

Effects of Exercise on Memory and Visual Reaction Times among 6th Class Primary School Students.

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Abstract

Extensive literature exists in the area of physical exercise and its effects on cognition. However, there has been little research in the 6th class age group. The purpose of this study was to examine the effect that physical exercise has on short term memory and visual reaction time among 6th class primary school students. It was hypothesised that short term memory and visual reaction time would significantly increase after physical exercise. However, regarding the speed of reaction time, experimentation here showed no significant difference between an experiment group and a control group. Additionally, in relation to memory recall, a significant difference was found within both groups. However it was the control group that recalled more objects. These results are not consistent with previous literature, and likely reflect the experimental limitations. The results therefore highlight the need for future research on this age group in more strictly controlled environments.

Introduction

1.1 Introduction

Physical exercise and its effects on wellbeing is a vast area of research for e.g. a meta analysis carried out by Bauman (2004) showed evidence that physical activity is good for our health. Research into this area has a profound impact on the general and mental health of an individual. In the recent past, focus has moved away from exercise, due to the popularity of technology and children spend much longer stationary while gaming and using social media. More people now than ever use motorised transportation reducing the level of everyday exercise they engage in. Physical exercise has been shown to have a positive effect on concentration and mood, along with cognitions such as memory, perception and reaction times e.g Pendeo & Dahn (2005). Research into the effect that physical exercise has on general health is of extreme importance for healthcare professionals in the education and implementation of policies so to increase awareness of the benefits of exercise on general physical and mental health. The use of current research in this field is invaluable in both academic settings and in practice. Findings, when implemented, may provide improved cognition for the student such as memory, reaction times and concentration. These findings may also lead to a more favourable future with better career prospects, and well-being.

1.2 Physical exercise

“Physical activity is defined as any bodily movement produced by skeletal muscles that result in energy expenditure” Caspersen, Powell & Christenson (1985). Physical exercise is activities that enhance or maintain physical fitness and overall general health. Exercise is important for many reasons including muscle strength, weight loss, cardiovascular

system, immune system, self esteem and cognitions. Regular physical exercise may improve a variety of physiological and psychological factors in depressive persons (Nabkasorn et al.,2006). It has been well documented in the past that exercise is high on the list of behaviours that people believe are important for good sleep patterns. Research by Gambelungho, Rossi, Mariucci, Tantucci & Ambrosini (2001). found that light physical exercise favours sleep. Several different forms of exercise exist such as aerobic, cardiovascular and flexibility.

The effect physical exercise has on cognition is an important area of research. It is now widely accepted that the participation in physical exercise impacts positively on general and mental health. Several research studies have been carried out over the past decades resulting in significant findings. These findings have been fundamental for implementing changes in the way people are educated regarding the importance of physical exercise. Pendo & Dahn (2005) conducted both cross-sectional and longitudinal studies as well as randomised clinical trials among adolescents, middle-aged and older adults, looking at the relationship between exercise, physical activity and physical and mental health. They found that the results were in keeping with the growing literature suggesting that exercise and physical activity have benefits across several physical and mental attributes. Participants engaging in regular physical exercise displayed more favourable health outcomes across a variety of physical conditions. Better general health, health related quality of life, functional capacity and mood states were found in participants with physical exercise intervention in the random clinical trials. They concluded that the assessment and promotion of exercise and physical activity may be beneficial in achieving desirable health affects across populations. A meta analysis carried out by Bauman (2004) in updating the evidence that physical activity is good for our health showed that physical activity contributed to the prevention of many diseases. These include cardiovascular disease, diabetes, stroke, mental health, falls, injuries and obesity. The

results of this analysis are significant and have implications for clinical practice and research. The research could be extended further in examining the effects that physical activity has on cognition such as memory and reaction time within a young population.

McDonald, Raupp, Leung and Hanhauser (2013) carried out experimental research on the effects of acute exercise on short term memory. The study involved 19 to 22 year olds who were placed in three groups and asked to memorise a set of flash cards. The research showed no significant difference in the number of cards correctly memorized between any of the groups. The purpose of their study was to research healthy options in improving memory for a test situation. While other acute forms are available to improve short term memory many are unhealthy and have negative side effects. Energy drinks are high in sugar and caffeine disturbs sleep and can cause anxiety. The healthy alternative of exercise is now emerging to aid in short term memory. However, the study found no significant results between the participation in acute aerobic exercise and short term memory. Further research is needed into the effects acute physical exercise has on short term memory in a younger population. All forms of opportunities for exercise needs to be utilized.

Further research from Monika, Hem, Lily & Omesh (2013) on the effect of exercise on auditory and visual reaction times in 20 to 50 year olds found “auditory and visual reaction times are better in aerobic exercisers as compared to non-exercisers irrespective of age and gender”. Fifty subjects were enrolled, with intervention of 30 to 40 minutes in a gym. The visual and auditory reaction time was measured using digital display time apparatus. Findings in the study indicate that using 30 minutes of regular aerobic exercise in a gymnasium improved reaction time. The improvement was irrespective of age or gender. There was a trend for delayed auditory reaction time with increasing age in both groups and in females compared to males. However other variables such as IQ, diet, workload, tiredness

and stress that may have an effect on reaction time were not measured. This study focused only on an adult population and has not examined the pre adolescent age group. While this is an important group, the younger population too need to be equipped with the knowledge to the benefits of exercise on general and mental health. If the information is provided it may result in lifelong healthy habits from a younger age.

