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Can children with AD/HD learn relaxation and breathing techniques through biofeedback video games?

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ABSTRACT

This study investigated *The Journey to Wild Divine* as a biofeedback management tool teaching breathing and relaxation skills to children with Attention-Deficit/Hyperactivity Disorder (AD/HD). The children played the game by manipulating their heart rate using breathing techniques taught in the game, measured through three finger sensors. Parents completed questionnaires to measure behavioural and emotional changes. In the experimental group, children with AD/HD (n= 24) demonstrated significant reductions in the AD/HD Questionnaire, $F(1,34)= 44.30$, and the Strengths and Difficulties Questionnaire, $F(1,34)= 19.90$, compared to a control group (n= 12). The Wild Divine has shown potential in teaching breathing and relaxation techniques to reduce disruptive behaviours in children with AD/HD.

INTRODUCTION

A child with Attention-Deficit/Hyperactivity Disorder (AD/HD) demonstrates an inability to sit still, concentrate, develop self control, and maintain consistent work performance (American Psychiatric Association [APA], 2000). Whilst pharmacological treatments have been the most prevalent use of therapy for AD/HD, issues of side effects (including nausea, headaches, insomnia, irritability, appetite suppression; Greydanus, 2005), the efficacy of medicating young children (Sparks & Duncan, 2004), and the possibility of future drug abuse (Barkley, et al., 2003) have led to the growing number of research towards alternative treatments (including dietary, counseling/therapy, yoga, and biofeedback). Such research provides greater treatment options for parents with children diagnosed with AD/HD (Sinha & Efron, 2005).

As evidenced by numerous studies, the positive effects of relaxation training in children include decreased dysfunctional behaviour, reduced stress and anxiety levels, alleviated

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headaches, encouraged reading achievement, improved self-concepts, and enhanced self-esteem (Margolis, 1990). Findings from previous research studies have shown the use of yoga and meditation to have positive benefits for children with AD/HD in improving concentration, classroom behaviours, and emotional developments (Harrison, Manocha, & Rubia, 2004). Similarly, the use of neurofeedback has shown improvements in AD/HD symptoms and related behaviours (Fuchs et al., 2003).

The current study explored the use of biofeedback video games. Biofeedback is a training technique which teaches individuals to recognise and modify their body's physiological signals to help improve health (Schwartz & Andrasik, 2003). This study used a readily available, off the shelf, computer and biofeedback program called "*The Journey to the Wild Divine*".

Early research by Chang (1991) and Margolis (1990) discussed relaxation methods which could be used to train children in child and youth care settings. Training included meditation procedures, autogenic training, progressive relaxation, abbreviated relaxation methods, visual imagery, and biofeedback training.

Meditation is described as creating a harmonious relationship between the mind and physical body, to create a state of silence and self-awareness (Harrison, Manocha, & Rubia, 2004). Chang (1991) highlighted four important elements to meditation needed to generate a relaxed state. These included; (1) a quiet environment, (2) an auditory, or visual stimulus, (3) passive attitude, and (4) a comfortable position. Autogenic training concentrates on the use of autosuggestions in which an individual internally repeats a specific autosuggestion, such as 'my heart is warm and has slowed to a steady pace', by which after maintaining focused attention on the process the desired affect is achieved, and physiological relaxation follows (Chang, 1991; Goldbeck & Schmid, 2003). Progressive relaxation is described as a procedure in tensing then relaxing various muscle groups, to teach an individual the contrast between tension and relaxation. Individuals develop the ability to relax muscles at will, and by learning to relax particular muscle groups on cue, muscles discreetly relax throughout the day, not only when it is needed (Chang, 1991; & Margolis, 1990). Abbreviated relaxation methods include; (1) cue-controlled relaxation involving pairing a relaxed state and a cue, such as the use of cue words (for example, 'peace', or 'calm') to condition the relaxed state and the stimulus – the cue word, and (2) quieting response training which works as an arousal shifting technique for use in a demanding situation. This method uses cues, self-suggestion, and progressive relaxation exercises to teach behavioural and physical cues for tension awareness, deep breathing, and differential relaxation to adapt to difficult situations (Chang, 1991). Visual imagery has been described as a simple technique to teach individuals to imagine peaceful scenery while lying down, or closing their eyes, and focusing on their breathing and visualising images and scenery. The combination of audio tapes adds an attractive element in helping the individual imagine a peaceful rainforest whilst listening to the sounds of light rain drops, peaceful bird sounds, and light background music (Margolis, 1990).

Chang (1991) and Margolis (1990) reported that, when conducted appropriately, relaxation 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.

