatment for anxiety disorders. However, no randomized controlled trial has examined ABMT effects on anxiety in a real-world fear-provoking context. The current study examined the immediate effects of ABMT in reducing state-anxiety among healthy participants awaiting dental treatment. Method: Seventy-one healthy participants seeking treatment in a dental clinic were randomly assigned to either: (a) Dental ABMT; (b) Attention Control Training (ACT); or (c) Neutral Distraction. The study used a modified dot-probe task consisting of dental and neutral words. In the ABMT condition, participants were trained to shift attention away from the dental words, whereas in the ACT condition, the same stimuli were presented, but attention was not trained in any specific direction. The Neutral Distraction task consisted of a casual video game. State-anxiety was measured before and after completing the tasks while in the dentist's waiting-room and immediately following the dental treatment. Results: Results indicated a significant interaction between time and condition on anxiety levels. The Neutral Distraction group showed a significant reduction in anxiety levels from pre- to post-task (before dental treatment), but neither the ABMT nor the ACT group showed this trend. Following dental treatment, only the ACT group demonstrated a decrease in anxiety levels, while no change was reported by either the ABMT or the Neutral Distraction group. Conclusion: Findings from this exploratory study suggest distraction tasks have a better immediate effect than ABMT in alleviating state-anxiety in non-anxious individuals who are expecting a relatively unpleasant experience.

Running head: DENTAL ABMT

Distraction versus training attention away from threat: How to best wait for the dentist?

Abstract

Objective: Attention Bias Modification Training (ABMT) is a promising novel treatment for anxiety disorders. However, no randomized controlled trial has examined ABMT effects on anxiety in a real-world fear-provoking context. The current study examined the immediate effects of ABMT in reducing state-anxiety among healthy participants awaiting dental treatment.

Method: Seventy-one healthy participants seeking treatment in a dental clinic were randomly assigned to either: (a) Dental ABMT; (b) Attention Control Training (ACT); or (c) Neutral Distraction. The study used a modified dot-probe task consisting of dental and neutral words. In the ABMT condition, participants were trained to shift attention away from the dental words, whereas in the ACT condition, the same stimuli were presented, but attention was not trained in any specific direction. The Neutral Distraction task consisted of a casual video game. State-anxiety was measured before and after completing the tasks while in the dentist's waiting-room and immediately following the dental treatment.

Results: Results indicated a significant interaction between time and condition on anxiety levels. The Neutral Distraction group showed a significant reduction in anxiety levels from pre- to post-task (before dental treatment), but neither the ABMT nor the ACT group showed this trend. Following dental treatment, only the ACT group demonstrated a decrease in anxiety levels, while no change was reported by either the ABMT or the Neutral Distraction group.

Conclusion: Findings from this exploratory study suggest distraction tasks have a better immediate effect than ABMT in alleviating state-anxiety in non-anxious individuals who are expecting a relatively unpleasant experience.

Keywords: attention bias modification treatment (ABMT), dental anxiety, non-clinical population, RCT, threat-related attention biases

Attention Bias Modification Training (ABMT) is a promising novel treatment for anxiety disorders (Bar-Haim, Lamy, Pergamin, Bakermans-Kranenburg, & Van, 2007; Hakamata et al., 2010; Linetzky, Pergamin-Hight, Pine, & Bar-Haim, 2015). A number of studies also suggest its potential efficacy in treating other chronic conditions, such as mood disorders (Beevers, Clasen, Enock, & Schnyer, 2015), eating disorders (Renwick, Campbell, & Schmidt, 2013), addictions (Boffo, Pronk, Wiers, & Mannarini, 2015; Cox, Klinger, & Fadardi, 2015) and chronic pain (Sharpe, 2012; Sharpe et al., 2012). To this point, however, no randomized controlled trial (RCT) has examined the degree to which ABMT reduces anxiety in a real-world fear-provoking context among a non-clinical population. The current RCT study begins to fill this gap by providing the first set of data on the immediate effects of ABMT in reducing anxiety levels among healthy participants awaiting dental treatment.

Dental treatments are perceived as anxiety-provoking by almost 25% of the general population (Oosterink, de Jongh, & Hoogstraten, 2009; Smith & Heaton, 2003). Dental anxiety has been associated with decreased frequency of dental visits (Pohjola, Lahti, Vehkalathi, Tolvanen, & Hausen, 2007), poor oral health and hygiene (Liu et al., 2015) and negative quality-of-life reports (Crofts-Barnes, Brough, Wilson, Beddis, & Girdler, 2010), making this a major health problem. Interventions targeting dental anxiety, including cognitive behavioral therapy (Davies, Wilson, & Clements, 2011) and pharmacological interventions (Coldwell et al., 2007; Willumsen, Vassend, & Hoffart, 2001), are currently available. However, these interventions are typically time-consuming and expensive and have shown limited efficacy, even with highly-anxious individuals (Carter, Carter Boschen, AlShwaimi, & George, 2014). Therefore, its efficacy for milder forms of dental anxiety is unknown. The lack of efficacious treatments for

dental anxiety urges the development of new treatment methods for dental anxiety that are feasible, potent and easy to disseminate among the general population.

Here, ABMT shows promise, notably its ability to target threat-related attention biases associated with heightened anxiety (Bar-Haim, 2010; Hakamata, et al., 2010; Linetzky et al., 2015). ABMT has emerged from information-processing theories that view anxiety disorders as associated with biases at different levels of cognitive processes, for example, attention biases. These particular biases result in an increased tendency to attend to threatening cues in the environment. Extensive research has demonstrated the relevance of threat-related attention biases in the etiology and maintenance of anxiety disorders (Cisler & Koster, 2010; Van Bockstaele et al., 2014; Yiend, 2010). Because higher levels of state-anxiety are associated with attentional biases to threatening stimuli even among non-clinical samples (Mogg, Bradley, de Bono & Painter, 1997), the use of ABMT to reduce anxiety in a non-clinical sample seems reasonable.