1.3 Memory

Memory refers to “the process that allows us to record, store and later retrieve experiences and information”, (Passer & Smith, 2008, P. 251). Atkinson and Shiffrin (as cited by Goldstein, p. 139) developed the Modal model of memory having three structural features: 1: sensory memory, 2: short term memory (STM) and 3: long term memory (LTM). This model suggests that information moves through the different structures with bidirectional movement between STM and LTM. Information in the STM through rehearsal will enter the LTM. A process of phonological, visual and semantic coding enables information to enter memory. It is widely accepted through the study of patient HM that there is a division between the types of memory and that they work independently of each other. HM showed an inability to form new long term memories after the removal of his hippocampus yet retained the ability to store information for a short period of time. Further evidence comes from patient KF who had normal LTM but impaired STM. Research from Aggleton & Brown (2006) on brain structures for episodic and recognition memory through advancements in functional brain imagining showed that recognition memory comprises at least two independent but linked processes. One process is recollective and the other using familiarity relying on episodic memory. Frequently cited capacity is the magical number of 7 plus or minus 2 elements, Miller (as cited by Goldstein, 2005, p. 157). STM is crucial for

everyday functioning. For example it is needed for the comprehension of a sentence. The beginning of the sentence must be held in the STM in order for the remainder to be read and understood. Holding small amounts of information for brief periods is the basis for many mental functions. The visual system is capable of taking in a vast volume of images of the world around us, yet the STM where it is stored is extremely limited only holding a fraction of the information. Todd & Marois (2004) found through the use of functional magnetic resonance imaging that “activity in the posterior parietal cortex is tightly correlated with the limited amount of scene information that can be stored in VSTM. These results suggest that the posterior parietal cortex is a key neural locus of our impoverished mental representation of the visual world”. A recent study from Erickson, Voss, Prakash, Basak, Szabo, Chaddock & Kramer, (2011) showed how exercise training increases the size of the hippocampus and improves memory. In late adulthood the hippocampus shrinks leading to memory impairments and a higher risk of dementia. Erickson et al., (2011) found that aerobic exercise training increased hippocampal volume by 2%, effectively reversing aging by 1 to 2 years. These findings indicate that aerobic exercise training protects against and reverses hippocampal volume loss in late adulthood, which is accompanied by improved memory. Hopkins, Nitecki & Bucci (2011) carried out research in adult and adolescent rats to find how physical exercise effects memory. Hopkins et al., (2011) found that results differed greatly between the two groups. After four weeks of exercise the adult rats had improved object recognition memory, but tested two weeks after exercise finished the improvement was no longer present. On the other hand the adolescent rats two to four weeks after exercise had finished were able to distinguish between novel and familiar objects. This research can have far reaching benefits for healthcare professionals and educators in policy making. Within an educational setting research into exercise training may result in findings that can increase memory and recall functions thus enabling students to perform better.

1.4 Visual Reaction Time

Reaction time or the study of mental chronometry as it is scientifically known is the time difference between the presentation of sensory stimulus and the subsequent behavioural response (Goldstein, 2005, p. 6). It can be referred to as the speed of processing, the time taken for an individual to execute the mental operations to perform the given task. The behavioural response in reaction time normally is to press a button, give a vocal response or some other observable behaviour. There are many types of reaction time, including, simple, auditory, choice and discrimination. Although Galton is known as the founder in the measurement of reaction time it was Donders who was the first scientist to measure reaction time in a laboratory. His experiments are important because they show how measuring the relationship between the presentation of a stimulus and the participant's response can infer a mental response, which cannot be directly measured. The fact that mental process cannot be measured directly and must be inferred is a principle that holds up for all research in cognitive psychology (Goldstein, 2005, p. 7). Mental chronometry is used in the study of cognitive development. The speed of processing is used in relation to age. Speed in counting, repeating sounds and motor skills in young children are observable behaviours that indicate normal cognitive functioning. Brain imaging has allowed the measurement of mental chronometry. Research has shown that physical exercise has a positive impact on reaction times. A study carried out by Audiffren, Tomporowski & Zagrodnik (2008) found that aerobic exercise in young adults increased the speed of reaction by energizing motor outputs but disappear very quickly after the cessation on the exercise. In a study by Davranche, Audiffren & Denjean (2006) on the effect physical exercise has on reaction time, it was found that exercising participants were faster than non exercising participants. Although the effect was small it was consistent through a range of reaction times. Due to neural placidity, brain training has been shown to increase the speed of processing and

reaction time. Dye, Green & Bavelier (2009) showed evidence in their research that the very act of playing action video games significantly reduces reaction times without sacrificing accuracy. The advances in brain imagining has meant that understanding the brain structures involved in mental chronometry can lead to further direction for improvements in cognition.

1.5 The current study

The current study aims to examine the effect that physical exercise has on short term memory and visual reaction time in 6th class primary school students. This is an important area of research for educators and healthcare professionals. Many pre-adolescents are unaware of the importance physical exercise has on their general and mental health. There have been many studies showing the effects that physical exercise has on both mental and general health. However, very little research has been carried out within a younger population. Studies that have involved the pre-adolescents have not examined specifically the effect physical exercise has on short term memory and visual reaction time among 6th class primary school students. Studies described above such as Pendeo & Dahn (2005) showed that exercise and physical activity have benefits across several physical and mental outcomes. While this research focused on the broader area of physical and mental health across many age groups, it has not examined a specific cognition such as memory or reaction time. The study carried out by Mc Donald et al., (2013) on the effects of acute exercise on short term memory- which is more in keeping with the current study- only examined the 19 to 22 year old group. Research from Monika et al., (2013) on the effect of exercise on auditory and visual reaction times was within the 20 to 50 year olds. Therefore there is a need for this current study in examining the effect physical exercise has on cognition, particularly memory and reaction time in a younger population.

