BOYS WITH CHALLENGING BEHAVIOURS: THE EFFECTS OF PHYSICAL EXERCISE ON INATTENTION, HYPERACTIVITY, AND IMPULSIVITY

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Research indicates that challenging behaviours such as poor attention, hyperactivity, and impulsivity, commonly associated with ADHD, have a significant effect on school age children and are more likely to be found in boys. In this field case study, four 12-year-old boys were trained in a controlled, intense exercise programme that focused on planning and persistence. It was predicted that this programme might improve attention and decrease hyperactivity and impulsivity. The training was conducted before school, 3 days a week over a 7-week period, in a nonschool setting. Observations of classroom behaviour were made during morning sessions following the intervention. Pre- and post-testing on the teacher rating scale of the Child Behaviour Check List (Achenbach, 1992) produced improved scores in the combined inattentive-hyperactive category. It was concluded that structured physical activity containing behavioural and cognitive training elements are likely to modify some challenging behaviours in boys. Although the small number of participants involved in this study and the short period of time over which the study was conducted are limiting factors, these data suggested that a more detailed examination of this type of intervention is warranted.

Boys with challenging behaviours

Three behaviours of concern for parents are poor attention, hyperactivity, and impulsivity. These behaviours have been regularly reported by teachers and used to identify two conditions known as Attention Deficit Disorder (ADD) and Attention-Deficit Hyperactivity Disorder (ADHD). Although there is considerable research in the area, disagreement about etiology and, to a lesser extent, diagnosis exists (Barkley, Du Paul, & MacMurray, 1990). The condition is currently defined by the Diagnostic and Statistical Manual-IV (American Psychiatric Association, 1994) as a disorder with three distinct clusters of behaviours: predominantly inattentive, predominantly hyperactive-impulsive types, and combined. It may be more general in the population of school-aged boys than defined by a diagnosis of ADHD (Sagvolden, 1999).

Research into ADHD covers a wide perspective of medical, psychological and educational speculation about prevalence and comorbidity, cause and treatment (Purdie, Hattie, & Carroll, 2002). There are some points of general agreement. ADHD is a highly prevalent disorder (Robinson, Sclar, & Skaer, 1999) with estimates that ADHD affects up to 6% of children, accounts for 50% of child psychiatry clinic referrals, and has proven comorbidity with other conditions, including Asperger's Syndrome (AS), Oppositional Defiant Disorder (ODD), Conduct Disorder (CD), Tourette's Syndrome (TS), Obsessive/Compulsive Disorder (OCD), anxiety, depression and a number of learning and speech/language disorders (Kewley, 1999). The condition seems to have most effect within the population of school-aged children. It generally manifests prior to age 7 and is more common in boys (Sagvolden, 1999).

Research indicates that the condition might result from deficiencies in neurological development (Tripp & Ryan, 2002), affecting the operation of neurotransmitters in regions of the brain and central nervous system that are linked to motor and cognitive functioning and, in particular, areas related to response delay and executive functioning (Edwards & Barkley, 1997). It has been widely accepted that a predisposition to ADHD arises from neurochemical and neuroanatomical factors likely to be genetically linked (Karmiloff-Smith, 2002), and research using positive emission tomography (PET) has established links between ADHD causes and genetic values. Deficiencies in the development of neural connections and levels of chemical transmitter substances regarded as important components of normal processing have been identified (Chugani, Phelps, & Mazziotta, 2002). Deficiencies have been linked to the areas of the brain and central nervous system that are known to control cognitive development, motor development, and certain behaviours, particularly those involving aggression (Aman, Roberts, &

Pennington, 1998; Diamond, 2002). Transmitter substances like serotonin (Mizek, Fish, De Bold, & De Almeida 2002), and dopamine (Nieoullon, 2002), have been examined both for effect and for hereditability (Ernst et al., 1999; Wigg, Zai, Schacher, & Tannock, 2002). The idea that food additives are a major reason for inattentive, hyperactive, and impulsive behaviours remains unproven (Henker & Whalen, 1989). However, continuing research into food chemistry, particularly in areas like protein synthesis, may yet provide acceptable evidence to support such theory (Liu, 1997; Stefanis, Kholodilov, & Rideout, 2001).

