Effects of game-based relaxation training on attention problems in anxious children.

Michele Knox, Jennifer Lentini, & Stacey Aiton
The University of Toledo College of Medicine
Correspondence: Jennifer Lentini, M.D.
PI: Michele Knox, Ph.D.
The University of Toledo College of Medicine
3130 Glendale Avenue, Toledo, OH 43614

Abstract

Results of recent research have suggested that game-based, biofeedback relaxation training may reduce symptoms of both Attention-Deficit Hyperactivity Disorder (ADHD) and Anxiety Disorders in children and youths. Inattention and poor concentration are common features of these disorders. However, it has not yet been explicitly studied whether the problems with attention and concentration that are characteristic of anxious youths may be lessened with this intervention. The present study examines the effects of an intervention combining game-based relaxation training with psychoeducation and behavioral practice in a sample of twenty-three 9 to 17 year olds. It was hypothesized that intervention participants would show significant improvements on the attention problems subscale of the Child Behavior Checklist – Parent Report Form relative to participants in the waitlist control group. Results indicated significant improvements in posttest attention problems scores for the intervention group relative to the control group. The findings of this preliminary study suggest that game-based relaxation training may be beneficial for attention and concentration problems in anxious children and adolescents.
Introduction

Anxiety is a common mental health problem in childhood and adolescence (Cartwright-Hatton et al., 2006; Shaffer, 1996). According to the Diagnostic and Statistical Manual of Mental Disorders 4th Edition (DSM-IV-TR), anxiety disorders are characterized by intense fear and or inappropriate (American Psychiatric Association, 2000). This intense fear of an anxiety-provoking stimulus or in situations that normally do not produce lead to panic attacks which are severe incidences of fear that can cause shortness of breath, palpitations, chest pain/discomfort, choking or smothering feelings, and fear Children and adolescents with anxiety also may experience restlessness, fatigue, tension, and sleep disturbance.

In addition to these symptoms, inattention and poor concentration are common features of anxiety in children and youths (American Academy of Child and Adolescent Psychiatry, 2007; Semrud-Clikeman & Ellison, 2009). These problems appear to relate, at least in part, to people to attend too much to potentially threatening or dangerous situations tend to selectively attend to what they perceive to be the more threatening aspects of situations. Such tendencies may cause them to be less attentive to the more important or relevant information in their environment. Children with anxiety are thought to have problems with “attentional allocation,” (Rapee et al., 2009) such that attention is focused on targets that may not be useful or appropriate for meeting goals. Thus, these children, unlike children with Attention-Deficit/Hyperactivity Disorder, have impaired ability to concentrate or pay attention, but rather tend to focus unhelpful features of their environments. For example, in cases of social phobia, individuals attend too intensely to bodily symptoms such as blushing, trembling or sweating (Bogels, 2006) and too little to relevant information in the environment. Intense self-focus of these individuals to evidence poor concentration in academic and other settings called Task Concentration Training (TCT) was developed to address this problem. During TCT, patients learn to direct their attention to the task at hand and away from their bodily symptoms. This technique has been shown to effectively alter the attentional shifts by providing improvements beyond those offered by cognitive therapy and traditional relaxation (Bogels, 2006).

Treatment Of Attention Problems Though Relaxation Training

Research conducted over the past four decades has indicated that relaxation training may produce improvements in attention span for children and adolescents (Lupin et al, 1976; Braud, 1978; Dunn & Howell, 1982; Denkowski et al, 1983; Chang, 1991). In a study of the effects of meditation as a form of relaxation training, college students who completed meditation sessions demonstrated significantly better scores on a test of attention (Tang, 2007). Research also suggests that attention and impulsivity can be altered b
been taught traditional biofeedback techniques, such as relaxation training, progressive relaxation, or interactive metronome training (Weize, 2004). A study with ADHD was conducted using “coherence training” to alter aspects of cognition (Lloyd et al., 2010). Coherence training involves teaching the regulation of heart rhythm to shift attention, regulate breathing, and activate positive emotions.