1.6 Rationale

Not only has physical exercise an effect on our general health it also effects our cognition and ability to perform tasks. Areas such as learning are deeply enhanced when combined with the participation in exercise (Ahmadiasl et al., 2003). Physical exercise also impacts on other areas of cognition including memory and performance, both important areas for an individual's ability to learn. Exam performance and future careers may also be affected. The modern popularity of social media applications and computer gaming appear to be taking the place of physical exercise among pre-adolescents today. Some pre-adolescents appear to have more time for computational devices than for physical activities. With technological advances a certainty, a disconcerting future with potential increases in many types of physical and mental illnesses, relating to low rates of exercise is likely. The current study will address the gap in the literature by examining the effects physical exercise has on short term memory and visual reaction time in the specific 6th class primary school students group, mainly 11 to 12 year olds. Results from this study can help to aid policy makers in amending the school curriculum towards increasing physical exercise among pre-adolescents. This can also raise awareness of the importance that physical activity has for good mental health and cognition. Many 11 to 12 year olds, the 6th primary school age group, are uneducated regarding health and fitness. Physical exercise should become a priority in the curriculum as soon as possible, thus engaging a younger population in healthy habits concerning physical and mental health from an early age.

1.7 Measurement

This study will address the hypotheses by carrying out experiments in short term memory and visual reaction time. An experiment group will be tested before and after the

intervention of physical exercise and a control group will be tested before and after continuing with their normal class work social, environment and scientific education (SESE). The experiments will involve 6th class primary school students in a mixed school. Statistical analysis including descriptive and inferential statistics will be used to determine if the null hypothesis is accepted or rejected. The null hypothesis is the default position that there is no relationship between two measured phenomena which is generally accepted to be true until evidence indicates otherwise.

1.8 Hypotheses

Hypothesis 1:

It is hypothesised that short term memory scores will be significantly increased after the physical exercise intervention when compared to pre-intervention.

Hypothesis 2:

It is hypothesised that visual reaction time scores will be significantly increased after the physical exercise intervention when compared to pre-intervention.

Methods

2.1 Participants

The study consists of a total of 45 (n=45) participants (20 male and 25 female) from two 6th classes in St. Cronan's Senior National School, Swords, Co Dublin, Ireland. One class became the control group (group A) and the other class the experiment group (group B). The control group consisted of 23 participants and the experiment group consist of 22 participants. All the participants in each group are capable readers who have given their full consent to participate. Participants have all been debriefed regarding the nature of the study and are aware that participation is voluntary. Participants are aware that they can leave the study at any time taking their data with them. An information letter was provided to parents (see Appendix 1) and a signed letter of parental consent was sought (see appendix 1). A letter of application (see Appendix 2) and a signed letter of consent (see Appendix 3) were sought from the principal of St.Cronan's Senior National School to carry out the experiment (see Appendices 2&3). A statutory declaration was also sought and signed by a solicitor (see Appendix 4).

2.2 Design

This study is a quantitative, true-experiment of mixed, within and between groups design that consists of an experiment group and a control group. The sample was sought by probability sampling, by means of a simple random sample. One class was randomly assigned to the experiment group and one class to the control group by selecting class A or class B from a hat. Each participant in both the experiment and control groups was given a number from 1 to 22 for reference at pre-intervention and post-intervention for the within

group data. The experiment group was tested before and directly after 50 minutes of moderate physical exercise. The control group was tested before and directly after a social, environment and scientific education (SESE) lesson. The independent variable is the presence or absence of the physical exercise. The dependent variables are the short term memory test scores and the visual reaction time test scores. Class A and class B are the between group variables and the short term memory test scores and the visual reaction time test scores are the within group variables.

2.3 Materials/Apparatus

In the experiment a short term memory test was used for both the experiment and the control groups, using an online 20 colour picture memory game (see Appendix 5a), at pre-intervention and a different set of 25 black and white pictures (see Appendix 5b), at post-intervention to avoid skewing the data. Participants received a recall sheet to write the words recalled (see Appendix 6). A simple visual reaction time test was used by both groups on a laptop (see Appendix 7), at pre-intervention and post-intervention. Intervention consisted of a 50 minute physical exercise class for the experiment group. The control group continued with the in-class curriculum of social, environment and scientific education (SESE) work, having no physical exercise. Both the experiment and the control group were in a classroom and were seated in their own seats during the short term memory test at pre-intervention and at post-intervention. During the visual reaction time test, participants walked to a designated seat beside the laptop at the front of the class.

2.4 Procedure

On Wednesday January 21st 2015 at 9.45am the students in the control group were in their classroom and all were seated at their places. Students who were not taking part were present in the classroom and were asked to read quietly. Students were pre advised earlier in January that an experiment would take place during class time on this date. Participants were debriefed to explain the experiment process and the first test to be administered, the memory test. All participants received a recall sheet to record picture objects recalled. The purpose of the recall sheet was explained, and participants were asked to write their individual number, given to them, on the top right hand corner. At 10am they were shown 20 pictures (see Appendices 1.a) as part of the memory test, on the whiteboard for a period of 30 seconds. Participants were then asked to chat among themselves for a period of two minutes. After 2 minutes had passed the participants were asked to write down as many names of objects from the memory test they could remember on the recall sheet (see Appendices 2), using a pen. All participants started the word recall at the same time. A two minute time frame was allowed for the word recall. At the end of the two minutes the researcher collected all the recall sheets. Immediately after the memory test was administered the simple visual reaction time test (see Appendices 3) commenced. Each participant then walked individually in turn when called to the designated seat beside the laptop at the front of the classroom. Each participant had the procedure and operation of the online traffic light reaction time test explained to them individually. Each participant was asked if the instructions were clear to them. The participant was then asked to press the start button on the laptop to begin in their own time. Participants were pre advised that when they noticed that the traffic light had turned from green to red they had to press a stop button. Each participant had five attempts and at the end an average time was recorded per student. All students then had a 15 minute break as per the school timetable. Participants returned from break and then proceeded with

the scheduled (SESE) lesson for 50 minutes. At 12 pm they were shown 25 different pictures (see Appendices 1.b) as part of the memory test and the procedure at pre-intervention was repeated exactly the same. The simple visual reaction time test at pre-intervention was repeated exactly at post-intervention. On Friday January 23rd 2015 at 9.45am for pre-intervention and 12 pm for post-intervention the procedure was repeated exactly with the experiment group as it was carried out in the control group. The intervention in the experiment group was a 50 minute physical exercise class instead of the (SESE) class in the control group.