ABMT procedures typically employ the dot-probe task to train attention away from threat-related stimuli. The task involves a series of trials in which pairs of threat-related and neutral stimuli (e.g., words) are presented simultaneously on a computer screen for a relatively short time (e.g. 500 ms). These stimuli are followed by a target; participants are asked to identify the target as quickly as possible without compromising accuracy. Unlike the classical dot-probe task in which the target appears in equal proportions behind the neutral stimulus ('incongruent condition') and the threatening stimulus ('congruent condition'), in ABMT, the target always appears behind the neutral stimulus, thus training individuals to shift their attention away from threat (Shechner et al., 2014). Previous studies have demonstrated the efficacy of ABMT as a stand-alone treatment in reducing anxiety (Britton et al., 2013; Eldar et al., 2012; Hakamata et al., 2010). Therefore, we expected similar therapeutic benefits in an anxiety-provoking context.

The present RCT study was designed to explore the efficacy of ABMT as an immediate intervention for reducing state-anxiety among non-clinical participants while waiting for a dental procedure at a clinic. To this end, we modified the typical ABMT task to include pairs of neutral and dental related words, with the aim of training attention away from the dental words, which in this context, constitute anxiety-provoking stimuli. ABMT was compared to two control conditions: an Attention Control Training (ACT) task and a Neutral Distraction task. We hypothesized that ABMT would result in a reduction in state-anxiety immediately before dental treatment, compared to the other conditions. At the same time, we hypothesized state-anxiety would decline in pre- to post-dental treatment under all three conditions. Finally, we expected lower levels of anxiety before the dental treatment would be associated with better overall subjective evaluation of the experience following the dental treatment.

METHOD

Participants

Participants were 73 adults seeking treatment in a private dental clinic. All volunteered and signed a consent form agreeing to participate in the study. The experiment's design and procedures were approved by the University Institution Review Board (IRB). Two participants were excluded because of pathological dental anxiety (MDAS score > 19; see below for details). Seventy-one participants (*mean age* = 47.89 years, *SD* = 17.49 years) were randomly assigned to one of three conditions: (a) Dental ABMT (n = 23); (b) ACT (n = 25); (c) Neutral Distraction (n = 23). Sample demographics and clinical indices are presented in Table 1. A consolidated standard of reporting trials (CONSORT) diagram is depicted in Figure 2.

Materials and Tasks

Modified Dental Anxiety Scale (MDAS)

The Modified Dental Anxiety Scale (MDAS) is a valid and reliable questionnaire assessing the severity of dental anxiety (Humphrish, Morrison & Lindsay, 1995). It consists of 5 questions, each with a 5-category rating scale, ranging from 'not anxious' (1) to 'extremely anxious' (5), and yielding an overall sum ranging from 5 to 25. A cut off score of 19 indicates extremely high levels of dental anxiety.

State-Trait Anxiety Inventory (STAI)

The State-Trait Anxiety Inventory (STAI) is a commonly-used measure of state and trait anxiety (Spielberger, 1989). It consists of 20 items assessing state-anxiety and 20 assessing trait-anxiety. Items on the state-anxiety scale assess intensity of feelings 'at this moment' on a 4-point scale from 'not at all' (1) to 'very much so' (4). It has been found to be valid and reliable (Spielberger, 1983).

Overall Subjective Evaluation Scale

In the study, we used a single question with a 7-point scale to assess the participant's overall experience during treatment. The scale ranges from a 'very positive experience' (1) to a 'very negative experience' (7). Higher scores therefore indicate greater *negative* subjective experience during dental treatment.

Dentist Assessments

A single dentist performed all types of dental procedures according to the patient's dental needs. For each patient, the dentist completed a series of assessments, including: treatment complexity on a scale from 'quite easy' (1) to 'very complex' (5); previous visits to the clinic ('yes/no'); and the need for a follow-up visit to the clinic ('yes/no').

Demographic Information

We asked a series of demographic questions for descriptive and comparative purposes (e.g. age, gender).

ABMT and ACT Tasks

We used a modified dot-probe task consisting of aversive dental and neutral words (partially adapted from: Shechner et al., 2014). Aversive dental words were chosen based on a preliminary survey conducted among healthy volunteers (n = 31). In this survey, words were rated on a 7-point scale (e.g., from 'highly positive' (1) to 'highly negative' (7)). Words with an average rating of 4.5 or higher were subsequently included in the ABMT and ACT tasks (e.g. root-canal, filling). Words in each pair were matched according to number of letters.

A trial began with a fixation cross (20x20mm) in the center of the screen for 500 ms, followed by a pair of words displayed for 500 ms. Each task featured 22 pairs of dental-neutral words and 11 pairs of neutral-neutral words, with the words in each pair presented vertically and equidistant from the central fixation position. Each dental-neutral pair was presented 8 times and each neutral-neutral pair was presented 4 times, with the location of the words (i.e., top/bottom) alternating but counterbalanced. The tasks comprised of 220 trials in total.

