Biofeedback video games to teach ADHD children relaxation skills to help manage symptoms

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Children diagnosed with ADHD frequently demonstrate a continuous pattern of inattention, and/or hyperactivity-impulsivity, which are more frequent or serious than is typically observed in individuals of the same developmental level (APA, 2000). Affected with an inability to sit still, failure to concentrate, and the lack of self-control, children with ADHD are often lacking important social skills, and found to be at the bottom end of the academic scale (Barkley, 2006).

Whilst research has had a predominant focus on pharmacological treatments for ADHD, there js a growing interest in research on alternative options to help manage the disorder (Traywick, Lamson, Diamond, & Carawan, 2006).

Donney and Poppen (1989) reported relaxation training a 'non-chemical' alternative to reduce disruptive behaviour and increase academic performance in children with hyperactive tendencies. Relaxation skills include meditation procedures, autogenic relaxation training (ART), progressive relaxation, biofeedback training, abbreviated relaxation methods, and visual imagery. Margolis (1990) and Chang (1991) discussed these relaxation techniques to train children in child and youth care settings, and found that, when conducted appropriately, these techniques are useful skills in minimising dysfunctional behaviour, reducing stress and anxiety levels, treating headaches, encouraging reading achievement, improving self-concepts, and enhancing self-esteem.

More particularly, the effects of yoga have been associated with altered brain wave states, with specific increases in medium frequency and lowbeta ranges, which are related to concentration, perception, alertness, and attention (Aftanas & Golocheikine, 2001,2002). Similar changes in brain wave activity have also been reported in biofeedback studies with ADHD. Despite numerous published studies on biofeedback as a treatment option for ADHD, it remains somewhat hidden and parents ill-informed of it as a treatment option. Biofeedback is explained as a training technique to teach individuals to consciously use physiological signals from their bodies to recognise and change internal states and learn to control them to improve their health and performance (Schwartz & Andrasik, 2003; Yates, 1980).

Linked to neurological causes, neurofeedback - a form of biofeedback - has shown merit in its ability to train the brain to establish control over a desired response by making an individual aware of the sensations associated with the occurrence of the response. Neurofeedback works by attaching electrodes to the scalp of an individual, to measure the electrical activity of the brain (or electroencephalogram - EEG) and is sent to and processed by a computer and electroencephalograph. Modern technology has enabled data of the participant's EEG to take the form of the movements in a video game. Research studies have demonstrated this form of biofeedback has the ability to teach children to retrain brain wave activity. Thus, where brain frequencies are in excess, or in deficit, neurotherapy helps to modify it to appropriate levels by increasing or decreasing where necessary (Gunkelman & Johnstone, 2005) attempting to normalise levels of concentration, attention, impulses, emotions, and self-esteem

appropriate for their developmental age.

A less known form of biofeedback is through measurements of heart rate variable (HRV) and skin conductance levels (SCL), also known as the galvanic skin response (GSR). HRV is the measure of a person's natural changes between heart beats (McCraty & Tomasino, 2004), and SCL or GSR is the measure of electrical conductance in the skin associated with the activity of sW,eat glands (Peek, 2003). Whilst literature on HRV biofeedback shows positive results for disorders such as asthma, coronary heart disease, and depression ("Abstracts of Scientific Papers Presented at the 9th Annual Meeting of the Biofeedback Foundation of Europe," 2005), studies in this area of biofeedback for child and adolescent health and learning, are limited, and have only begun to emerge in recent years.

Like neurofeedback, HRV and SCL biofeedback uses sensors to measure an individual's physiological state. This form of biofeedback involves placing sensors on the patient's body fingertips or earlobes - to measure their heart rate, pulse, and peripheral skin temperature. Results are fed back to the individual via a computer through graphs, audio tones, or video games (Patrick, 2002).

There are important connections between emotions, learning, and performance. Thus, when emotional stress negatively affects learning and performance, the connection between nervous system activity and the brain is distorted, creating limitations important for cognitive processes essential for clear thinking, problem solving and reasoning, memory, and attention (Arguelles, McCraty, & Rees, 2003). Physiological coherence, is the result of positive emotional states where rational and consistent signals are sent to the brain coordinating nervous system activity, and generating high cognitive states (McCraty, 2003). Research studies have demonstrated the ability of biofeedback to reduce student stress, improve student's test taking skills, decrease distractability, increase calmness and positive emotions, improve attention, learning, and academic performance, and have created noticeable shifts towards positive classroom dynamics and cooperation in students not diagnosed with ADHD (Arguelles et al., 2003; HunterKane, 2003; McCraty, 2001, 2005; McCraty, Atkinson, Tomasino, Goelitz, & Mayrovitz, 1999; McCraty, Tomasino, Atkinson, Aasen, & Thurik, 2000). In relation to ADHD, studies on this form of biofeedback are very limited.