2.5 Data Analysis

Descriptive statistics were used to determine the mean and standard deviation. Inferential statistics using the alpha level 0.05 was used to test the hypotheses. A two-way analysis of variance (mixed ANOVA) was used to compare scores on memory and reaction time within each group pre-intervention and post-intervention. A mixed ANOVA was also used to compare overall scores between the groups not examining pre-intervention and post-intervention. A multivariate analyses of variance (MANOVA), was used to examine the scores between the groups pre-intervention and post-intervention.

Results

3.1 Descriptive statistics

Assumption checks were carried out and a univariate outlier was highlighted, which was removed for the purpose of descriptive and inferential statistics.

A total of 44 (N = 44) of students participated in the study. The control group had 22 (N = 22) participants, 64% were female (N = 14) and 36% male (N=8). The experiment group had 22 (N = 22) participants, 46% were female (N = 10) and 55% male (N = 12). The total mean score in recall pre-intervention was 7.89 (M = 7.89) and the standard deviation was 2.35 (SD = 2.35). For recall post-intervention, the total mean score was 10.20 (M = 10.20) and the standard deviation was 2.54 (SD = 2.54). The total mean score in reaction time pre-intervention was .40 (M = .40) and standard deviation was .11 (SD = .11). For reaction time post-intervention, the total mean score was .37 (M = .37) and the standard deviation was .09 (SD = .09). Descriptive statistics are shown in table 1.

Table 1 *Descriptive statistics for recall and reaction time pre-intervention and post-intervention*

Variable	Mean	SD	N
Recall 1	7.89	2.35	44
Recall 2	10.20	2.54	44
Reaction 1	.40	.11	44
Reaction 2	.37	.09	44

3.2 Inferential statistics

Recall

A mixed ANOVA found that there was no significant interaction effect between recall and the group type ($F(1,42) = .56, p = .457$) with an effect size of 1.3%. In relation to the main effects there was a significant difference for recall at pre-intervention and at post-intervention within the groups ($F(1,42) = 40.66, p = < .001$, effect size 49.2%), where more objects were recalled at post-intervention (mean difference = 2.32, $p = < .001$, CI (95%) 3.05-1.58). There was a significant difference found between the control group and the experiment group on recall ($F(1,42) = 20.46, p = < .001$) with an effect size of 32.8%, where the control group recalled more objects than the experiment group (mean difference = 2.41, $p = < .001$, CI (95%) 1.33-3.48). The null hypothesis is accepted due to significance in the control group and not the experiment. See Figure 1 for a bar chart and table 2 for inferential Statistics on recall.

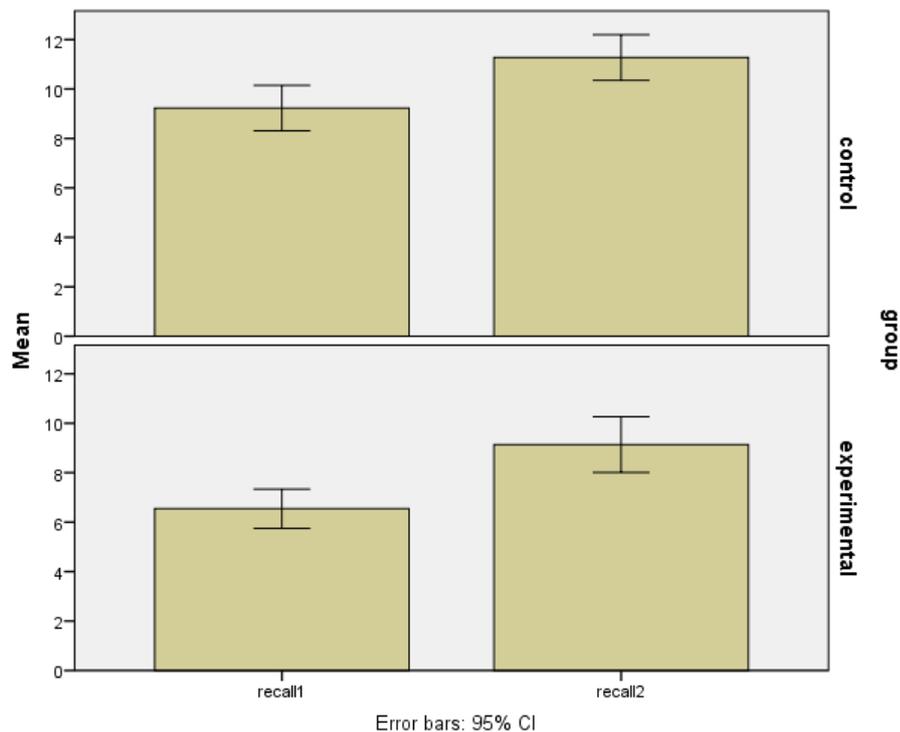


Figure 1 Bar chart to compare scores for recall in the control group and experiment group pre-intervention and post-intervention

Reaction time

A mixed ANOVA found that there was no significant interaction effect between reaction time and the group type ($F(1,42) = .00, p = .993$) with an effect size of 0%. In relation to the main effects there was no significant difference for reaction time pre-intervention and reaction time post-intervention ($F(1,42) = 3.08, p = .087$, effect size .67%). There was no significant difference between the control group and the experiment group ($F(1,42) = 1.46, p = .234$) with an effect size of 3.3%. The null hypothesis is accepted. See Figure 2 for a bar chart and table 2 for inferential statistics on reaction time.