Following the word display, a target probe appeared in one of the locations vacated by the words; it remained on the screen until a response was given by the participant. The target-probe consisted of either the letter 'E' or the letter 'F'. Participants were required to determine which letter appeared on the screen and to press the relevant pre-specified button on the computer mouse using their dominant hand. They were told it was important to perform the task as quickly as possible without compromising accuracy. In the ABMT task, the target always

appeared behind the neutral word ('incongruent' trials), thereby training participants to shift their attention away from the dental threatening words. In the ACT task, the same stimuli were presented, but in this case, the target probes appeared with equal probabilities at the locations of the dental and the neutral word (50% 'dental-congruent' and 50% 'dental-incongruent' trials). A schematic visual description of the ABMT task is presented in Figure 1.

Neutral Distraction Task

The Neutral Distraction task consisted of a 'bubble shooter' game, a casual video game with elements of puzzle and shooter. The screen of the game consists of a grid of cells, filled with rows of colored balls. The color scheme of the balls varies depending on the complexity of the game. The player sees the current ball and the next ball to shoot. The trajectory of the ball shot changes by moving the cursor; the task is to clear the playing field by forming groups of three or more like-colored marbles. The goal is to get the highest possible score. As in the dot-probe tasks, we used a 15" lap-top.

Procedure

Upon arrival at the dental clinic, participants completed demographic, MDAS and STAI questionnaires (t_0). They were then randomly assigned to one of three experimental conditions: 1) Attention Bias Modification Training (ABMT); 2) Attention Control Training (ACT); or 3) Neutral Distraction. After completing the assigned task in the waiting room and before the dental treatment, a second STAI assessment was conducted (t_1). At the end of the dental treatment, a third STAI assessment was conducted (t_2). In addition, participants completed the overall

subjective evaluation scale, and the dentist assessed the type of treatment performed, treatment complexity level, level of dental plaque, level of oral hygiene, and level of overall cooperation.

Statistical Analysis

We compared demographics, psychological indices at baseline and treatment characteristics across the three treatment conditions using analyses of variance (ANOVAs) and chi-square tests.

State-anxiety was the main dependent variable used to examine differences in task efficacy in terms of anxiety reduction across the three conditions. We used a Mixed Linear Model (MLM; Singer, 2003) with SAS GLIMMIX procedure (SAS, 9.2) to test for time and condition effects of the task, along with their interaction. Time (t_0,t_1,t_2), condition (ABMT, ACT, Neutral Distraction), and the interaction of the two factors were included as fixed effects. We defined the random intercept separately for each experimental group and used restricted maximum likelihood to estimate model parameters.

In addition, we examined group differences across the three conditions using one-way ANOVA in each time point, followed by a Least Significant Difference (LSD) post-hoc test. Finally, we tested the association between STAI scores at different time points and the overall subjective evaluation of experience post-treatment using the Pearson correlation.

All statistics were computed in SAS 9.2 and SPSS 21 All data are presented as group means and SEMs. Significant effects were detected at $\alpha < .05$, and all tests were two-sided.

RESULTS

As depicted in Table 1, participants in the three conditions were similar in age. However, the proportion of female participants in the ACT condition was higher than in the ABMT or Neutral Distraction conditions, $\chi^2_{(4)} = 12.098$, p=.017. No other differences emerged between the groups in either the psychological measurements at baseline (trait-anxiety, state-anxiety, MDAS) or the dental procedures (treatment complexity, previous visit to the clinic, follow-up visit) (all ps > .12).

MLM analysis of state-anxiety levels revealed a significant interaction between time (t_0, t_1, t_2) and condition (ABMT, ACT, Neutral Distraction), $F_{(4, 135)} = 2.36$, $p = .037$. This interaction is presented in Figure 3. Follow-up comparisons revealed that the Neutral Distraction group showed a significant reduction in anxiety levels from pre- to post-task (and before dental treatment), $t_{(135)} = 2.09$, $p = .038$; neither the ABMT nor the ACT group showed this trend (all ps > .695). Next, only the ACT group demonstrated a significant decrease in anxiety levels from post-task to post-treatment, $t_{(135)} = 3.33$, $p = .001$; no change in state-anxiety was reported by either the ABMT or the Neutral Distraction conditions (all ps > .428). Finally, a significant decrease in state-anxiety from t_0 to t_2 was obtained for Neutral Distraction, $t_{(135)} = 2.33$, p = 0.022, and ACT, $t_{(135)} = 3.67$, $p = .001$ conditions.

MLM analysis also yielded a main effect of time, $F_{(2, 135)} = 8.08$, $p = .001$ and a marginally significant trend for task, $F_{(2, 38)} = 3.09$, $p = .052$.

To complement these analyses, we compared anxiety levels of the three conditions in each time point (t_0, t_1, and t_2) using one-way ANOVA. Baseline state-anxiety levels before the task (t_0) did not differ between the groups, $F_{(2,68)} = 1.249$, $p = .293$, indicating comparable initial levels of state-anxiety.

Levels of state-anxiety following the task and before the dental treatment (t_1) were different across the groups, $F_{(2,67)} = 3.314$, $p = .042$. Contradicting our major hypothesis, post-hoc comparisons indicated participants in the Neutral Distraction group reported lower state-anxiety ($M = 27.65$, $SD = 7.49$) than those in the ABMT group ($M = 33.91$, $SD = 8.93$), $p = .015$; and a similar trend was observed when Neutral Distraction was compared to ACT ($M = 32.07$, $SD = 8.95$), $p = .076$.

Following the dental treatment (t_2), significant group differences emerged in state-anxiety, $F_{(2,67)} = 3.535$, $p = .035$. Post-hoc comparisons showed that participants in both the Neutral Distraction ($M = 26.91$, $SD = 8.04$) and the ACT ($M = 27.56$, $SD = 7.15$) groups reported lower state-anxiety score than those in the ABMT ($M = 32.87$, $SD = 9.53$) group, ps $< .031$. The Neutral Distraction and the ACT groups did not differ ($p = .787$).