Clinical research by Hunter Kane Ltd. for HRV and SCL biofeedback with ADHD has only been underway for the last two years, with publications under preparation (HunterKane, 2006). In this 6 week trial, a double blind controlled study on the effects of HeartMath tools on 38 ADHD children was undertaken. The experimental group received four HeartMath training sessions, and the control group received four sessions of a placebo. Participants in both groups worked with a Learning Support Research Assistant for 15 minutes with either HeartMath training including the use of the FreezeFramer, or the placebo involving active participation in free play of LEGO projects. Preliminary results demonstrated that in comparison to the placebo activity, the use of HeartMath training with the Freeze-Framer, ADHD children demonstrated significant improvements in their cognitive performance. Also, Freeze-Framer results demonstrated that in comparison to baseline measurements, the control groups post intervention coherence scores reduced by roughly 40 percent, and the experimental group revealed as much as 550 percent in coherence improvement, over the same 6 week experimental period. The combination of standardised questionnaires, cognitive function testing, and measurements from the biofeedback system, have strengthened the study by eliminating issues such as rater bias when relying solely on questionnaires for results.

Biofeedback studies have shown significant abilities in helping children and adolescents without ADHD in cognitive and behavioural performance following biofeedback intervention, however further scientific research into the use of HRV and SCL measurements of biofeedback for ADHD is needed, as preliminary studies have shown it capable of helping children manage ADHD symptoms and improve physiological coherence and cognitive performance.

Researchers at The University of Sydney, Faculty of Health Sciences, in Australia, are currently in the final experimental stage of their exploratory study looking into the effectiveness/of biofeedback video games to help children diagnosed with ADHD. The study is investigating another biofeedback program called *The Journey to Wild Divine.* This interactive game uses three biofeedback finger sensors, 'Magic

Rings', to measure the player's HRV and SCL. Measurements from the sensors are registered through the Wild Divine 'Light Stone' and fed back to the player through visual events on the computer screen. The equipment monitors the player's physiological states and uses visual feedback to hep the player learn how to control these states, by balancing, releasing, or recovering from the situation they find themselves in.

The Journey to Wild Divine has combined biofeedback technology with relaxation and meditative techniques. Individually, these approaches have been shown to show positive effects on children with and without ADHD. Together, these processes can teach players how to recognise and control their body's internal states whilst receiving personal physiological information, in real time, and applying it away from the training site. These skills will be useful in situations at home or at school that may make the children feel anxious, frustrated, in need to calm themselves, and/or clear their mind. It is important to note that in today's contemporary society, children are growing up in a technologically advanced world (Yelland, 2005). It is not surprising then that the prospect of learning relaxation skills on clearing the mind, and calming the anxiety or frustration, or getting treatment through a video game would increase a child's interest and cooperation with biofeedback.

Players are provided with mentors who teach the art of controlling body rhythms through relaxation, and meditative breathing techniques, such as the "Peaceful Breath" and the "Heart Breath". For example, one of the activities requires a player to use the "Heart Breath", this is described as breathing in gently to the count of 5, and exhaling slowly to the count of 5, to create a pathway to reach the other side of the Wild Divine Island. Once the player has reached a stable breathing pattern of heart breath, they can then cross the pathway they've created and proceed to the next activity. However, if the player becomes frustrated, the biofeedback equipment will respond by hindering the player from moving on. Players will learn that only a state of calm will allow progression in the game.

Events in the game will respond according to the energy the player is experiencing. Successful progress in the game depends on the ability of the player to use the breathing techniques taught to accomplish an event. The game requires different movements between breathing patterns. In this way, players are taught how to better control their internal states of consciousness, learning awareness of how to make a more voluntary shift from one state to another as they play the game. That is, the children will learn to recognise when they are experiencing feelings of frustration, anxiety, or tension, and be able to consciously modify their physiological state to a more calm and relaxed state. These meditative-like breathing techniques bring together the frequency of the heart and brain, creating a positive balance between positive emotions and synchronisation between heart rate and breath, to help reach a physiological coherence.