Recent studies at the Institute of HeartMath in the United States of America, have explored the use of heart rhythm coherence biofeedback in a classroom setting to teach students important skills in increasing emotional self-management, self-awareness, promoting effective communication, and practicing responsible behaviours, by managing their physiological internal states (McCraty, 2005; McCraty et al., 1999). There are important connections between emotions, learning, and performance. When emotional stress negatively affects learning and performance, the connection between nervous system activity and the brain is distorted, limiting important cognitive processes essential for clear thinking, memory, problem solving and reasoning, and attention (Arguelles, McCraty, & Rees, 2003, McCraty, 2005). Thus, an association between positive emotions and cognitive functions demonstrates that during positive emotional states,

rational and consistent signals are sent to the brain coordinating nervous system activity, generating high cognitive states, termed *physiological coherence* (McCraty & Tomasino, 2006). Individuals create a harmonious state between the body, brain, and nervous system. Evidently, this can be done through the use of HeartMath learning tools. These tools enable individuals to recognize stress reactions in order for them to intercept and modify their responses to these situations, and develop their ability to maintain positive emotions and physiological coherence for longer periods (Arguelles, McCraty, & Rees, 2003; McCraty & Tomasino, 2006).

The Wild Divine Project provides players with on screen mentors who teach the art of controlling body rhythms through relaxation, and meditative style breathing techniques, such as the "Peaceful Breath" and the "Heart Breath", to help improve health (Hall, 2004; Johnson, 2003). Three sensors are placed on the player's fingers to measure heart rate (HR) and skin conductance levels (SCL). Physiological changes are measured through the ring sensors and are reflected through the video game by means of on screen activities. For example, one activity requires a player to use the "Heart Breath"; this was 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 are then able to cross the pathway they created and proceed to the next activity. However, if the player becomes frustrated, the biofeedback equipment will measure the increase in heart rate and respond by hindering the player from moving on. Players will learn that only a state of calm, through slow even breathing, would allow progression in the game.

There is a lack of scientific research into biofeedback video games through measurements of HR and SCL with AD/HD children. Positive preliminary results from recent biofeedback studies (Hunter Kane, 2003, 2006; McCraty, 2005) and previous research on relaxation training with children provides a foundation to the potential for the use of The Journey to Wild Divine video game to help children with AD/HD.

In today's contemporary society, with an increasing number of game-based applications being applied in educational and health care settings, children are growing up in a technologically advanced world (Kiili, 2005; Yelland, 2005). The appeal then, of biofeedback therapy through a video game format, serves as a high incentive to connect a child or young adolescent to participating in the treatment.

The aim of this study was to determine whether children with AD/HD were able to learn relaxation techniques through breathing skills taught through the Wild Divine biofeedback video game, and show this to be an acceptable alternative treatment to help reduce symptoms of AD/HD. It is hypothesised that attending biofeedback sessions will teach children with AD/HD, appropriate relaxation skills that will help reduce disruptive behaviour. It is also hypothesised that children who attended sessions more than once a week, would have a greater significant reduction in symptoms than those who attended sessions only once a week.

METHODS

Participants

A research project website (www.adhdresearch.info) was created to promote the study and recruit interested families. The project website is linked to various online AD/HD organisations to present our work to interested families. Research pamphlets were also distributed to AD/HD organisations, specialists, and health care centres.

Upon recruitment, both the experimental and control groups were further divided into two groups – Group One, attended biofeedback sessions once a week for 12 weeks (12 sessions), and Group Two, attended sessions three times a week for 8 weeks (24 sessions). This separation would help determine whether a difference between the amount and frequency of sessions

attended, would arise. To ensure a high attendance rate, parents chose which group they wished to attend.

The experimental group included a total of 24 children with AD/HD (15 males, and 9 females; mean age 9.50 years), and their parents (1 male, and 18 female; mean age = 38.79 years). Group One (once a week) included 17 children and Group Two (more than once a week) included 7 children. Parents provided written reports and psychological tests conducted with their children, which demonstrated that 83.3 percent of children were diagnosed with AD/HD by a primary health care professional (general practitioners, and paediatricians), and 16.7 percent were diagnosed by allied health care professionals (psychologists and psychiatrists). 62.5 percent of children were taking medication for AD/HD, 92.3 percent of which were taking stimulant medications (eg. Ritalin), and 7.7 percent were taking non-stimulants (eg. Straterra).

The control group included 12 children not diagnosed with AD/HD (9 males, and 3 females; mean age = 8.75 years), and their parents (8 female; mean age = 38.38 years). Group One included 10 children and Group Two included 2 children.