Finally, there was a positive correlation between post-task state-anxiety (t_1) and the overall subjective evaluation reported at the end of the dental treatment (t_2), $r = .352$, $p = .005$.

DISCUSSION

The aim of this RCT study was to test the immediate effects of a single-session ABMT in reducing state-anxiety among a non-clinical population while waiting for a dental procedure. Three major findings emerge. First, countering our hypothesis, the group that performed the Neutral Distraction task reported lower state-anxiety before the dental treatment relative to the ABMT and ACT groups. Second, state-anxiety for those in the ABMT group remained elevated even after the dental treatment was completed. Finally, anxiety levels immediately before the dental treatment were associated with the overall subjective evaluations of participants following the dental treatment.

In contrast to our main hypothesis, only the Neutral Distraction task yielded a significant reduction in anxiety before the dental procedure. Specifically, although anxiety levels were similar at baseline, participants who completed this particular task reported lower anxiety levels than those in the two other conditions (ABMT and ACT) following the task and immediately before the dental treatment. Implementation of distraction relative to exposure techniques may explain this result. Several previous studies have used computer games as an acute distraction to reduce intrusive memories and cognitive rumination during anxiety-provoking tasks (for example, Holmes, James, Coode-Bate, & Deeprose, 2009). Video games are potent distractors even in stressful contexts. They provide immediate feedback on participants' performance and are therefore engaging and intrinsically rewarding (Green & Bavelier, 2015). As such, they may provide an effective and easily-implemented means to alleviate dental anxiety. Conversely, the task in the two attention training conditions (ABMT and ACT) included explicit threat cues (dental words) that might have maintained phasic fear responses to the imminent threat (dental procedure) (Craske et al., 2009), regardless of the direction of the attention training.

Interestingly, despite its established effect in reducing anxiety and stress vulnerability, the levels of state-anxiety in the ABMT condition were not only higher before the dental treatment, but they remained elevated following the dental procedure compared to the two other conditions. ABMT is believed to alleviate anxiety by having specific effects on threat bias patterns, namely reducing anxiety symptoms by training individuals to shift attention *away* from threats (MacLeod & Mathews, 1988; Mogg & Bradley, 1998). However, there is considerable evidence that in anxiety-provoking contexts, attention mechanisms are inherently biased *away* from threats, thereby assisting mental coping with the hardships of acute stress. For example, threat avoidance was found in a field study of non-anxious individuals in a life threatening

context (Bar-Haim, 2010), among soldiers exposed to stressful combat drills (Wald et al., 2013), and in several laboratory studies using mild threat induction protocols (Constans, McCloskey, Vasterling, Brailey & Mathews, 2004; Helfinstein, White, Bar-Haim & Fox, 2008; Shechner et al., 2012). These data suggest patterns of attention bias are context-dependent and more complex and varied than originally conceptualized. In this vein, the dentist's waiting room, where awaiting patients can hear, smell, and often see cues of the imminent aversive experience, could be considered an anxiety-provoking context. Hence, patients are likely to exhibit a tendency to avoid the dental-related threatening words in the attention tasks. The relatively high anxiety reports even after the completion of dental treatment may suggest that strengthening the avoidance bias by training subjects to shift their attention farther away from threats might worsen the situation. Future studies may consider training towards threat in these acute and mildly stressful conditions.

Participants in the ACT condition who were trained in a more flexible regimen (toward and away from threat) exhibited a reduction in anxiety levels following the dental treatment. This finding supports the suggested link between threat avoidant and elevated anxiety post-treatment. In addition to contextual effects on attention bias to threat, individual differences in the magnitude and the direction of attention bias have been extensively documented (for a review, see Shechner et al., 2012; Van Bockstaele et al., 2014). We did not tailor a specific training program for each individual based on bias measurements at baseline, so it is not surprising that training attention in a more flexible way did not affect state-anxiety before the dental treatment (expectancy effect). That said, training attention in a flexible way could be beneficial when coping with an imminent aversive situation.

Attention bias was not assessed in this study because it took the form of a single-session intervention, and previous research has suggested that a pre-training bias measurement task might interfere with subsequent learning processes during training (Abend et al., 2013). Therefore, it is impossible to determine the precise reason for group differences across conditions. Further, it remains unclear whether the single, relatively short ABMT session successfully induced the intended pattern of selective attention away from threat. This is critical, as data from several ABMT studies consistently show that when ABMT successfully modifies attention bias, it also mitigates anxiety disposition of dysfunction. However, clinical effects are usually absent when studies fail to achieve successful change in attention bias (for a comprehensive review, see MacLeod & Clarke, 2015).

Although differences among groups emerged in the opposite direction than expected, we observed a positive correlation in the entire sample between state-anxiety before the dental treatment and the overall subjective evaluation of the experience when it was over. This finding supports the need to develop psychological interventions aiming to reduce negative expectations before dental treatment and corroborates previous studies indicating the reduction of aversive dental expectations buffers the effect of cognitive vulnerability (i.e. dangerousness, unpredictability, and disgustingness) on dental fear in both adults and youth (for example, see Carrillo-Díaz, Crego, Armfield & Romero, 2013).