This current study looks to determine the effectiveness of *The Journey to Wild Divine* as a suitable biofeedback program for children diagnosed with ADHD, compared with children without ADHD. A total of 38 children (age range= 5-15 years) and their parents (mean age= 38.12 years) have been recruited for the study. Twenty-six ADHD children (10 girls, 16 boys; ·mean age= 9.38) formed the experimental group, and 12 children without ADHD (3 girls, 9 boys; mean age= 8.75) formed the control group. Participants were further separated into Group One - attended sessions once a week for 12 weeks (12 sessions), and Group Two - three times a week for 8 weeks (24 sessions). This separation would help determine whether there is a difference between the number of sessions, or the frequency of sessions attended. Any changes from the children were measured through questionnaires - ADHD Symptoms Questionnaire based on the DSM-IV-TR (APA, 2000), the Strengths and Difficulties Questionnaire (SDQ) (Goodman, 1997), and the Depression, Anxiety, and Stress Scale (DASS) (Lovibond & Lovibond, 1995) completed as part of the parent's Diary entries at four stages of the study, combined with observations of heart rate graphs of the children's progression through the game, using The Wild Divine Grapher.

It is hypothesized that; (i) results may show whether ADHD children have demonstrated any reductions in the core ADHD symptoms (hyperactivity, impulsivity, and inattention); (ii) an involvement in biofeedback se?sions may produce significantly less, if any, side effects in comparison to a treatment plan involving medication as found in earlier studies, (iii) a difference in outcomes from children who attended

biofeedback sessions three times a week, to those who received sessions once a week, and (iv) parent's experiences with stress from their children's behaviour could decline with session progression.

Preliminary analysis of data shows pre-intervention scores of the experimental group higher in each of the ADHD symptoms (mean Inattention= 25.41, mean Hyperactivity= 16.54, mean Impulsivity= 8.34) scores, compared to the control group (mean Inattention= 10.25, mean Hyperactivity= 4.58, mean Impulsivity= 3.58) and not surprisingly higher in the SDO (mean= 26.65; abnormal), in comparison to the children in the control group (mean= 16.08; borderline). Interim results also demonstrate a difference in behaviour changes between each of the two groups in the experimental and control groups as reported by parents through each of the questionnaires completed as part of their Diary entries. Whilst not all participants have completed the sessions, thus are yet to complete their final Diary entry, both the experimental and control groups were found to show decreases in scores, demonstrating improvements in behaviour, analysed up to the third Diary entry. Scores are anticipated to continue to decrease to the fourth Diary, maintaining improved behaviour. Parents of ADHD children were also reported to have higher DASS scores in comparison to parents in the control group. Similarly, parents from both groups were also shown to have decreases in their depression, anxiety, and stress levels up to the third Diary, also anticipated to maintain improvement.

These preliminary findings demonstrate a difference between behaviour levels in children in the experimental and control groups, and differences in parent's mental health in these groups. Findings from this study show that this form of biofeedback has the potential to produce positive developments on ADHD symptoms, which may consequently produce improvements in reducing parental depression, anxiety, and stress levels, also.

Further scientific analysis of results following the completion of all participants will help report (i) the nature of *The Journey to Wild Divine* as an effective biofeedback video game for ADHD children, (ii) movement of changes to behaviour at certain intervals of the study, (iii) any differences of biofeedback effects between children who were taking medication whilst attending sessions, to those solely attending biofeedback sessions, and (iv) depression, anxiety, and stress levels experienced from parenting ADHD children, compared with children without ADHD.

Literature on the growing number of parents seeking, and using alternative treatments, in association with studies on biofeedback provide much justification for the need for further scientific research into alternative treatments for ADHD. Research by McCraty and Hunter Kane Ltd. have coordinated the groundwork into biofeedback video games and its potential for children and adolescents. Further work needs to be conducted with biofeedback video games, particularly with ADHD children, as it has been shown to have the ability to help teach skills that can create physiological coherence for improved concentration and attention to tasks and activities, and may also help reduce symptoms of hyperactivity and impulsivity.

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NOTE: For information only. This research is currently incomplete.