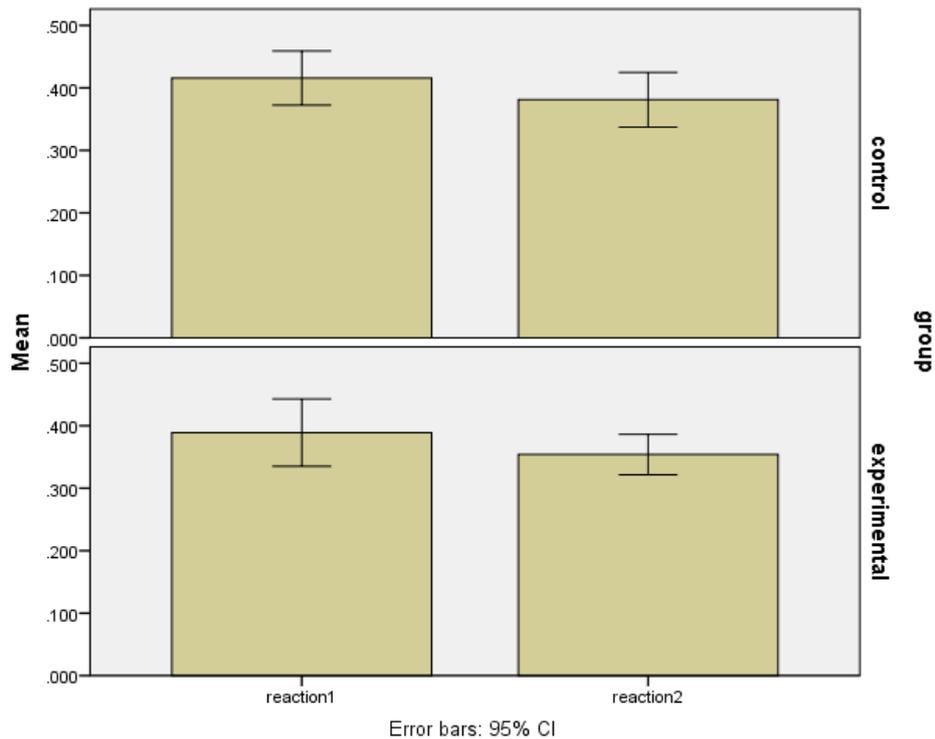


Figure 2 Bar chart to compare scores for reaction time in the control group and experiment group pre-intervention and post-intervention

Pre-intervention

A one-way multivariate ANOVA (MANOVA) found that there was a significant difference in levels of performance between the groups at pre-intervention ($F(1,42) = 10.9$, $p = < .001$, effect size .35). Following a Bonferroni adjustment to .025, a method used to correct the problem of multiple comparisons, in this case to allow for two time points. There was a significant difference between the groups on recall pre-intervention ($F(1,42) = 21.12$, $p = < .001$, effect size .34) with the control group ($M = 9.23$, $SD = 2.07$) recalling more objects than the experiment group ($M = 6.56$, $SD = 1.8$). No significant difference was found between the groups in reaction time pre-intervention ($F(1,42) = .65$, $p = .425$, effect size .02).

The null hypothesis is accepted for recall pre-intervention and accepted for reaction time pre-intervention, due to a significant difference in the control group rather than experiment group. See table 2 for inferential statistics.

Post-intervention

A one-way multivariate ANOVA (MANOVA) found that there was no significant difference in the levels of performance between the groups at post-intervention ($F(1,42) = 5.2, p = .010, \text{effect size } .20$). Following a Bonferroni adjustment to $.025$, there was a significant difference between the groups on recall post-intervention ($F(1,42) = 9.3, p = .004, \text{effect size } = .18$) with the control group ($M = 11.27, SD = 2.07$) recalling more objects than the experiment group ($M = .38, SD = .10$). No significant difference was found between the groups in reaction time post-intervention ($F(1,42) = 1.07, p = .306, \text{effect size } = .03$). The null hypothesis is accepted for recall post-intervention and accepted for reaction time post-intervention. See table 2 for inferential statistics.

Table 2 ANOVA for recall and reaction time in the control group and the experiment group pre-intervention and post-intervention

Variable	Groups	Mean	SD	F	dfs	p
Recall 1	control	9.23	2.069	21.121	1 42	.000
	experiment	6.55	1.792			
Recall 2	control	11.27	2.074	9.291	1 42	.004
	experiment	9.14	2.550			
Reaction 1	control	.41582	.097616	.650	1 42	.425
	experiment	.38900	.121687			
Reaction 2	control	.38109	.098846	1.074	1 42	.306
	experiment	.35391	.073203			

Discussion

4.1 Purpose of study

The purpose of this study was to examine whether the participation in physical exercise had an effect on short term memory and visual reaction time. It was hypothesised that short term memory scores and visual reaction time scores would be significantly increased after the physical exercise intervention when compared to pre-intervention.

4.2 Summary of Findings

Inferential statistics using a mixed ANOVA were used to examine if one group's score increased and the other decreased (the interaction). It was also used to measure the scores at two different time points within each group as well as the scores between the groups not examining the different time points. The first mixed ANOVA was used to examine memory recall. It was found that there was no significant interaction effect on memory recall and the group type. However it did find a significant difference for memory recall within the groups pre-intervention and post-intervention with more objects recalled post-intervention. A significant difference was also found between the groups in overall scores for memory recall with the control group recalling more objects than the experimental group. A second mixed ANOVA was used to examine reaction time. It was found that there was no significant interaction effect for reaction time and the group type. It was also found that there was no significant difference within the groups for reaction time pre-intervention and post-intervention. Between the control and experiment group no significant difference was found in overall scores on reaction time. However, inferential statistics show a score close to the significant level of .005 at .087, suggesting that there is some sort of movement taking place.

Descriptive statistics show that the experiment group had faster reaction time pre-intervention and post-intervention. However the control group showed a greater improvement pre-intervention and post-intervention.