The study's results should be viewed in light of some limitations. First, participants in the current sample did not perceive dental treatment as anxiety provoking. Therefore, lack of effect could be attributed to a floor effect. Indeed, the efficacy of ABMT has been demonstrated mainly in clinical samples or in situations that elicit strong fearful behaviors. Hence, examining the clinical effects of dental-ABMT among dental-phobics or before complicated dental procedures

that more strongly elicit fear could yield different results. Second, as mentioned previously, a major limitation of the study derives from the lack of attention bias measurement. In short, it is difficult to know if the dental ABMT task successfully modified selective attention. This is particularly relevant to the current study given the relatively short ABMT task that was only delivered once. Given the possible undermining effect of a measurement task on subsequent attention training, future studies may consider other type of bias assessment than the dot-probe task. Third, given the relatively small sample size in each condition, randomization does not guarantee comparable attention biases across the conditions at baseline. Again, without a measurement of attention bias, this possible limitation remains speculative.

Despite these limitations, this exploratory study adds to the growing ABMT literature, providing data on the potential therapeutic application of ABMT in a real-world anxiety-provoking context. Our findings suggest distraction tasks have a better immediate effect in alleviating state-anxiety than attention training tasks in non-anxious individuals who are expecting a relatively unpleasant experience.

REFERENCES

Abend, R., Karni, A., Sadeh, A., Fox, N. A., Pine, D. S., & Bar-Haim, Y. (2013). Learning to attend to threat accelerates and enhances memory consolidation. *PloS One, 8*(4), e62501. doi:10.1371/journal.pone.0062501 [doi]

Bar-Haim, Y., Lamy, D., Pergamin, L., Bakermans-Kranenburg, M. J., & van IJzendoorn, M. H. (2007). Threat-related attentional bias in anxious and nonanxious individuals: A meta-analytic study. *Psychological Bulletin, 133*(1), 1-24. doi:2006-23058-001 [pii]

Beevers, C. G., Clasen, P. C., Enock, P. M., & Schnyer, D. M. (2015). Attention bias modification for major depressive disorder: Effects on attention bias, resting state connectivity, and symptom change. *Journal of Abnormal Psychology, 124*(3), 463-475. doi:10.1037/abn0000049 [doi]

Boffo, M., Pronk, T., Wiers, R. W., & Mannarini, S. (2015). Combining cognitive bias modification training with motivational support in alcohol dependent outpatients: Study protocol for a randomised controlled trial. *Trials, 16*, 63-015-0576-6. doi:10.1186/s13063-015-0576-6 [doi]

Britton, J. C., Bar-Haim, Y., Clementi, M. A., Sankin, L. S., Chen, G., Shechner, T., . . . Pine, D. S. (2013). Training-associated changes and stability of attention bias in youth: Implications for attention bias modification treatment for pediatric anxiety. *Developmental Cognitive Neuroscience, 4*, 52-64. doi:10.1016/j.dcn.2012.11.001 [doi]

Carrillo-Diaz, M., Crego, A., Armfield, J., & Romero, M. (2013). The moderating role of dental expectancies on the relationship between cognitive vulnerability and dental fear in children and adolescents. *Community Dentistry and Oral Epidemiology, 41*(3), 269-278. doi:10.1111/cdoe.12009 [doi]

Carter, A. E., Carter, G., Boschen, M., AlShwaimi, E., & George, R. (2014). Pathways of fear and anxiety in dentistry: A review. *World Journal of Clinical Cases, 2*(11), 642-653. doi:10.12998/wjcc.v2.i11.642 [doi]

Cisler, J. M., & Koster, E. H. (2010). Mechanisms of attentional biases towards threat in anxiety disorders: An integrative review. *Clinical Psychology Review, 30*(2), 203-216. doi:10.1016/j.cpr.2009.11.003 [doi]

Coldwell, S. E., Wilhelm, F. H., Milgrom, P., Prall, C. W., Getz, T., Spadafora, A., . . . Ramsay, D. S. (2007). Combining alprazolam with systematic desensitization therapy for dental injection phobia. *Journal of Anxiety Disorders, 21*(7), 871-887. doi:S0887-6185(07)00004-7 [pii]

Constans, J. I., McCloskey, M. S., Vasterling, J. J., Brailey, K., & Mathews, A. (2004). Suppression of attentional bias in PTSD. *Journal of Abnormal Psychology, 113*(2), 315-323. doi:10.1037/0021-843X.113.2.315 [doi]

Cox, W. M., Klinger, E., & Fadardi, J. S. (2015). The motivational basis of cognitive determinants of addictive behaviors. *Addictive Behaviors, 44*, 16-22. doi:10.1016/j.addbeh.2014.11.019 [doi]

Craske, M. G., Rauch, S. L., Ursano, R., Prenoveau, J., Pine, D. S., & Zinbarg, R. E. (2009). What is an anxiety disorder? *Depression and Anxiety, 26*(12), 1066-1085. doi:10.1002/da.20633 [doi]

Crofts-Barnes, N. P., Brough, E., Wilson, K. E., Beddis, A. J., & Girdler, N. M. (2010). Anxiety and quality of life in phobic dental patients. *Journal of Dental Research, 89*(3), 302-306. doi:10.1177/0022034509360189 [doi]

Davies, J. G., Wilson, K. I., & Clements, A. L. (2011). A joint approach to treating dental phobia: A re-evaluation of a collaboration between community dental services and specialist psychotherapy services ten years on. *British Dental Journal, 211*(4), 159-162. doi:10.1038/sj.bdj.2011.674 [doi]

Eldar, S., Apter, A., Lotan, D., Edgar, K. P., Naim, R., Fox, N. A., . . . Bar-Haim, Y. (2012). Attention bias modification treatment for pediatric anxiety disorders: A randomized controlled trial. *The American Journal of Psychiatry, 169*(2), 213-220. doi:10.1176/appi.ajp.2011.11060886 [doi]

Green, C. S., & Bavelier, D. (2003). Action video game modifies visual selective attention. *Nature, 423*(6939), 534-537. doi:10.1038/nature01647 [doi]