Studies examining attention, hyperactivity, and impulsivity as cognitive and behavioural constructs have often defined these conditions as attention, regulation of response, and response inhibition. These studies have acknowledged the role of self-regulation, rule-governed behaviour, and executive function with deficits in working memory, internalisation of self-directed speech, self-regulation of emotions, and rule governed behaviour being seen as contributing factors (Barkley, 1997). Response inhibition, the capacity to delay a response to a signal or event, is believed to regulate the development of higher functioning through language. In this model, language controlled response is contrasted with an emotional response that is less reflective and more impulsive. This research into higher order thinking, which has suggested that disruption to executive function accounts for disorders such as ADHD (Barkley, 1997; Seidman, Biederman, Monteaux, Doyle, & Faraone, 2001), offers educators some direction for developing effective strategies that would allow students to manage learning tasks.

Research into ADHD has been strongly influenced by medical and psychological views, which has influenced treatment and management approaches. The most commonly used treatment intervention involves the use of stimulant medications (methylphenidate and dexamphetamine), which appear to improve neurotransmitter activity in certain areas of the brain thought to be important for control of attention. These medications are considered to be generally effective in controlling the symptoms of ADHD (Tannock, 1999). Although evidence of widespread, severe side effects has not been proven, some medical authorities claim that the use of stimulant medication has the long-term potential to be harmful (Baughman, 1999; Breggin, 2000). Baughman and Breggin have supported a more generally held belief that ADHD is purely one expression of the diversity that exists within the range of normal human behaviour, albeit challenging and at times disruptive to group regulation, not a disease requiring a medical quick fix.

There is evidence to support the efficacy of cognitive and behavioural therapies (Miranda, Presentacion, & Soriano, 2002). Some key elements of behaviour and cognitive therapies include manipulation of behaviour triggers, operant conditioning of competing behaviours, and identification of distorted and unhelpful thought processes. These therapies, although costly, have proven effective in treatment of ADHD, and there is some support for these treatment approaches to be combined with stimulant medication (Johnston & Leung, 2002). Research into behavioural interventions, which have commonly been used to improve student performance generally, has led to recommendations that interventions be used as an adjunct to medication (Henker & Whalen, 1989).

A search using attention deficit hyperactivity disorder as a key phrase uncovered up to 2,546 citations in the period from 1990 to 1999, an increase of 800% over a similar period, 10 years earlier (Purdie et al., 2002). Based on a meta-analysis of 74 studies of ADHD interventions, they concluded that "sustained and deliberate attempts at educational interventions are necessary, and it is most likely that those educational programmes and interventions that work with other students are also effective with ADHD students. It is also likely that the educational interventions that work with ADHD students work whether the ADHD students are medicated or not" (Purdie et al., 2002, p. 89). Most interventions based on medical and psychological studies have claimed to influence educational outcomes even though an educational perspective is not represented in the program.

There is little doubt that inattentiveness and poor focus is a serious problem that can have a large and disruptive effect within the home and the school. These problems have challenged schools to provide learning environments that compensate for the difficulties in individual and group learning that these deficiencies create (Gordon, 1994). There is evidence that schools should use interventions that combine a number of treatment approaches with parents, teachers, and other professionals collaborating to achieve more effective learning outcomes for children who are inattentive, hyperactive, and impulsive (Miranda et al., 2002).

Exercise

Although the precise effect of exercise on ADHD has not been widely documented, there is some evidence that a physical programme controlling energy expenditure may produce effects similar to those achieved in treatment using stimulant medication with benefits for central nervous system processing

(Butte et al, 1999; Spivak et al., 1999). Speculation about movement as a predictor of the disorder has uncovered links between delayed early motor development and subsequent display of ADHD behaviours (Kroes, Kessels, Kalff, & Ferron, 2002). Sports physiologists have found that moderate exercise leads to an increase in circulating catecholamine levels, affecting various parts of the body, including the brain (Brooks, Fahey, & White, 1996). It is possible that exercise might increase arousal levels, improve attention, and perhaps moderate impulsivity. Some benefits, particularly for boys, were detected in a study into the efficacy of vigorous exercise as a dopaminergic adjunct in the management of behavioural features of ADHD (Tantillo, Keswick, Hynd, & Dishman, 2002).