The goal is to achieve psychophysiological coherence, a highly efficient functional mode associated with increased nervous system harmony, enhanced emotional stability, and improved cognitive performance (McCraty, 2005). Improvements in immediate and delayed word recall and episodic secondary memory were evident in the treated participants following six weeks of coherence training (Lloyd et al., 2010).

Some recent research has demonstrated decreases in both inattention and anxiety following training in meditation. A study with combat veterans diagnosed with post-traumatic stress disorder (a type of anxiety disorder) suggested that biofeedback training may improve attention (Gingberg, 2010). A study using meditation training illustrated that undergraduate students in an experimental group performed significantly better on a test of attention and had significantly low control group (Tang et al., 2007). In another study (Harrison et al., 2004), 26 children diagnosed with ADHD were taught meditation. The participants in the study evidenced improvements in self-reported and parent-reported attention. Anxiety was also reduced over the course of the study. Grosswald et al. (2008) conducted a study using a type of concentration meditation to lower anxiety and stress, and results suggested that ADHD symptoms could be lessened through this method.

**Treatments Utilizing Computer Technology To Aid In The Treatment Of Anxiety and Inattention**

Biofeedback has been utilized successfully to help individuals with a variety of disorders achieve a state of relaxation (Yucha et al., 2008). Biofeedback has the goal of improving the individual’s ability to control physiological processes. There are various types of biofeedback, some of which address improved control over central nervous system activity (e.g., neurofeedback) and others that promote improved control over peripheral nervous system activity (e.g., thermal biofeedback). Biofeedback allows the participant to view real-time indicators of parameters such as heart rate variability (HRV) and skin conductance level (SCL). HRV is a measure of the Autonomic Nervous System (ANS). An increase in ANS activity may indicate stress and a decrease can indicate relaxation (McCraty & Tomasino, 2006). HRV measures the time between heartbeats; low variability implies that the participant is stressed (McCraty & Tomasino, 2004). SCL is a measure of the action of the sweat glands in the fingertips; increased perspiration suggests that the participant is experiencing excitement or anxiety, while the other hand, leads to low levels of perspiration. These real-time measures can be plotted on a graph or depicted in a variety of ways on a computer screen. Through biofeedback-based relaxation training, the individual can learn to manipulate images on the screen that are influenced by HRV and SCL (Culbert et al., 1996). This is achieved through practice and use of deep breathing, imagery, and muscle relaxation. The training also helps the participant to find techniques to manage stress and improve concentration.
methods work best for him/her and helps him/her stay "on task" when intrusive thoughts/feelings appear (Banquet, 1973; Condron et al, 2009; Lagopoulos et al, 2009).

A number of studies illustrate that, like adults, children and adolescents can peripheral nervous system processes such as heart rate and electrodermal ac 1980; Cobb & Evans, 1981; Siniatchkin, 2000). In recent years, technology has makes use of video-game-like technology and graphics which may significant engagement in biofeedback, particularly among young people. In game-based physiological coherence is achieved, the participant can make different actions through involvement in video-game-like activities.

Neurofeedback is a type of biofeedback which measures and provides the us ratios of alpha and beta waves detected via electroencephaolograph (EEG). It uses similar game-based formats to maintain interest and motivation. Neurofeedback is gaining evidence in favor of its effectiveness as a treatment for ADHD. A recent meta-analysis by Arns, De Ridder, Strehl, Breteler, & Coenen, (2009), for example, suggested that neurofeedback can produce clinically meaningful improvements in symptoms of ADHD, in children and youths. Neurofeedback is a type of biofeedback which measures and provides the us ratios of alpha and beta waves detected via electroencephaolograph (EEG). This approach is based on research indicating that individuals with ADHD have been shown to generate high levels of theta activity relative to beta activity in the prefrontal cortex (Hughes & John, 1999). Although neurofeedback appears a promising treatment for children and youth, it may not be the treatment of choice for the poor concentration that characterizes anxiety. Individuals with anxiety appear to have problems with inattention that occur directly linked to the central nervous system, promoting improved attentional capacity in anxious individuals may involve different approaches. As reviewed above, such individuals seem to need to learn to redirect focus away from anxiety-promoting stimuli and to prevent or reduce the escalation of peripheral nervous system activity. Additionally, while neurofeedback may be cost-prohibitive for some individuals (Anglada & Hakala, 2008) biofeedback technology for peripheral nervous system activity can be relatively less expensive because it can be completed using fewer sessions and less expensive equipment (Schwartz & Andrasik, 2003).