Hakamata, Y., Lissek, S., Bar-Haim, Y., Britton, J. C., Fox, N. A., Leibenluft, E., . . . Pine, D. S. (2010). Attention bias modification treatment: A meta-analysis toward the establishment of novel treatment for anxiety. *Biological Psychiatry, 68*(11), 982-990. doi:10.1016/j.biopsych.2010.07.021 [doi]

Helfinstein, S. M., White, L. K., Bar-Haim, Y., & Fox, N. A. (2008). Affective primes suppress attention bias to threat in socially anxious individuals. *Behaviour Research and Therapy, 46*(7), 799-810. doi:10.1016/j.brat.2008.03.011 [doi]

Holmes, E. A., James, E. L., Coode-Bate, T., & Deeprose, C. (2009). Can playing the computer game "tetris" reduce the build-up of flashbacks for trauma? A proposal from cognitive science. *PloS One, 4*(1), e4153. doi:10.1371/journal.pone.0004153 [doi]

Humphris, G. M., Morrison, T., & Lindsay, S. J. (1995). The modified dental anxiety scale: Validation and united kingdom norms. *Community Dental Health, 12*(3), 143-150.

Linetzky, M., Pergamin-Hight, L., Pine, D. S., & Bar-Haim, Y. (2015). Quantitative evaluation of the clinical efficacy of attention bias modification treatment for anxiety disorders. *Depression and Anxiety, 32*(6), 383-391. doi:10.1002/da.22344 [doi]

Liu, Y., Huang, X., Yan, Y., Lin, H., Zhang, J., & Xuan, D. (2015). Dental fear and its possible relationship with periodontal status in chinese adults: A preliminary study. *BMC Oral Health, 15*, 18-6831-15-18. doi:10.1186/1472-6831-15-18 [doi]

MacLeod, C., & Mathews, A. (1988). Anxiety and the allocation of attention to threat. *The Quarterly Journal of Experimental Psychology.A, Human Experimental Psychology, 40*(4), 653-670.

MacLeod, C., & Clarke, P.J.F. (2015). The Attentional Bias Modification Approach to Anxiety Intervention. *Clinical Psychological Science, 3*(1), 58-78. doi: 10.1177/2167702614560749 [doi]

Mogg, K., & Bradley, B. P. (1998). A cognitive-motivational analysis of anxiety. *Behaviour Research and Therapy, 36*(9), 809-848. doi:S0005-7967(98)00063-1 [pii]

Mogg, K., Bradley, B. P., de Bono, J., & Painter, M. (1997). Time course of attentional bias for threat information in non-clinical anxiety. *Behaviour Research and Therapy, 35*(4), 297-303. doi:S0005-7967(96)00109-X [pii]

Oosterink, F. M., de Jongh, A., & Hoogstraten, J. (2009). Prevalence of dental fear and phobia relative to other fear and phobia subtypes. *European Journal of Oral Sciences, 117*(2), 135-143. doi:10.1111/j.1600-0722.2008.00602.x [doi]

Pohjola, V., Lahti, S., Vehkalahti, M. M., Tolvanen, M., & Hausen, H. (2007). Association between dental fear and dental attendance among adults in finland. *Acta Odontologica Scandinavica, 65*(4), 224-230. doi:781732258 [pii]

Renwick, B., Campbell, I. C., & Schmidt, U. (2013). Review of attentional bias modification: A brain-directed treatment for eating disorders. *European Eating Disorders Review : The Journal of the Eating Disorders Association, 21*(6), 464-474. doi:10.1002/erv.2248 [doi]

Sharpe, L. (2012). Attentional biases and their role in the management of pain. *Pain, 153*(12), 2307-2308. doi:10.1016/j.pain.2012.09.004 [doi]

Sharpe, L., Ianiello, M., Dear, B. F., Nicholson Perry, K., Refshauge, K., & Nicholas, M. K. (2012). Is there a potential role for attention bias modification in pain patients? results of 2 randomised, controlled trials. *Pain, 153*(3), 722-731. doi:10.1016/j.pain.2011.12.014 [doi]

Shechner, T., Pelc, T., Pine, D. S., Fox, N. A., & Bar-Haim, Y. (2012). Flexible attention deployment in threatening contexts: An instructed fear conditioning study. *Emotion (Washington, D.C.), 12*(5), 1041-1049. doi:10.1037/a0027072 [doi]

Shechner, T., Rimon-Chakir, A., Britton, J. C., Lotan, D., Apter, A., Bliese, P. D., . . . Bar-Haim, Y. (2014). Attention bias modification treatment augmenting effects on cognitive behavioral therapy in children with anxiety: Randomized controlled trial. *Journal of the American Academy of Child and Adolescent Psychiatry, 53*(1), 61-71. doi:10.1016/j.jaac.2013.09.016 [doi]

Singer, J. D. (2003). In W (Ed.), *Applied longitudinal data analysis : Modeling change and event occurrence*. Oxford: Oxford University Press.

Smith, T. A., & Heaton, L. J. (2003). Fear of dental care: Are we making any progress? *Journal of the American Dental Association (1939), 134*(8), 1101-1108.

Spielberger, C. D. (1983). *Manual for the state*. Palo Alto: Consulting Psychologists Press.

State-trait anxiety inventory : A comprehensive bibliography (1989). In Spielberger C. D. (Ed.), (2nd ed.). Palo Alto, Calif.: Mind Garden.