There has been more support for the theory that sport has a positive effect on young male populations. Reports have consistently highlighted benefits for self-concept, self-esteem, self-regulation, and motivation (Allison, 1999; Cameron & MacDougall, 2000; Hodge, Sherburn, & Dugdale, 1998; Kickett-Tucker, 1999; Pestall, 2001). The idea of combining cognitive training and behavioural training within a carefully regulated physical exercise activity as a beneficial intervention for boys who exhibit behaviours typically clustered under ADHD would seem to be worth consideration. In a discussion of specific issues surrounding ADHD, the National Health and Medical Research Council suggested that "participation in sport may give a child with ADHD enjoyment, peer approval and acceptance in the face of less competence in the academic or social arena. The traits of intensity, high activity, impulsivity, and risk taking which predispose to ADHD may also allow natural sporting ability to lead to competitive success" (NHMRC Publications, Part 8.3).

Project

As long as the exact cause of ADHD remains unidentified, the debate concerning the efficacy of treatments and ethical considerations concerning the use of stimulant medications is likely to continue. An attempt by teachers to manage these behaviours using interventions that have an accepted role in the curriculum seems worthwhile, particularly as there is at least some evidence that exercise provides benefits for students with ADHD, similar to those provided by the use of stimulant medication. Given that children learn social rules through sport and play and gain benefits for their self-esteem and motivation (Pestall, 2001), an intervention that provides these benefits, together with the potential to have a positive influence on attention, hyperactivity and impulsive behaviour, warrants further detailed research.

This project examines how a controlled physical exercise intervention, when combined with cognitive and behavioural training, might affect attentiveness, hyperactivity, and impulsivity in four 12-year-old boys with deficiencies in these areas. Cognitive training and behavioural training has been shown to improve attentiveness and reduce hyperactivity and impulsivity, characteristics of ADHD. The project sought to measure the improvement gained from combining these approaches within an exercise intervention based on triathlon training. Four main questions formed the basis for research in the project. Will regular practice on physical tasks increase attention in the classroom? Will physical activity before school lead to a decrease in hyperactive behaviour in the classroom and how long will it have effect? Will physical training that incorporates cognitive training such as planning and goal setting, improve academic task performance? Will self-monitored improvements during training, increase self-esteem and improve persistence on classroom tasks?

Methodology

Participants

The 4 participants were chosen from a group of ten 12-year-old boys at a local primary school. School administrators and classroom teachers identified the boys for the project on the basis that they were of average intelligence (based on school related performance) and that they displayed challenging behaviours. Before these boys were identified, the researcher gave all Year 7 students information about a new extended learning programme (a term commonly used in the school to remove stigma from "special" programmes). The students were informed that an opportunity to participate would be offered to some of the year seven students. The CBCL: Teacher Rating Scale (Achenbach, 1991) was used to confirm the selection of boys who would eventually form the study group for this research. The Teacher Report Form was filled out for each boy in the initial sample of 10 students. Paul, John, and Tom (not their real names), whose scores were within the clinical or subclinical range for inattentiveness, hyperactivity, and impulsivity, were selected. Mark, whose score was slightly below the subclinical range for Attention Problems, was added to the experimental group when a boy previously selected, left the school unexpectedly. Paul and John tested in the clinical range for Attention Problems (inattention and hyperactivity/impulsivity), and Tom was slightly below the subclinical range for Attention Problems.

Mark, the only boy officially diagnosed as having ADHD, was being treated with stimulant medication before school to regulate his behaviour. The four boys were re-rated after the program was completed. The four boys were re-rated on the CBCL, after they completed the programme.