Procedure

The project received ethics approval from The University of Sydney, Ethics Board. Experiments were held at The University of Sydney, Faculty of Health Sciences Campus, in Australia. With only one researcher present for the experiments, biofeedback sessions allowed for a maximum of three children on separate computers at any one time. The room was arranged with desks in three rows, with one laptop per desk, aligned so that the children cannot directly see the other children in front or behind them. In sessions with more than one child, the children used headphones to minimise sound disruption from the other laptops. Both the experimental and control groups attended 45 minute biofeedback sessions to play the same biofeedback video game.

The role of the researcher during the session was to help guide the child through the game where they may have needed direction of where to go next, or aided in motivating with the breathing technique required for an activity. The researcher demonstrated examples of how to breathe and helped count breaths to assist relaxation, but in no instance did the researcher wear the biofeedback rings to demonstrate how to complete an activity.

Measures

To measure any changes, parents were required to complete online questionnaires as part of their Diary at four stages of the study. Baseline scores were measured at pre-intervention, in Diary 1, Diary 2 was to be completed after the first month of session, Diary 3 was to be completed after the second month of sessions, and Diary 4 was to be completed after the third month of biofeedback sessions. The Diary entries included an AD/HD Questionnaire, the Strengths and Difficulties Questionnaire (SDQ) (Goodman, 1997), and a Questionnaire on the Wild Divine video game.

Demographic Questions

This non-standardised 13-item questionnaire was created by the researchers to focus on the background of the parent filling out the questionnaire (4 items), and their child/ren undergoing the biofeedback experiments (9 items). Questions asked about the parents included their gender, age, occupation, etc. Questions regarding their children included gender, age, type of professional who diagnosed their child (for example, psychologist, psychiatrist, paediatrician), etc. This questionnaire was only asked in the first Diary. These questions would help provide a demographic outline of the participants involved in the study.

Strengths and Difficulties Questionnaire

The SDQ measured social, emotional, and behavioural functioning in children and adolescents. With a five-factor structure, the SDQ includes 25 positive and negative attributes with response options on a 3-point Likert scale (0= not at all, 1= a little, sometimes, and 2= very much, all of the time; for the positive attributes; and reverse scores for the negative attributes) to indicate how far each attribute applies to the child or adolescent. Responses for each item are grouped into one of five domains; Conduct Problems, Emotional Symptoms, Inattention-Hyperactivity, Peer Problems, and Prosocial Behaviour. The Total Difficulties Score is generated by summing all domains, but the Prosocial Behaviour subscale. Cut off scores are banded into the following; 0-13= Normal, 14-16= Borderline, and 17-40= Abnormal (SDQ completed by parents).

AD/HD Questionnaire

Researchers created a non-standardised questionnaire involving questions targeting specific AD/HD symptoms. This AD/HD Questionnaire incorporated 18-items which presented parents with AD/HD symptoms derived from the Text Revision of the Diagnostic and Statistical Manual for Mental Disorders (DSM-IV-TR) (APA, 2000) regarding inattention, hyperactivity, and impulsivity. The questions asked parents to rate how often their children presented several scenarios that resemble these symptoms on a 5-point scale, ranging from 1= Never, to 5= All of the time. The higher the total score, reflects the greater severity of symptoms. This questionnaire was asked in every Diary to assess improvements, deteriorations, or stability in the movements of the children's behaviour following biofeedback, throughout the study.