A multivariate analysis of variance, a MANOVA was used to examine the performance levels between the groups at pre-intervention and post-intervention. The first MANOVA was used to examine pre-intervention. It was found that there was a significant difference between the groups in levels of performance at pre-intervention. Where the control group recalled more objects than the experiment group. However no significant difference was found at pre-intervention between the groups for reaction time. A second MANOVA was carried out to examine the performance levels at post-intervention between the groups. It was found that there was a significant difference in performance levels between the groups post-intervention. Where the control group recalled more objects than the experiment group post-intervention. However no significant difference was found between the groups for reaction time post-intervention.

4.3 Findings concerning the hypotheses

It was hypothesised that both memory recall and reaction time would increase in the experiment group post-intervention. The results presented here are not in keeping with the hypotheses set out and therefore the null hypothesis is accepted. On the contrary, the study found that the control group actually performed better than the experiment group for memory recall both pre-intervention and post-intervention. As mentioned earlier reaction time scores for both groups did improve and while no significant result was found the experiment group did perform better than the control group in reaction time both pre-intervention and post-intervention, yet the control group improved more post-intervention. An interesting finding

emerged from the results of the MANOVA in comparing the scores pre-intervention and post-intervention. It would have been expected to see no significant difference in both groups pre-intervention for both memory recall and reaction time, followed by a significant difference in the experiment group post-intervention for both memory recall and reaction time. However the analyses showed that the control group performed significantly different for memory recall than the experiment group at pre-intervention and at post-intervention. Possible reasons for this are discussed further in the discussion.

4.4 Findings and previous research

The current study did not find results similar to previous literature on the effects of physical exercise and mental health. Previous research from Pendeo & Dahn (2005) examined the relationship between physical exercise, physical activity and physical and mental health. That study found that the results were in keeping with growing literature suggesting that exercise and physical activity have benefits across several physical and mental outcomes. In both cognitions tested in the current study, short term memory and visual reaction time, no significant difference was found for the experiment group participating in physical exercise. This result suggests that the participation in physical activity does not impact on cognition positively which goes against previous literature, suggesting that there may be other variables at play in the current study to cause these findings. Possible reasons for this result are discussed further in the discussion.

The results in the current study do not support previous research from Mc Donald., et al (2013) who found no significant difference between the number of flash cards memorized by any of the groups post acute aerobic exercise. It was found in the present study that a significant difference did exist within both groups, with further inspection showing that it was

the control group that recalled more objects both within the group and between the groups. This result was not expected as the experiment group was hypothesised to significantly improve in the number of objects recalled. Limitations to the study are discussed below and these may provide a possible explanation for this result.

Previous research from Hopkins et al., (2013) on how physical exercise improves object recognition memory in rats found that after four weeks of exercise the adult rats had improved in object recognition memory, but when tested two weeks later the improvement was no longer present. However the adolescent rats were found to have improved object recognition memory after exercise had ceased. This suggests that exercise effects memory more positively in a younger population. This has implications for the findings within the experiment group in the current study in memory recall. It may be that physical exercise is needed on a regular and continuous basis in order for it to make a significant difference to memory compared to the control group.

The findings from this study showed no significant difference within each group or between the groups on reaction time. However mean scores showed an improvement in both groups post-intervention and inferential statistics showed a figure nearing significance. The present study did not find results in keeping with the research carried out by Monika et al., (2013) on the effect of exercise on auditory and visual reaction times in 20 to 50 year olds. They found that “auditory and visual reaction times are better in aerobic exercisers as compared to non-exercisers irrespective of age and gender”. The findings did not support literature by Audiffren et al., (2008) who found that aerobic exercise in young adults increased the speed of reaction time but disappear very quickly after cessation of exercise. Findings from Davranche et al., (2006) that those participating in exercise had faster reaction time than those not participating in exercise were also contrary to the findings from the present study.

Some possible reasons for the findings presented in this study, that do not support previous literature are discussed in the limitations of the study along with further direction of research.

4.5 Strengths and weaknesses of the study

A key strength of the study was in the simplicity of the procedure and the use of statistical measurements. Both the control group and the experiment group included participants from the same school and the same age group. The experiments were carried out in a controlled manner in identical settings, i.e. the classroom and with identical conditions, i.e. time. Furthermore all the participants had no previous experience of this type of experiment or had taken part in any similar study in the school. All the participants were debriefed in the exact same way. However, even with an attempt to control for outside variables skewing the data there were many problems which arose during the experiments that can be seen as limitations to the study. A surprising result which can be seen from the results is that the control group performed better than the experiment group both pre-intervention and post-intervention for memory recall. This may be due to the differences between the memory tests itself at pre-intervention and post-intervention which may have been better interpreted by the control group. The pre-intervention memory game consisted of 20 coloured objects while the post-intervention consisted of 25 black and white objects. It may also be due to the environment within the classroom. It was found during pre-intervention and post-intervention that the teaching style was somewhat different in the control group and resulted in a calm atmosphere. The participants in this group seem to understand the explanation of the experiment process faster and with more ease than in the experiment group. This does not seem to be due to the experimenter's explanation being clearer second time round, as the control group was the first to sit the experiment. A further

limitation to the study was with the familiarity of the reaction time test at post-intervention. As can be seen from the results, although not significant and the null hypothesis accepted, there was an improvement for both groups towards a significant level. The same reaction time test was used pre-intervention and post-intervention and some participants in both groups found it easier to grasp the test instructions leading to a faster score post-intervention. Another limitation found was that there were fundamental differences in how the test operated post-intervention for the experiment group as opposed to the control group. The procedure operated exactly the same in the control group pre-intervention and post-intervention, while in the experiment group it did not. During the post-intervention in the experiment group some participants needed to go to learning resource and it was requested that they sit the experiments on their own prior to their classmates in order to be able to leave. Overall these disruptions may have contributed towards the null hypotheses being accepted. To add to the limitations of the study, the intervention was carried out only once, on one day. This may have negatively impacted on the scores as external variables uncontrolled for may have skewed the data.