The school informed the parents of the students of their sons' selection in the programme, and the researcher visited each home to explain what would happen during the 7-week programme. Parents were not directly informed that the programme was focused on their sons' behaviour at school, and, while it was confirmed that the training programme was being trialled to see if it would assist the boys with their schoolwork, no detail was given. All parents received the assurance that they would have an opportunity to discuss the outcomes at the end of the project.

Procedure

Once the participants were selected, the school was asked to provide another boy in the same class as the "control" participant as a comparison for observation, to provide some comparison to general class behaviour. The teacher selected these "control" participants on the basis that they had displayed some disruptive behaviour. The observers for the project were selected from a group of first year students in an undergraduate teacher education programme. The observers were prepared for their role as observers in a practice session using a commercial video about a special needs student in a normal class setting, *Educating Peter* (Goodwin & Wurzburg, 1992). A behaviour checklist that asked observers to code for behaviours, shown in the video, was completed. The results were discussed within the group in an attempt to improve inter-rater reliability. Further improvement in inter-rater reliability was undertaken by giving immediate feedback on the initial observation in the classroom, which also involved a further refinement of behaviours being observed.

Before this session, observers were given a letter outlining the process of action research, the problems that might occur in this process, and the ethical guidelines that were to be followed. During the next 7 weeks, each participant and comparison was rated for behaviour, by one of the independent observers in the classroom, during the morning session following each intervention. The same observer generally collected data for a specific student one particular day, over the length of the programme. The means of all observations of classroom behaviour for each participant together with the means from data for the comparison student were analysed and recorded in three training periods. These were a baseline period in week 1, involving an introduction to the training programme, a build up period in Weeks 2–3, involving the development to full distance training, and a full training period in Weeks 4–7 involving intense training over the maximum distance.

Design

A field case study design was chosen. Four students were trained in triathlon over a 7-week period. The dependant variables, impulsivity, hyperactivity, and attentiveness were measured on the CBCL and compared to the means of observations of behavioural data recorded in the classroom by the observers. These categories for attention together with rule breaking behaviour and aggressive behaviour were used to select the four participants from the initial group rated by class teachers. The comparison students were chosen because they exhibited challenging behaviours on occasions. Although the project was a field case study, data that gave an insight into the behaviour of the classroom where each participant was being observed was considered potentially useful. During the training period, each participant and comparison was rated for behaviour by one of the independent observers in the classroom, during the morning session following each intervention. Observations were conducted for a half hour session, on Mondays, Wednesdays, and Thursdays over 7 consecutive weeks. The same observer generally collected data for a specific student on a particular day, over the length of the programme. The observations were recorded under four headings: interrupting inappropriately, fidgeting/squirming, moving out of seat without permission, and being off task (staring/daydreaming–not engaged in work). These behaviours were identified from the array of behaviours observed in the initial observation session in the classroom.

Training

The participants were introduced to the concept of triathlon through a training video. Every aspect of the competition was examined so that students understood the requirements for each leg, the rules of competition, and how the training methods would produce improvement in performance. This information was reproduced in a training manual developed and distributed during the study. The areas covered by the manual included skills involved in triathlon, rules that control each segment of the competition, training goals and targets for the overall programme, nutrition requirements during training, procedures for warm-up, goal setting, positive attitude, persistence, performance measurement, and

review. Each participant was reinforced for completing each task, for overcoming problems encountered in the programme, and for improving performance. Certificates recognising individual achievements were produced.

Participants were engaged in the same triathlon training each Monday, Wednesday, and Friday for one hour over 7 consecutive weeks. The heart rate of each participant was electronically recorded on one training session each week to measure the increase in intensity of exercise and to compare the intensity against the dependant variables. A qualified triathlon trainer, also a physical education teacher, controlled recording of times and production of data. Individual performance times were recorded during each training session, and the results were discussed at the end of each session. Specific elements related to better planning and goal achievement were highlighted for each boy at the end of each session. Behavioural elements such as improved concentration and increased persistence were discussed during the training sessions. The performance goal for the boys was to produce a best time below 20 minutes. The mean for performance for the group was 20.05. Mark and Paul consistently performed better than the mean for the group and showed an improvement over the training period. Tom showed a steady improvement over the training period and achieved a time slightly below the group mean in the last training session. Each of these boys generally appeared to be trying harder over the training period. John was involved in an accident during the bike leg in Week 5 and virtually took little part in the final training sessions. However, he competed in the final club triathlon and showed a considerable improvement in his attitude on that day. Table 1 shows an outline of training over the 7-week period.