Wild Divine Questionnaire

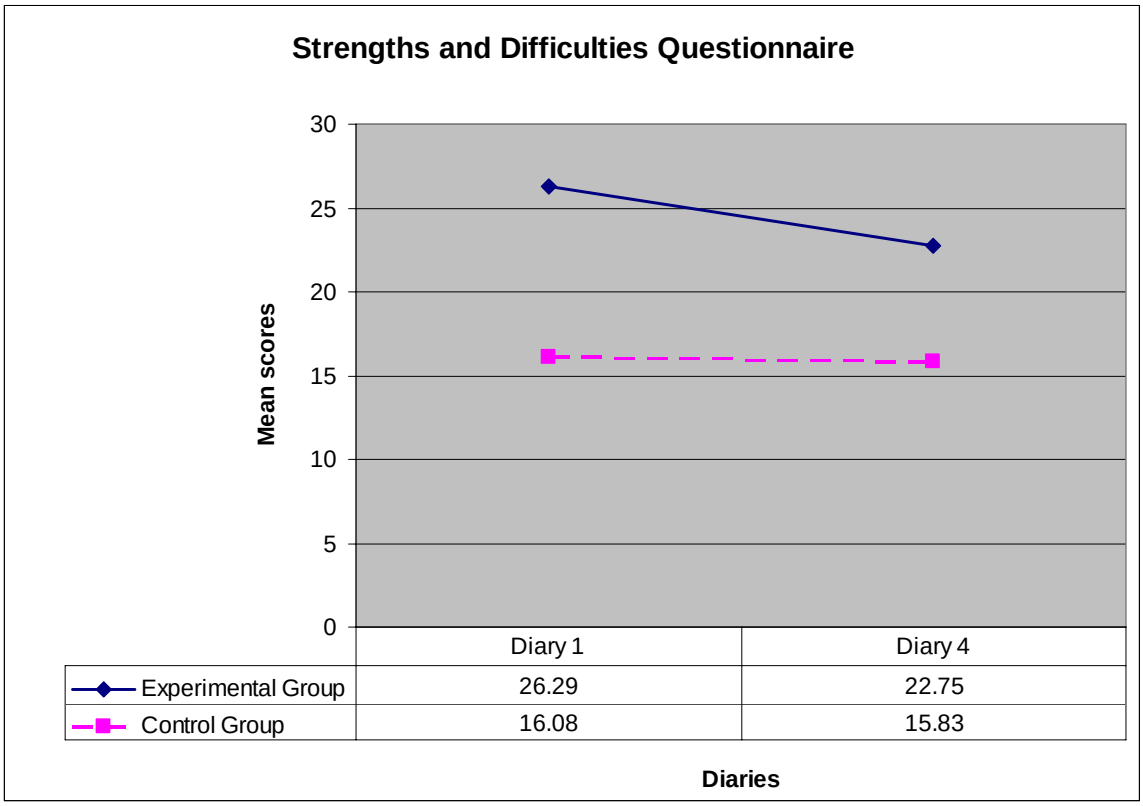
A 7-item non-standardised questionnaire was created based on the experience of the Wild Divine game as a biofeedback system following sessions. Questions included, "On a scale of 1-5 how difficult did your child find the Wild Divine Program?" (1= easy, 2= little bit easy, 3= somewhat difficult, 4= very difficult, 5= frustratingly difficult); and "Has your child experienced any side-effects from the use of the biofeedback video game?" (Yes/No); "If you answered yes, what were they?" etc. The higher the total score, the more difficult the child found the game, and the worse the behaviour had regressed. And, the lower the total score, a more positive effect. This part of the questionnaire was included in every Diary following the first (that is, Diary 2, Diary 3, and Diary 4).

RESULTS

Strengths and Difficulties Questionnaire

The Strengths and Difficulties Questionnaire measured social, emotional, and behavioural functioning in the children who participated. An independent samples t-test was conducted to compare scores on the SDQ from participants in the experimental group (M= 26.29, SD= 6.06), and control group (M= 16.08, SD= 4.37), and found a significant difference in scores between the two groups, $t(34)= 5.18$, $p<.05$ (2-tailed). SDQ results placed children in the experimental group under the "abnormal" category range (M= 26.29, SD= 6.06), and children in the control group under the "borderline" category (M= 16.08, SD= 4.37), at pre-intervention. Results reported in Diary 4 show that the experimental group remained under the "abnormal" category (M= 22.75, SD= 6.38), and likewise, the control group remained "borderline" (M= 15.83, SD= 4.73) (Figure 1).

Figure 1: Mean pre- and post-intervention scores for experimental and control groups reported in the Strengths and Difficulties Questionnaire.



Multivariate analysis of variance (ANOVA) tests show a substantial main effect for time between Diary entries, Wilks' Lambda= .80, $F(1, 34)= 8.28$, $p<.05$, and a significant interaction was found between experimental and control group and time, Wilks' Lambda= .84, $F(1,34)= 6.24$, $p<.05$. A between-subjects ANOVA also found the main effect comparing experimental and control groups to be significant, $F(1,34)= 19.90$, $p<.05$.

In the experimental group, Group One (attended sessions once a week, n=17) results revealed a statistically significant reduction in SDQ scores from pre-intervention, $t(16)= 4.14$, $p<.05$, however reductions for Group Two (attended sessions three times a week, n=7) were non-significant, $t(6)= 1.53$, $p>.05$. Due to the small and uneven nature of the sample size, non-parametric tests were conducted to confirm parametric findings. A Wilcoxon Signed Rank Test also revealed a statistically significant reduction in scores in Group One, $z= -3.19$, $p<.05$, $r= .54$, but was non-significant for Group Two, $z= -1.47$, $p>.05$, $r= .25$.