To date, very little research has been conducted on the effectiveness of game-based relaxation training. Although there is not yet ample empirical evidence demonstrating the efficacy of these new programs, it stands to reason that such technology may be useful for work with children and youths, in part because children and adolescents in the United States are often avid users of videogames (Gentile & Walsh, 2002; Gentile et al, 2004). Research by Pop-Jordanova (2009) examined the use of HRV biofeedback training for the treatment of anxiety, conduct disorder and ADHD in children. Results after 15 sessions of training showed that children from all groups improved; the best...
results were obtained for children with conduct and anxiety disorders. Another study examined the efficacy of this approach with 24 children diagnosed with ADHD (Amon & Campbell, 2008). The experimental group showed significant reductions in parent-reported ADHD symptoms. Researchers also noted that children took great interest in the study and were motivated by the use of technology and video game format. These results suggest that video game-based treatments may be an enjoyable and motivating medium for treatment and adolescents. Results of a pilot study indicated that 14 to 35 percent of high school students performed higher on standardized tests in reading and math after biofeedback (McCraty & Tomasino, 2004). This result was hypothesized to occur because participants high-performance states by learning to better manage test anxiety and promote ANS coherence (McCraty & Tomasino, 2004).

The present study examines symptoms of inattention in a sample of 9 to 17 year olds who received game-based relaxation training combined with psychoeducation and behavioral practice. Intervention was found in previous research to result in significant improvements in anxiety and depression (Knox et al, manuscript under review). It is posited that anxious children and youths who receive this intervention will demonstrate improvements in attention. Therefore it is hypothesized that intervention participants will show significant improvements on the attention problems subscale of the Child Behavior Checklist – Parent Report Form relative to participants in the waitlist control group.

**Methods**

**Participants**

Thirty-one participants consented to take part in the study. However, eight participants (two females and six males) failed to complete the study, leaving a final sample of 23 children/adolescents (nine females and 14 males). The portion of the sample who dropped out did not differ from completers in terms of demographics (age, gender, or SES) or in pretest scores (scores on the Attention Problems subscale for the Child Behavior Checklist (CBCL)). The final sample of 23 participants ranged in age from 9 to 17 years (M = 12.7, SD = 2.38). Each participant had clinically significant symptoms of anxiety, either a clinical disorder or problems such as excessive worry or fear. They were referred from pediatricians, nurse practitioners, and other mental health providers. The large majority of the participants were receiving traditional mental health treatment for anxiety or other mental health problems prior to and during the study (medication, therapy or both). None of the participants started medication during the course of the study. Twelve participants were assigned to the intervention group and the next 11 were assigned to the waitlist control group, assigned sequentially to groups, starting with the intervention group, because it was not clear at the beginning of the study if there would be enough referrals to enroll a control group.
Independent sample t-tests and chi-square analysis were conducted to examine differences between the groups. The intervention and control groups did not differ on age, gender, or socioeconomic status (SES).

**Apparatus**

Two biofeedback programs were utilized in this study. In the Freeze Framer software program, as the player relaxes, he/she can color and add characters to a meadow, make a rainbow, or float a hot-air balloon (Institute of HeartMath, 2010). In the other program (The Wild Divine Project, 2009) the participant achieves many different goals (e.g., making a fire, building a wall, shooting a bow and arrow) in a fantasy land. This game also uses images and sound to aid in rhythmic breathing and coherence.