Table 1.

An outline of the training programme by time

Stage	Heart Rate	Cognitive Training	Behavioural Training
Oct 6-22 Approval & testing. Introduce task Brief teachers & observers Record baseline data	208bpm max rate **100%**	To develop positive attitude, understand feelings, identify skills, plan, prepare physically, review, set goals and understand body needs (continuing)	To cope with problems, finish tasks, develop good training habits and develop persistence (continuing)
Oct 27 (Wk 2) Warm up routines 1000 cycle 1000 run 2000 cycle 1000 run	125bpm **60%**	**Session Frequency** Monday 7 – 8am Wednesday 7 – 8am Thursday 7 – 8am	Meeting with supervisor to review observational data **Data collection**
Nov 3 (Wk 3) 3000 cycle 500 run 5000 cycle 1000 run 5000 cycle 1000 run	145bpm **70%**	**Session Frequency** Monday 7 – 8am Wednesday 7 – 8am Thursday 7 – 8am	**Data collection**
Nov 10 (Wk 4) 50 swim 5000 cycle 1000 run	166bpm **80%**	**Session Frequency** Monday 7 – 8am Wednesday 7 – 8am Thursday 7 – 8am	**Data collection**
Nov 17 (Wk 5, 6, 7) 100 swim 5000 cycle 1000 run	**80%**	**Session Frequency** Monday 7 – 8am Wednesday 7 – 8am Thursday 7 – 8am	**Data collection**
			Data review and report

Material

The CBCL: Teacher Rating Form has been used in over 4,000 published studies. It is scored on profiles of scales for problems, competencies, and adaptive functioning that compare an individual's scale scores with national norms for peers of the same age range and gender. Classroom observations for participant and comparison students were recorded on a data sheet, prepared by the researcher, in a series of 2-minute observations over a 30- to 60-minute session. The parent interview was conducted around two questionnaires, which were administered at the completion of the project. In the first questionnaire, students were asked to rate themselves on a 5-point scale ranging from always to never, for six attributes (confidence, task completion, goal achievement, focus, planning, and concentration). In the second questionnaire, parents were asked to rate their child on a 5-point scale for six attributes (self esteem, persistence, realistic goal setting, logical approach, planning, and concentration). Participants used a

standard light framed racing bike and wore Polar electronic heart rate monitors for the duration of each leg (swim, ride, and run) on each Thursday training session. The results were downloaded onto computers for analysis.

Results

Teacher rating scale

The improvement in the syndrome scales ranged from 2.2 to .8 standard deviations for the combined attention category (see Table 2). There was an improvement in rule breaking for each participant and for aggressive behaviour for two of the four participants. The scores for Mark remained the same. The fact that Mark was the only participant receiving stimulant medication for ADHD may account for his low score and limited gains in behavioural changes over the period of this intervention.

Table 2.

T scores for CBCL syndrome scales for Inattention and Hyperactivity (6), Rule Breaking (7), and Aggressive Behaviour (8) and standard deviations across pre- and post-tests for all four students

Group		6	7	8	Total T Score	Tested
Paul		91	79	95	85	8/10/2003
		69	68	70	69	8/12/2003
	SD differences	**2.2**	**1.1**	**2.5**	**1.6**	
John		86	72	87	81	8/10/2003
		68	63	74	68	8/12/2003
	SD differences	**1.8**	**0.9**	**1.3**	**1.3**	
Tom		61	58	66	62	8/10/2003
		60	53	63	58	8/12/2003
	SD differences	**0.8**	**0.5**	**0**	**0**	
Mark		64	68	67	61	8/10/2003
		56	63	67	61	8/12/2003
	SD differences	**0.8**	**0.5**	**0**	**0**	