An ANOVA assessed the impact of attendance frequency on participant scores at the two time intervals (pre-intervention, Diary 1: M= 26.82, SD= 5.18); and post-intervention, Diary 4: M= 25.00, SD= 8.14). Multivariate test results found no significant interaction between attendance frequency and time across the two time periods, Wilks' Lambda= .93, $F(1,22)= 1.48$, $p>.05$. The main effect comparing attendance frequency was non significant, $F(1,22)= .78$, $p>.05$, suggesting no difference in the effectiveness of attending sessions three times a week, over once a week.

In the control group, paired samples t-tests found no significant change in SDQ scores following intervention for either Group One ($M_{(pre)}= 17.10$, $SD_{(pre)}= 3.95$, $M_{(post)}= 11.00$, $SD_{(post)}= 2.82$), $t(9)= -.10$, $p>.05$, or Group Two, ($M_{(pre)}= 17.20$, $SD_{(pre)}= 3.82$, $M_{(post)}= 9.00$, $SD_{(post)}= 1.41$, $t(1)= 2.00$, $p>.05$. This non-significant finding was confirmed through a Wilcoxon Signed Rank

test for both Group One, z= -.28, p>.05, r= .06, and Group Two, z= -1.34, p>.05, r= .64. Whilst both Groups demonstrated a reduction in scores, no significant interaction was found between attendance frequency and time, Wilks' Lambda= .92, F(1,10)= .79, p>.05. However, a between-subjects ANOVA found the main effect comparing attendance frequency was significant, F(1,10)= 7.22, p<.05. This significant difference suggests an effectiveness of attending either sessions weekly, or three times a week, for participants in the control group.

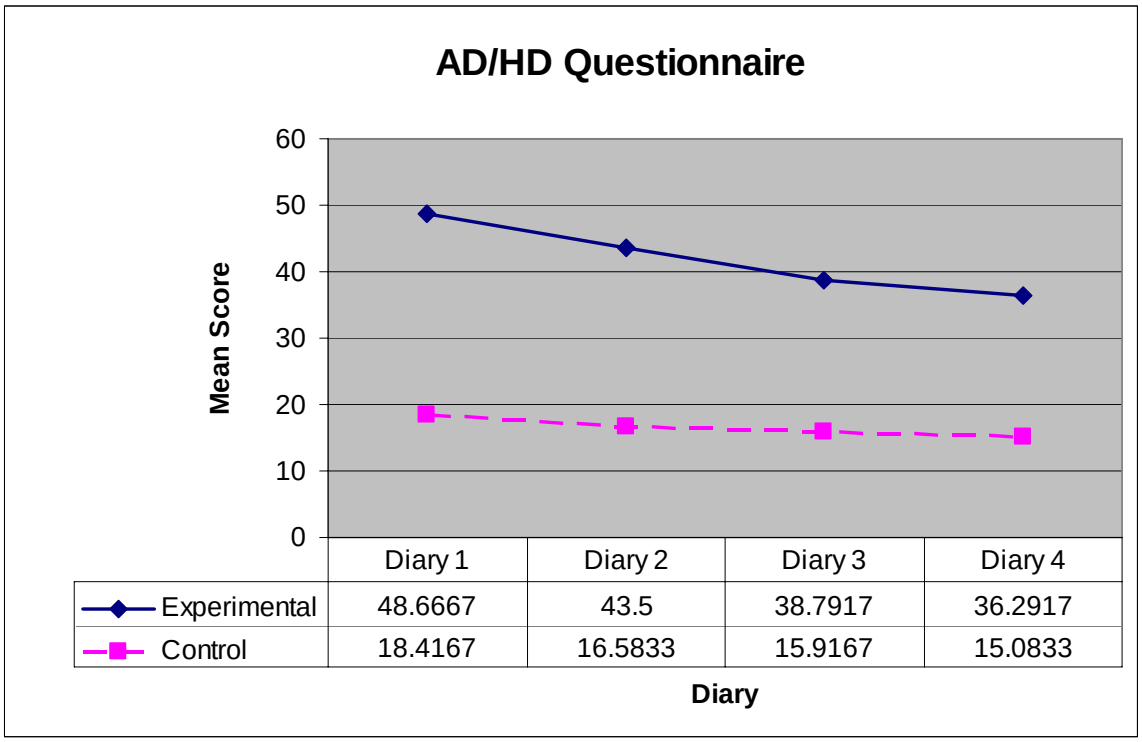
AD/HD Questionnaire

The AD/HD Questionnaire measures levels of inattention, hyperactivity, and impulsivity as reported in the DSM-IV, in the children throughout the study. An independent samples t-test found a significant difference between results from the experimental (M= 48.66, SD= 9.11) and control groups (M= 18.41, SD= 13.39), t(34)= 8.00, p<.05, showing a great difference in AD/HD symptom levels between children diagnosed with AD/HD and typically developed children.