**Materials**

The Attention Problems subscale for the Child Behavior Checklist (CBCL) was utilized in this study. The CBCL is a questionnaire completed by parents of primary caregivers that measures children and youth’s emotional and behavioral symptoms. The CBCL is very well established and has been reported to have high test-retest reliability, internal consistency, and discriminant validity (Achenbach & Edelbrock, 1983). Socioeconomic Status was evaluated using the Updated Occupation Prestige and Socioeconomic Scores (Nakao & Treas, 1994).

**Procedure**

The study was approved by the University Institutional Review Board. Participants completed informed assent forms, and their parents/caregivers completed informed consent forms prior to their participation in the study. Parents completed the CBCL upon enrollment into the study prior to the treatment (pre-test). The game-based relaxation biofeedback (intervention) condition was based on a session-by-session protocol combining relaxation training and practice with psychoeducation about how stress can affect people, how relaxation can relieve or prevent stress, and when and how to use relaxation techniques in real life. Participants were also helped to identify signs of anxiety as well as events and thoughts that trigger anxiety. Participants were assigned behavioral practice that was designed to help them most effectively incorporate the use of relaxation into their daily lives. Appendix 1 shows the session-by-session protocol that was used. Each session lasted 45 minutes to one hour. The control group was waitlisted, and offered game-based relaxation training after the end of the study. At the completion of the study, parents completed a post-test CBCL questionnaire.

**Results**

The intervention group’s mean T-score on the CBCL Attention Problems subscale was
65.25 (SD=12.57) at pretest. This score falls in the “borderline” range of the CI group's posttest mean T-score was 61.08 (SD=10.69), a score which falls in the waitlist control group's mean T-score on the CBCL Attention Problems subscale at pretest, and 61.27 (SD=9.52) at posttest. Both scores fell in the “normal” range with condition (intervention or control) as the fixed factor. The dependent variable was CBCL Attention Problems subscale T-scores. The covariate was pre-test CBCL subscale T-scores. This analysis revealed significant differences between the groups at post-test (F(2,22)= 6.31, p=.008; partial 2=0.39) favoring the intervention group. Test analyses revealed that the intervention group’s scores reduced significantly from pre to post-test (t(11)=3.12; p=.01), but the control group’s scores did not.

**Discussion**

The present study examines the efficacy of game-based biofeedback relaxation training, in combination with psychoeducation and behavioral practice as a treatment for attention problems in anxious youths. Children and youths who completed the intervention showed improvement in parent-reported attention compared with the wait-list control group. The control group showed no improvement on the attention problems subscale, while the intervention group’s scores improved significantly, suggesting that this intervention may be beneficial in improving the attention problems experienced by anxious children.

Whether this intervention improves on existing treatments such as neurofeedback is unknown. However, it is possible that biofeedback and neurofeedback achieve similar outcomes. Previous research has correlated increased Alpha brain wave activity with meditative states recorded at a slower and very regular 8 Hz frequency and Beta waves at quicker and less regular 12 Hz on EEGs. The link between HRV, SCL, and brain wave activity are correlational; that is they happen concurrently. One does not cause the other. When a person is more relaxed, his/her heart rate is more rhythmically varied, sweat gland activity is decreased and Alpha brain wave activity is increased. These are “end measures/results” of the mental meditation efforts. People often find that deep breathing, peaceful imagery, or positive memories help them produce decreased Autonomic Nervous System arousal, as measured by the above outputs. Thus, both methods may be beneficial.

There are a number of limitations to the current study. The relatively small sample size may limit the generalizability of the findings. Attrition was also an issue; of the original sample of 31 participants, eight participants dropped out of the study. Although there were no identifiable differences between those who dropped out and those who remained in the study, it is possible that attrition posed a threat to the internal and external validity of the study.