4.6 Further research

This study examined the effect if any that physical exercise has on short term memory and visual reaction time. As pointed out there have been many limitations that arose while carrying out the experiments. There are many areas of further research that could be explored within the 6th class age group to enhance findings. Firstly the memory tests themselves involved using two different sets of objects so as not to skew results. However, it is the fact that there were two different sets of objects that may have skewed results. It may be that one set of objects have certain advantages over the other set in the process of memory recall.

Further research is needed to eliminate this and to produce clearer results. On the other hand, the same test was used to record reaction time, so it may be that no advantage existed between pre-intervention and post-intervention. However, results showed although not significant, that both the groups improved post-intervention. This may suggest familiarity existed post-intervention. Further research could be carried out with a practice round to eliminate the participant's lack of knowledge in operation technique pre-intervention. An area of concern that arose during the experiments was with the teaching style. This may have had an impact in the current study. Further research could replicate the experiment using only one teacher thus controlling for teaching style that may result in a similar atmosphere in each group. A key limitation of this study was in the time taken to carry out the experiment. The tests were run once, on one day for both the control and experiment group. To achieve a more in-depth and significant result a longitudinal study could be used. As seen from the Hopkins et al., (2013) study the object recognition memory in rats only increased while physical exercise had been ongoing and returned to normal levels post exercise. This suggests that further research is needed into the effects physical exercise has on memory on a long term basis. This would provide a clear pattern to emerge as to the true effects of physical exercise on short term memory.

4.7 Implications

Results from this study and further research in the area of physical exercise and its effects on cognition can help to aid policy makers in amending school curriculum towards increasing physical exercise amongst pre-adolescents. Findings can also raise awareness of the importance of physical activity for good mental health and cognition. Many pre-adolescents are uneducated regarding the benefits of good health and fitness. To address this

problem changes are needed in the education curriculum as soon as possible. There are far reaching implications for the general public to heighten their awareness of exercise and of its importance for overall health and wellbeing. Findings from future research regarding exercise can transfer into knowledge on the health benefits of a healthy diet. With this information parents can then educate their children from an early age within the home about the benefits of a healthy diet. Children will then learn lifelong habits for healthy eating and exercise.

4.8 Conclusion

This study examined the effect physical exercise had on short term memory and visual reaction time in 6th class primary school students. A total of 44 students participated in a memory test and reaction time test pre-intervention and post-intervention, which consisted of physical exercise and SESE class work. Inferential statistics found a significant difference existed in memory recall within the groups, where both groups recalled more objects post-intervention. A significant difference was also found between the groups with the control group recalling more objects. This led to the null hypothesis being accepted for memory recall, as it was hypothesised that the experiment group should perform better. No significant difference was found in reaction time within or between the groups, resulting in the null hypothesis being accepted for visual reaction time. However inferential statistics showed a score approaching significance. Findings presented in this study do not support previous literature regarding the benefits of physical exercise. This may have resulted from the many limitations that emerged during experimentation. These limitations, if addressed can provide a future direction for research that may lead to findings similar to previous literature. It is crucial that research continues among the 6th class age group as existing literature does not

include research within this group. Results from further research can enable amendments to be implemented in the school curriculum regarding the health benefits of physical exercise.

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Appendices

Appendix 1

INFORMATION SHEET FOR PARENTS

Research topic: The effect of physical exercise on short term memory and visual reaction time.

Researcher: Meabh Nimmo . Contact: meabhnimmo@gmail.com

Supervisor: Dr John Hyland. Contact: john.hyland@dbs.ie

Dear Parents/Guardians,

Background and Purpose: In fulfilment of a BA (Hons) Degree in Psychology which I have undertaken, I am currently writing my research thesis. I am interested in conducting an experimental study that will involve looking at the effect physical exercise has on short term memory and visual reaction times among 6th class students.

What happens if my child takes part? I will be visiting your child's school during class time in January 2015 at a time arranged with the principal. I will ask all participating children in the class to perform a memory test, by means of viewing 25 objects and then to recall as many as possible. They will also perform a reaction time test by tapping a button on the laptop as soon as a light turns green.

How will my child's information be protected? The children's answers will remain confidential. All data gathered will be anonymous. The study's results will be displayed in a poster format and presented at the student symposium.

Voluntary Participation: It is up to you and your child to decide whether your child is going to take part or not. Participation is completely voluntary. Your child is free to withdraw at any time. I will remind the children of this when I meet them.

Important: The consent form: There is a consent form attached to this information sheet. Every child participating on the day must have a consent form which you have signed, as without it your child will not be allowed to take part.

I very much hope that you will agree to let your child take part in the research. If you require any assistance or have any questions about the research study, please feel free to contact me.

Thank you very much for supporting this research study. Please keep this information for your records.

PARENT'S CONSENT FORM

Research topic: The effect of physical exercise on short term memory and visual reaction time.

Researcher: Meabh Nimmo . Contact: xxxxx@gmail.com

Supervisor: Dr John Hyland. Contact xxxxx @dbs.ie

Parent's/Guardian's Name:

Child's Name:

I confirm that I have read and understood the Information Leaflet for Parents for the above research study. I understand what my child's involvement will be.

I have explained this study to my child and I am happy that he/she understands what is involved.

I understand that my child's participation is voluntary and that my child is free to withdraw at any time if she/he chooses to do so.

I understand that the information collected may be presented the student symposium, but that no child will be identifiable from the information.

I agree for my child to take part in the above study.

Signature.....

Room number.....

Date

Appendix 2

13/10/14

Ms. Loreto Desmond

Principal St. Cronan's Senior National School

Dear Ms Desmond,

RE: Permission to conduct a research study

I am writing to request permission to conduct a research study at your school. Currently I am undertaking a BA (Hons) in Psychology in Dublin Business School (DBS). As I have just entered my final year, I am writing a research thesis. This experimental study will involve looking at the effect physical exercise has on short term memory and visual reaction times among 6th class students.