ANOVA tests show a substantial main effect for time over the four Diaries, Wilks' Lambda= .53, F(3, 32)= 9.23, p<.05. There was also a significant interaction found between experimental and control group and time, Wilks' Lambda= .75, F(3, 32)= 3.44, p<.05. A between-subjects ANOVA also found the main effect comparing experimental and control groups was significant, F(1,34)= 44.30, p<.05.

Through closer analysis of results from the experimental group (Diagram 2), t-tests were able to show the movement of change in the children's behaviour during intervention. There was a statistically significant decrease scores between Diaries 1 and 2, t(23)= 3.02, p<.05, and Diaries 2 and 3, t(23)= 3.55, p<.05, but whilst there were further reductions in scores between Diaries 3 and 4, the changes were not found to be significant, t(23)= 1.77, p>.05, revealing a possible plateau period during the last month of sessions.

Figure 2: Mean scores for experimental and control groups between Diaries for the AD/HD Questionnaire.



When the participants in the experimental group were separated into Group One (attended sessions once a week, n= 17) and Group Two (attended sessions more than once a week, n= 7), the changes reported in Group One were significant between Diaries 1 and 2, $t(16)= 3.71$, $p<.05$, and Diaries 2 and 3, $t(16)= 3.09$, $p<.05$, but non-significant between Diary 3 and 4, $t(16)= 1.59$, $p>.05$. However, Group Two demonstrated no significant changes between either Diaries 1 and 2, $t(6)= .83$, $p>.05$, Diaries, 2 and 3, $t(6)= 1.63$, $p>.05$, or Diaries 3 and 4, $t(6)= .74$, $p>.05$. An ANOVA assessed the impact of attending biofeedback sessions once a week or more than once a week across the four time intervals at Diary 1, Diary 2, Diary 3, and Diary 4. Multivariate tests show no significant interaction between frequency of sessions attended and time, Wilks' Lambda= .95, $F(3,20)= .32$, $p>.05$. The main effect comparing the frequency of sessions attended, was non-significant, $F(1,22)= 1.52$, $p>.05$, suggesting no difference between participants who attended sessions once a week, to those who attended three times a week.

In the control group, no significant interaction was found between attendance frequency and time from between Diaries, Wilks' Lambda= .88, $F(3, 8)= .33$, $p>.05$. A between-subjects ANOVA also found the main effect comparing attendance frequency was non-significant, $F(1,10)= 3.88$, $p>.05$, suggesting no effectiveness of attending either sessions weekly, or three times a week.

Wild Divine Questionnaire

The Wild Divine Questionnaire aimed at asking specific questions targeting the experiences of the use of The Wild Divine video game. Parents were asked to answer the following questions based specifically on the experience and following use the biofeedback video game.

Majority of children in the experimental group (70.8%) were reported to find the game 'Somewhat difficult'. By the end of the study, most children (58.3%) still found the game 'Somewhat difficult'. In the control group, the majority of children (83.3%) were reported to find the game 'Somewhat difficult'. By the end of the study, most of the children (58.3%) still found the game 'A little bit difficult'. Independent samples t-test revealed no significant differences in difficulty levels between the experimental and control groups at either Diary 2, $t(34)= .24$, $p>.05$ after the first month of session, or post-intervention scores in Diary 4, $t(34) = 1.50$, $p>.05$.

The questionnaire asked the parent's if their children practiced the breathing techniques they learnt through the game, away from the sessions. Independent samples t-test results between the experimental group and control group demonstrate no differences whether the children practiced their breathing away from the sessions or not, $t(34)= 14$, $p>.05$. Table 1 demonstrates that at each Diary, majority of parents in the experimental group reported that their children did practice the breathing techniques they learnt through the game, while they were away from the sessions. Multivariate tests show that there was no significant change in reports of the children using the breathing techniques away from the sessions, over the duration of the study, Wilks' Lambda= .96, $F(2,22)= .38$, $p>.05$.

Of the parents in the control group who reported their children did use the breathing techniques away from the sessions, results from Diary 2 reveal 10% answered that practicing the breathing helped "yes, a lot", 70% answered "yes, a little", and 20% answered "no, not really". Post-intervention results from Diary 4 reveal that 25% answered "yes, a lot", and 75% "yes, a little". This was different in the control group whereby Diary 2 results show that all parents felt that practicing the techniques at home helped "yes, a little". However, by the end of the study, 75% answered "yes, a little", and 25% answered "no, not really". Independent samples t-tests show that the differences between experimental and control group in Diary 2 was non-significant, $t(9)= .55$, $p>.05$. However, the difference in Diary 4 was significantly different, $t(18)= -2.40$, $p<.05$, which suggests that by the end of the study, parents in the experimental group found practicing their breathing at home, or at school, to be more beneficial than parents in the control group.