Assignment to condition was sequential rather than random. Future studies should employ random assignment in order to better ensure the validity of the research. Also, the large majority of the participants in the study were undergoing treatment at the start of and during the study, which included medication, therapy, or both. Subsequent research should involve collection of more detailed information about medications and other medical or mental health treatments.
allow for more precise conclusions about the implications of the findings. Another problem encountered during the study was that the finger electrode children and as a result were quite large. Consequently, they did not collect F consistently so that data could not be used (data was not collected about 20% physiological data could not be provided. The use of child-sized hardware would benefit future clinical use and research involving this intervention.

Because anxiety is known to affect cognitive performance (Derakshan & Eysenck 2009), further research is indicated to examine whether the improvements in enhancements in cognitive performance. This should be taken a step further improvements lead to improved academic achievement. Because anxiety is c problems afflicting the school age population, such research could have impr the school-age population. Future research also is recommended to examine this intervention as compared to medication and therapy for anxiety and atte children and youths. If replicated, these findings may provide important in caregivers considering options for treatment.

References


Appendix 1

Game-Based Relaxation Training Study Protocol: Intervention Condition

Session #1
Pre-test measures
Rate Anxiety on 1-10 Visual Analogue Scale (VAS)
Feelings that get in my way; What it means to feel “upset.”
Feelings are OK We need a healthy way to deal with them.
How the brain affects the body (favorite food example).
When we are frustrated, scared, worried, angry or upset, our heart rhythms are irregular and uneven.
Activity: How stress gets in my way.
List: Things and situations that make me feel anxious or stressed.
List/Draw: Where I notice tension in my body.
What will be better in my life when stress is no longer getting in my way.
Teach Relaxation
Introduce Freeze Framer and Wild Divine.
Rate Anxiety on VAS

Session #2
Rate Anxiety on VAS
REVIEW:
Feelings are OK
Need a healthy way to deal with them
REVIEW:
How to relax

REVIEW:
How the brain affects the body (favorite food example).
When we are frustrated, scared, worried, angry or upset, our heart rhythms are

REVIEW:
Where I notice tension in my body.

TEACH AND IDENTIFY:
Triggers of fear, worry, and insecurity.
Examples of thought triggers:
I'll never pass the test
I'm so stupid/ugly/fat/clumsy/unpopular....
I'll never get all this done
I can’t believe I said that. I am so ....
I know I'll screw this up
I can’t...
Everybody thinks I’m....
Continue with Freeze Framer and Wild Divine.

Rate Anxiety on VAS

PLAN: When I will relax this week

Session #3
Rate Anxiety on VAS

REVIEW:
How did relaxation at home go?
How to relax
Modify relaxation plan if needed
Continue with Freeze Framer and Wild Divine.
Rate Anxiety on VAS

PLAN: When I will relax this week

Session #4
Rate Anxiety on VAS

REVIEW:
How did relaxation at home go?
Modify relaxation plan if needed
Continue with Freeze Framer and Wild Divine.
Rate Anxiety on VAS

PLAN: When I will relax this week
Session #5
Rate Anxiety on VAS
REVIEW:
How did relaxation at home go?
Modify relaxation plan if needed
Continue with Freeze Framer and Wild Divine
Rate Anxiety on VAS
PLAN: When I will relax this week

Session #6
Rate Anxiety on VAS
REVIEW:
How did relaxation at home go?
Modify relaxation plan if needed
Continue with Freeze Framer and Wild Divine.
Rate Anxiety on VAS
PLAN: When I will relax this week

Session #7
Rate Anxiety on VAS
REVIEW:
How did relaxation at home go?
Modify relaxation plan if needed
Continue with Freeze Framer and Wild Divine.
Rate Anxiety on VAS
Identifying additional triggers, plan for in-vivo use
PLAN: When I will relax this week

Session #8
Rate Anxiety on VAS
REVIEW:
How did relaxation at home go?
Modify relaxation plan if needed
Continue with Freeze Framer and Wild Divine.
Rate Anxiety on VAS
Review triggers to stress, more plans for in-vivo use
PLAN: When I will relax this week
Post-test measures
Referral if needed