Classroom observations

Paul recorded a slight reduction from baseline to full training for inattentiveness with an improvement of 8%. A much larger reduction in his hyperactivity was observed, with the full training mean being 25% less than baseline. The comparison student data showed a 100% increase in inattentive behaviours and 33% increase in hyperactivity. John's data recorded an increase in inattentive behaviours of 33%. A reduction in his hyperactivity was observed with the full training mean being 25% less than baseline. The comparison student data showed a 300% increase in inattentive behaviours with a 25% improvement in the area of hyperactivity. Tom's attention from baseline to full training recorded an increase in inattentive behaviours of 12%. An improvement in his hyperactive behaviour was observed with the full training mean being 75% less than baseline. The comparison student data showed an increase of 60% in inattentive behaviours and a 50% increase in hyperactivity. Mark's attention recorded a reduction in inattentiveness from baseline to full training with an improvement of 50%. A much larger gain was recorded for hyperactive behaviour with the full training mean being 80% less than baseline. The comparison student data showed a small decrease of 13% in inattentive behaviours and an improvement of 37% in hyperactivity.

There was a common trend for a decrease in hyperactive behaviour over the intervention period for three participants and an ultimate improvement in hyperactivity for the four participants. The improvement in attention did not follow a regular pattern and, although improvements were noted at intervals, a trend for continual improvement over the intervention was evident for only two participants.

Discussion

It was thought that exercise might produce observable benefits for boys whose behaviour was regarded as challenging. The current study, despite many design limitations, has shown some reduction in inattentive/hyperactive, rule breaking and aggressive behaviour. Mark, the only boy diagnosed with ADHD and receiving daily stimulant medication, showed slightly more improvement in the attention

category. The data from classroom observations showed an improvement in attention for Paul and Mark and a decline in the results for Tom and John. Hyperactive behaviour decreased for all boys over the training period. The comparison behaviour showed an increase in inattention in three out of four cases and an increase in hyperactivity in two cases. Although this effect is difficult to interpret, it is likely that the target students' behaviour was not merely a reflection of a generalised improvement in classroom behaviour. Comparison students are not study controls; they are approximate indicators of general class climate and represent an attempt to monitor general classroom effects.

The results did not support the idea that an improvement in academic performance might occur as a result of physical exercise. Although it was planned to carry out a controlled weekly test of spelling for all Year 7 students, this activity ultimately proved to be impractical because of constraints at the host school. It would be worthwhile to include this element in future research. However, during the study, regular, controlled physical exercise appeared to produce an increase in attention for other tasks. This effect was noticed even though the dependant measures were taken in the classroom removed physically from the intervention. More significantly, hyperactive behaviour in the classroom was reduced for at least 4 hours following the intervention.

The question of persistence and self-esteem remain largely unanswered in this project. Although the boys generally worked hard to improve their performance and were enthusiastic, improvement in these attributes were not measured. However, a post-study questionnaire indicated a trend towards improved self-esteem and confidence. Further research could involve measurement of these characteristics using pre- and post-intervention questionnaires of parents, students, and teachers.

The role of physical activity in effecting a behavioural change for boys with challenging behaviours can be considered important (Hodge et al., 1998), particularly for boys, who have been identified with inattention and hyperactivity. Exercise that produces physiological and biological changes may result in an improved sense of well-being, which may generalise to boys feeling more comfortable within the relatively confined space of a classroom (Purdie et al., 2002). Although this change may be due to a number of physiological factors, the fact that a change has been produced seems evident even in this limited study. It is also possible that intense physical activity containing embedded learning tasks will allow learning to be generalised. This study, although limited by its small sample size, provides some indication that physical exercise programmes can reduce hyperactivity in the short term. As a tool for teaching rules and encouraging more positive behaviours, the intervention would seem worthwhile, particularly as there is little chance of causing physical danger or long-term detrimental effect. The current study suggests the influence of exercise and sport on problem behaviour and consequent academic failure is worthy of further study. Future studies might incorporate a larger sample and a more robust design to determine how factors of exercise fitness might relate to problem behaviour in school settings.

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