Table 1: Frequency and percentages of participant's use of breathing techniques used away from the sessions.

			Frequency	Percent	Valid Percent	Cumulative Percent
Diary 2	Valid	Yes	10	41.7	41.7	41.7
		No	5	20.8	20.8	62.5
		Don't know	9	37.5	37.5	100.0
		Total	24	100.0	100.0	
Diary 3	Valid	Yes	12	50.0	50.0	50.0
		No	5	20.8	20.8	70.8
		Don't know	7	29.2	29.2	100.0
		Total	24	100.0	100.0	
Diary 4	Valid	Yes	13	54.2	54.2	54.2
		No	3	12.5	12.5	66.7
		Don't know	8	33.3	33.3	100.0
		Total	24	100.0	100.0	

The Questionnaire included the question "*From the last Diary, did you find any changes with your child's behaviour and temperament, as a result of the biofeedback sessions*?". After the first month of sessions (reported in Diary 2), majority of parents (62.5%) reported their child demonstrated "no change". By the end of the study (reported in Diary 4), majority of parents (54.2%) reported their child had a "slight improvement". A paired samples t-test was conducted to evaluate changes in this question that the parent's observed in the children's behaviour following biofeedback sessions. There was a significant difference between Diaries 2 ($M= 2.79$, $SD= .78$) and 4 ($M= 2.21$, $SD= .66$), $t(23)= 2.93$, $p<.05$, $r= .27$. Which demonstrates that the parents believed their children experienced improvements in their child's behaviour. Despite the improvement in behaviour between Diaries 2 and 4, there was a deterioration in scores between Diaries 3 and 4. Thus, whilst there was a significant change between Diaries 2 and 3, $t(23)= 3.49$, $p<.05$, the increase in scores between Diaries 3 and 4 was non-significant, $t(23)= -.24$, $p>.05$.

In contrast, the change between Diaries 2 ($M= 2.67$, $SD= .49$) and 4 ($M= 2.75$, $SD= .45$), in the control group were non-significant, $t(11)= -.43$, $p>.05$. Thus, a between-subjects test found the difference in changes reported by parents between experimental group and control group to be significant, $F(1,34)= 4.31$, $p<.05$.

Results from Diary 2 show that 25% of children in the experimental group demonstrated side effects after the first month of biofeedback sessions. Side effects included dizziness (20%), emotional/teary (20%), feeling tired (20%), lack of appetite (20%), and tantrums (20%). In Diary 3, 8.3% of children were reported to experience side effects, which only included hyperactive behaviours (100%) Then, in Diary 4, 16.7% of children demonstrated side effects, of which included feeling tired (25%), and hyperactivity (75%). Regardless of the decrease in the experience of side effects over the sessions, multivariate ANOVA tests found no significance of change over time, across the three Diary entries, Wilks' Lambda= .87, $F(2,22)= 1.57$, $p>.05$. No children in the control group were reported to experience side effects.

DISCUSSION

The study aimed to explore the use of biofeedback video games to teach relaxation skills to children aged between 5 and 15, diagnosed with AD/HD. Including children without a diagnosis of AD/HD, as a control group, was integrated to determine the effectiveness of The Journey to Wild Divine to help children with AD/HD, in comparison to children without AD/HD. It would not be ethically viable to use a waitlist control group, because research has shown there are treatments for AD/HD that would help manage AD/HD behaviour. A placebo group with children with AD/HD being treated with an imitation biofeedback system would also be unethical and inappropriate given that both the participants and researchers would be able to distinguish between The Wild Divine biofeedback video game, and a pseudo biofeedback system. Researchers would also be able to distinguish between different biofeedback video games, for example, The Wild Divine, and HeartMath's Freeze Framer.

The experimental group differed significantly in the AD/HD Questionnaire and SDQ, which is important as the experimental group included children diagnosed with AD/HD, and were expected to report high scores, compared to children not diagnosed with AD/HD in the control group with significantly lower scores.

Analysis of results demonstrate a number of significant differences in behaviour changes between participants in the experimental and control groups, as reported by parents through each of the questionnaires completed as part of their Diary. Based on the results demonstrated, the first hypothesis can be accepted as both the experimental and control group had significant reductions in the SDQ and the AD/HD Questionnaire, resulting in improvements in behaviour by the final session.