Van Bockstaele, B., Verschuere, B., Tibboel, H., De Houwer, J., Crombez, G., & Koster, E. H. (2014). A review of current evidence for the causal impact of attentional bias on fear and anxiety. *Psychological Bulletin, 140*(3), 682-721. doi:10.1037/a0034834 [doi]

Wald, I., Degnan, K. A., Gorodetsky, E., Charney, D. S., Fox, N. A., Fruchter, E., . . . Bar-Haim, Y. (2013). Attention to threats and combat-related posttraumatic stress symptoms: Prospective associations and moderation by the serotonin transporter gene. *JAMA Psychiatry, 70*(4), 401-408. doi:10.1001/2013.jamapsychiatry.188 [doi]

Willumsen, T., Vassend, O., & Hoffart, A. (2001). One-year follow-up of patients treated for dental fear: Effects of cognitive therapy, applied relaxation, and nitrous oxide sedation. *Acta Odontologica Scandinavica, 59*(6), 335-340.

Yiend, J., Mathews, A., Burns, T., Dutton, K., Fernandez-Martin, A., Georgiou, G. A., . . . Fox, E. (2015). Mechanisms of selective attention in generalized anxiety disorder. *Clinical Psychological Science : A Journal of the Association for Psychological Science, 3*(5), 758-771. doi:10.1177/2167702614545216 [doi]

Running head: DENTAL ABMT

Table 1. Sample demographics, psychological and clinical (dental) indices

	ABMT		**ACT**		**Neutral Distraction**		**Total**		
	n = 23		*n* = 25		*n* = 23		N = 71		
Demographic									*p.v.*
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	
Age (years)	50.61	15.99	46.48	19.24	46.64	17.38	47.89	17.49	.67
Gender (% females)	43.47%		84%		59.09%		62.85%		.02
Psychological									
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	
MDAS(t_0)	9.56	2.95	10.24	3.30	9.47	2.44	9.77	2.91	.62
STAI-traits (t_0)	37.25	8.22	35.19	6.46	32.67	6.84	35.04	7.33	.10
STAI-states (t_0)	33.91	8.69	32.72	9.24	29.98	7.98	32.22	8.70	.29
Clinical (dental)									
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	
Treatment complexity	1.87	1.25	2.17	1.12	1.70	1.25	1.91	1.21	.41
Previous dental clinic visit (% yes)	86.96%		88.00%		86.96%		87.32%		.99
Follow-up visit to the clinic (% yes)	60.86%		72.00%		52.18%		61.97%		.37

Note. ABMT = Attention bias modification training; ACT = Attention control training; MDAS = Modified dental anxiety scale; STAI = State trait anxiety inventory

Running head: DENTAL ABMT

FIGURE CAPTIONS

Figure 1. Dental dot-probe task. A modified dot-probe task consisting of aversive dental related and neutral words. A trial began with a fixation cross, followed by a pair of words displayed for 500 ms. Words were presented in dental-neutral or neutral-neutral pairs, vertically (500 ms). Following the word display, a target probe (the letter 'E' or the letter 'F') appeared in one of the locations vacated by the words. Participants were required to determine which letter appeared on the screen and to press a relevant pre-specified button on the computer mouse using their dominant hand.

Figure 2. Consolidated standard of reporting trials (CONSORT) diagram. A schematic representation of participants' recruitment, exclusion and conditions allocation.

Figure 3. Effects of Time and Condition on state-anxiety. A significant interaction between time (t_0, t_1, t_2) and condition (ABMT, ACT, Neutral Distraction) on state-anxiety emerged, $F_{(4, 135)} = 2.36$, $p = .037$. Only participants in the Neutral Distraction condition reported lower anxiety levels following the task. In addition, levels of state-anxiety in the ABMT condition remained elevated following the dental procedure.

ABMT = Attention bias modification training; ACT = Attention control training.