This is an experimental study that involves two 6th classes. Both classes will carry out two short term memory tests and two visual reaction time tests (copies attached). Class A, the experiment group will be tested before and after a physical exercise class. Class B, the control group will be tested before and after a Social, Environment and scientific Education lesson. The experiment will be carried out during the school day and the impact on the curriculum will be minimised.

A debriefing will occur prior to the experiment and all aspects of the study will be explained. The students will be informed of the right to choose participation and to withdraw at any stage. A letter of parental consent will be sent to all parents prior to the experiment, which must be returned signed for permission to participate. All data gathered will be anonymous.

Data will be held in a file separate from the study for the period of one year, and then destroyed by shredding. Participants will be informed that the data gathered will be presented in a poster format at the student symposium. Ethical guidelines set out by the DBS and the Psychological Society of Ireland will be strictly adhered to. The study must be passed by the Board of Ethics for it to proceed.

Your approval to conduct this study would be greatly appreciated. I would be happy to answer any questions or concerns that you may have. You may contact me at my email address xxxxx@gmail.com or by phone: 087 xxxxxx.

If you agree, would you kindly send an e-mail to me, acknowledging your consent and permission for me to conduct this study at your school.

Yours Sincerely

Meabh Nimmo

cc: Dr Patricia Frazer, Lecturer Dublin Business School. 13/14 Aungier St, Dublin 2.

Memory test before intervention: <https://faculty.washington.edu/chudler/chmemory.html> (the memory game)

Memory test after intervention: <https://faculty.washington.edu/chudler/puzmatch.html>

Simple reaction time test: <https://faculty.washington.edu/chudler/java/redgreen.html>

Appendix 3



Scoil Chrónáin

St Cronan's Senior National School

17.10.2014

Dear Ms. Nimmo,

I refer to your letter of 13.10.2014 requesting permission to conduct an experimental study at St. Cronan's Senior National School. The Board of Management has agreed to allow this study to proceed as outlined in your letter.

Yours Sincerely,

A handwritten signature in black ink, which appears to read 'Loreto Desmond', is written over a horizontal line.

Loreto Desmond, Principal.

Appendix 4



Dublin Business School

Excellence through learning

13/14 Aungier Street
Dublin 2, Ireland
Telephone : (01) 417 7500
Facsimile : (01) 417 7543
E mail: admissions@dbs.ie
Web site: www.dbs.ie

DUBLIN BUSINESS SCHOOL / DBS SCHOOL OF ARTS
STATUTORY DECLARATION

I Maebh Nimmo of 38, The Warren Male
C.D. all

aged 18 years and upwards do solemnly and sincerely, declare that:

1. I am not and have never been engaged in any conduct which could result in a conviction for any offence under the Child Pornography Act 1998. I understand that the offences under the Act comprise child trafficking, the taking of children for the purposes of sexual exploitation, allowing children to be used for the production of child pornography, the dissemination of child pornography, and the possession of child pornography.
2. I have never been convicted of any criminal offence for assault, battery, rape, murder, false imprisonment or unlawful carnal knowledge.
3. I have also never been convicted of any criminal offence relating to the trafficking or possession of drugs for supply.
4. I have never been excluded from working with children.
5. I have read and agree to abide by the code of ethical conduct set out by the Psychological Society of Ireland currently in force at the date of making this Declaration and I agree to abide by this code as subsequently amended from time to time.
6. I have read and agree to abide by the guidelines as set out in the DBS Ethics Policy.
7. I have been informed and understand that if I make a false declaration regarding any of these matters Dublin Business School will immediately terminate my research in the department and that any qualifications from the School will be negated.

I make this declaration for the satisfaction of Dublin Business School believing the same to be true and by virtue of the Statutory Declarations Act 1938.

Maebh Nimmo
Signature

DECLARED before me by the said Maebh Nimmo

Who is personally known to me
(or who is identified to me by

Who is personally known to me) as The Queen Rd,
Malahide, Co. Dublin
In the City of Dublin this 14 day of October 2014

Mark A Kennedy
Commissioner for Oaths / ~~Practising Solicitor~~

Appendix 5.a

The memory test, before intervention:

<https://faculty.washington.edu/chudler/puzmatch.html>

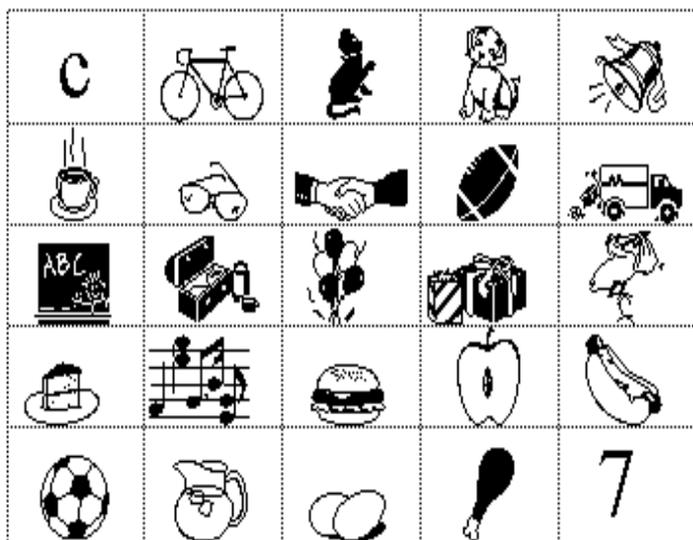


Appendix 5.b

The memory test, after to intervention:

<https://faculty.washington.edu/chudler/chmemory.html>

The memory game-25 objects.

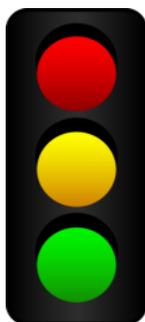


Appendix 7

The simple reaction time test:

<https://faculty.washington.edu/chudler/java/redgreen.html>

Test time	Reaction	The stopwatch to watch	The button Number to click
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Average score: _____