However, although there was a significant change from Diary 1 to Diary 4 on the AD/HD Questionnaire, significant changes occurred between Diaries 1 and 2, and Diaries 2 and 3, but there was no significant change between Diaries 3 and 4. This did not occur in the control group, where no significant differences were found throughout all Diaries. This suggests that after an initial improvement on AD/HD symptoms, the effect of biofeedback training plateaus. Researchers speculate that because many of the children were going back to repeat activities in the last few weeks of the study, this may have reduced the children's interest, and stimulation. This in effect, may have reduced the efficacy of biofeedback, causing the plateau. Further research needs to look at how the video game can produce greater stimulation to extend beyond 12 weeks.

Analysis of results from the AD/HD Questionnaire revealed no significant differences in scores of either experimental or control groups when participants were separated into Group One or Two. However, results revealed a significant difference in the SDQ scores found in the control group. That is, parents in the control group found attending sessions either once or thrice a week to be more beneficial. Whilst the difference in pre- and post intervention scores were non-significant in both Groups One or Two, when compared, the analysis demonstrated a difference in attendance frequency, where reductions in scores show Group Two to have a greater change in behaviour scores. Thus, at this stage the second hypothesis is neither supported nor rejected. Participants in each group did show improvements in behaviour, shown through the decrease in scores, through the duration of the 12 weeks. However, further testing needs to be conducted with a greater sample size to determine the benefits of attendance frequency.

Over 66% of participants who experienced side effects in Diary 2 were reported to be taking medication. The side effects listed by parents are similar side effects reported in literature linked to side effects experienced with the use of medications. For example, the side effects listed by parents included dizziness, emotional/teary, and lack of appetite, which are frequent side effects reportedly cited following the use of both stimulants and non-stimulants (Greydanus, 2005). Therefore, whilst no participants in the control group experienced side effects, the side effects

reported in the experimental group may or may not have, been the effect of the biofeedback intervention, the medication, or a combination of both.

Results form The Wild Divine Questionnaire found all children experienced the same level of difficulty throughout the study. This demonstrates that children as young as 5 years of age, with or without AD/HD diagnosis can use and learn breathing techniques through the biofeedback video game.

A great number of participants in both experimental and control groups exercised the breathing techniques learnt through the video game either at home, at school, or elsewhere away from the sessions. However, whilst parents from both groups felt that it helped the behaviour of their children following the first month of session, by the end of the study parents from the control group did not feel it was as beneficial as parents in the experimental group. Therefore, whilst the children are able to learn breathing and relaxation skills through the video game, as shown through the number of participants who were reported to use these techniques away from the sessions, future research should consider a way to involve teaching the parents the skills and linking the skills with situations that parents would know to initiate the use of the breathing techniques to help control the behaviour and/or situation.

The study was limited in the small and uneven sample sizes used. The experimental group was able to recruit a total of 24 participants, of which 17 were in Group One and 7 in Group Two, and the control group recruited 12 participants, with 10 in Group One and 2 in Group Two. Researchers experienced greater difficulty in recruiting participants for the control group, as the intervention was targeted at investigating the biofeedback system as a way to help manage AD/HD symptoms. To overcome this limitation in the analysis, non-parametric tests were used to confirm findings from parametric tests applied.

Whilst allowing parents to choose which sessions they would attend limited the study from random allocation. The choice aimed to help increase involvement in continued participation, and reduce dropout rates, as parents would decide when they are able to work around their own personal schedules to attend the sessions. In a similar sense, Fuchs et al. (2003) revealed that while allowing parents to choose which treatment Group they were to attend resulted in a high compliance rate, it may have also influenced how parents were motivated to rate in their questionnaires given they were in their preferred Group. Researchers justified this by stating that it would not be feasible to administer treatment plans without parent's consent or continued attendance.

With the support from previous relaxation and biofeedback research studies, findings from this study show that the Wild Divine video game, as a biofeedback system, has the potential to produce positive developments on AD/HD symptoms and disruptive behaviours, with few side effects. The video game used biofeedback technology and combined relaxation techniques reported by Chang (1991) and Margolis, such as the use of meditation procedures, abbreviated relaxation methods, and visual images and auditory stimulus. It is not surprising that in this generation of technically advanced children, participants in this study took great interest and was stimulated with the therapy, through the video game format. Further research however, needs to explore long term effects of biofeedback on a greater number of participants, as it has been shown to have the ability to help teach skills that can help improve concentration and attention to tasks and activities, and may also help reduce the core symptoms of AD/HD.

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