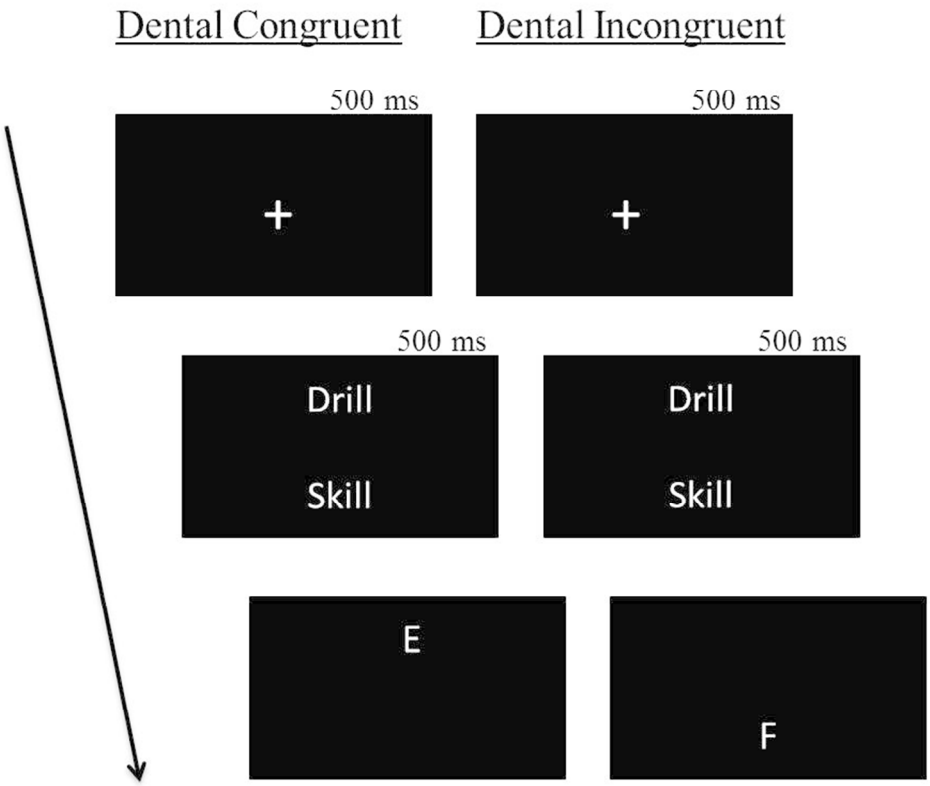

Figure 1. Dental dot-probe task. A modified dot-probe task consisting of aversive dental related and neutral words. A trial began with a fixation cross, followed by a pair of words displayed for 500 ms. Words were presented in dental-neutral or neutral-neutral pairs, vertically (500 ms). Following the word display, a target probe (the letter 'E' or the letter 'F') appeared in one of the locations vacated by the words. Participants were required to determine which letter appeared on the screen and to press a relevant pre-specified button on the computer mouse using their dominant hand.
158x130mm (150 x 150 DPI)

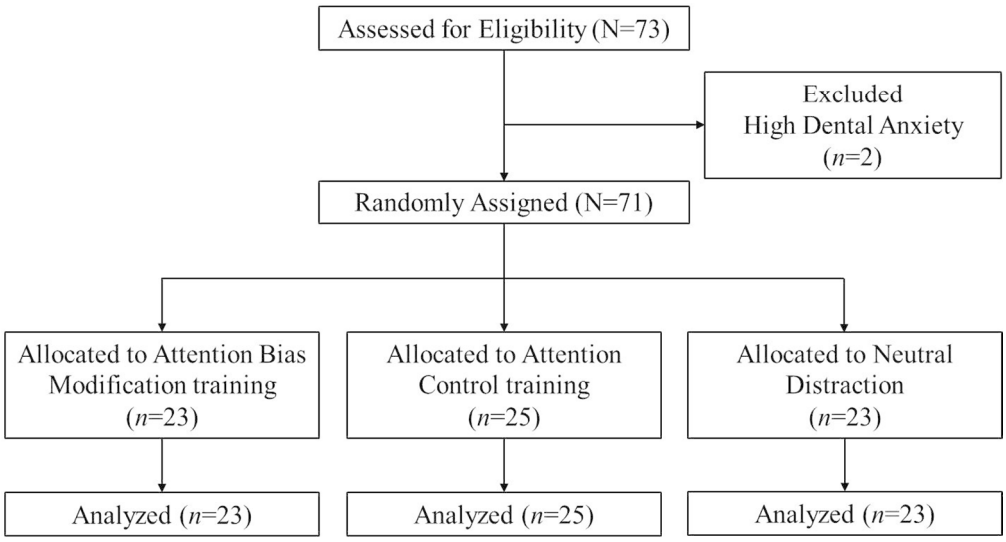

Figure 2. Consolidated standard of reporting trials (CONSORT) diagram. A schematic representation of participants' recruitment, exclusion and conditions allocation.
240x131mm (150 x 150 DPI)

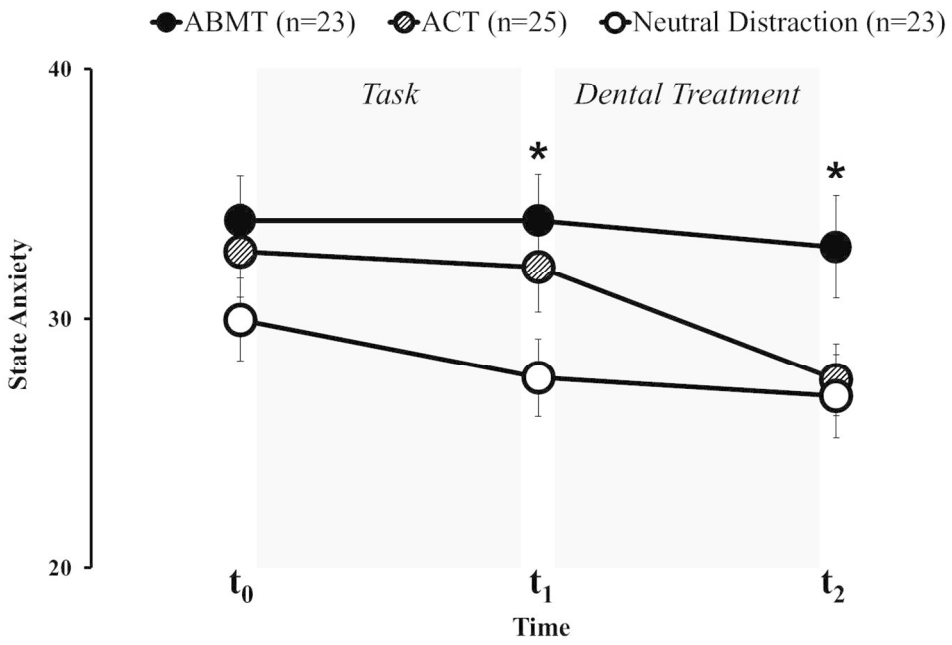

Figure 3. Effects of Time and Condition on state-anxiety. A significant interaction between time (t0, t1, t2) and condition (ABMT, ACT, Neutral Distraction) on state-anxiety emerged, $F(4, 135) = 2.36$, $p = .037$. Only participants in the Neutral Distraction condition reported lower anxiety levels following the task. In addition, levels of state-anxiety in the ABMT condition remained elevated following the dental procedure. ABMT = Attention bias modification training; ACT = Attention control training.

240x156mm (150 x 150 DPI)