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Effects of physical exercise on recall of concrete and abstract words in pre-adolescents

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Abstract

The aims of the current study were to; establish the effect of physical exercise in the recall of concrete and abstract words and to explore whether recall of words would vary across genders. 35 participants; 14 females and 21 males between 10-12 years, from a local Dublin urban primary school participated in the study which involved a mixed method, with qualitative and quantitative data analysis and collection. A mixed design with a between and within groups criteria was also used. The independent variable was; physical exercise, while the dependent variable was recall. Participants watched and recalled both concrete and abstract words, pre-, and post-, physical activity on day 1, and sedentary activity on day 2. A significant difference in the recall of concrete words after exercise was established, with no significance of either of the words after sedentary activity. Furthermore, gender differences in recall were not found.

INTRODUCTION

Physical exercise (PE) has an array of benefits to the mind and body systems (Carpesen, Plowan & Smith, 2008), and is of vital concern in psychology. There is a growing interest in the field of psychology, education and sport (Martin, 2010) aiming to establish the link between PE and academic achievement. Technology is gradually introducing a modern way of enjoying sports. For example, Wii sports is a creative way to exercise, where everyone is in control of the amount of fun they get out of exercise, creating a 'flow zone' as people get immersed in the gaming experience (Sheehan, & Katz, 2012). With the already identified benefits of exercise, current research explores the immediate effect of exercise on short term memory, also, aiming to establish whether the concreteness effect is present among children. The study also strives to investigate whether there would be a difference in recall of words across genders.

Children and adults alike have replaced physical activity with inactivity, which has been established as a major risk factor to 35 chronic death-related conditions (WHO, 2002). Sedentary behaviour impacts negatively on children's cognitive development; an hour of television viewing before the age of 3 was found to have detrimental effects on attention (Christakis, 2009). Sedentary behaviour is not only observed in the home environment but also in Irish schools. The Department of Education and Skills (1999), recommended 60 minutes of physical education per week in primary schools. However, not all schools in Ireland use the recommended 60-minute period. Schools in Munster for instance, use at least 54 minutes per week on physical education as highlighted by the Irish National Teachers' Organisation (INTO), (2008).

Physical Activity

Physical activity (PA) is any bodily movement that is produced by skeletal muscles resulting in energy expenditure (Carpesen et al., 1985). PA is determined by several factors; physiological, physical, social-cultural and ecological factors surrounding the individual (Knuth, & Hallal, 2012). There is a major decline in the level of physical activity among children (Erickson, Kramer, & Hillman, 2008). More than 99% of children spend over 2 hours on sedentary activities, and when the 2 hours are exceeded, the children are likely to develop long term health problems (Woods, Tannehill, Quinlan, Moyna, and Walsh, 2010).

Over 43 million children below 5 years were diagnosed with obesity and among them; 35 million were in developing countries and 8 million in developed countries (WHO, 2002).In Ireland, Temple Street University Hospital (2013) found that 1 in 4 children are obese due to increased sedentary behaviours. In order to control for childhood obesity, Japan introduced a 'walk to school' practice that has been practised in the country over 50 years and has since reported lower levels of childhood obesity (Mori, & Armada, n.d.).

Researchers established that as age increased, so was the likelihood of the hours spent on sedentary behaviour; for instance, 13-18 year olds spent 4.5 hours on inactive behaviour, which was twice that of 10-12 year olds (Woods et al., 2010). It is important to note that age may not be the only contributing factor as other factors such as influence from others may also contribute to inactive behaviour.

According to Sallis, (1992), a parent's level of PA may determine the child's PA behaviour since parents act as role models (Bandura & Bussey 1999) to their children and identification with parents' leads to learning new behaviour, which may also contribute to the acquisition of sedentary behaviour. Recent research by the National Survey of Lifestyle Attitudes and Nutrition (SLAN), (2007) as cited in Friel, Nic Gabhainn & Kelleher (1999)

revealed that Irish adults are more sedentary in nature as less than half (41%) of them engaged in moderate to strenuous PA for at least 20 minutes 3 or 4 times a week. This could be used as a possible explanation for the findings by the Health Service Executive (HSE) (2009), which established that 9 out of 10 girls compared to 7 out of 10 boys do not achieve the recommended PA level.

For children and pre-adolescents, exercising is fun because of its exciting and pleasurable characteristics, which could be a potential promoter for PA in children. In addition, Hinson (2001), identified 5 essential motivating components for children to participate in PA; control, challenge, curiosity, creativity, and constant feedback. These characteristics could be identified as possible motivators for children to engage in more PA, as the flow theory states (Csikszentmihalyi (1988), as cited in Eccles, & Wigfield, 2002). Physical exercise not only improves health and psychological well-being of a person, but may also increase memory.

Effect of Physical Exercise on Memory and the Brain

The effect of exercise on children's working memory is of growing interest. In an attempt to establish the influence exercise has on memory storage in pre-adolescents, Pesce, Crova, Cereatti, Casella, & Bellucci, (2009), carried out an experiment with 52, 11-12 year olds who performed a test involving free recall of 20 items in a word list during 3 different testing sessions at school; two sessions directly followed by physical education lessons, which were characterised by exercise but different cognitive demands of social interaction. The third baseline was not followed by any exercise. Pesce et al., (2009), recorded both primacy and recency scores and they found that recall in both primacy and recency following both team games was better and delayed recall scores were higher after both team games and aerobic training, their findings led to the conclusion that exercise facilitates memory storage.

Conversely, too much exercise leads to dehydration which has a detrimental effect on information processing and memory functions, while submaximal aerobic exercise of up to 60 minutes facilitated specific aspects of information processing according to Tomporowski, (2003). Additional research by Erickson, Kramer, & Hillman (2008), highlighted that achievement in standardized tests of mathematics and reading was positively related to physical fitness scores. In addition, a positive relationship between physical fitness and academic achievement was established in 3rd and 5th graders who performed better on standardized academic achievement tests (Castelli, Hillman, Buck, & Erwin, 2007). However, researchers did not account for parents' level of education which could have contributed to the children's level of PA; a possible confounding variable. This raises the question on whether physical fitness equates to academic achievement.

An FMRI study established that physical exercise (PE) increased brain size in the basal ganglia and hippocampus and also increased cerebral blood flow which facilitated improved cognitive functioning (Kramer et al., 2003 as cited in Brown, Heath, & Martin, 2010). Additionally, aerobically fit 9-10 year olds outperformed less fit peers on cognitive control challenges that involved inhibition, cognitive flexibility, and short term memory. The fit children showed a superior performance on a modified compatible and incompatible flanker task, and maintained accuracy during compatible and incompatible trials, while the less fit children showed performance decrements during the task (Erickson et al., 2011). An MRI showed an increased volume in the dorsal striatum in the physically fit children, which led Erickson et al., (2011**)** to associate a physically active lifestyle during childhood with brain and cognitive health.

Further research showed that there was progress in comprehension of a reading passage after 10-13 year olds participated in PA, (Mead, Roark, Larive, Percle, & Auenson, 2013). Similarly, when preadolescents were introduced to a 9months PA programme, there

was an improvement in both the cognitive control of short-term memory and in Sternberg's task performance (Kamijo et al., 2011).

According to Tzu-Wei, & Yu-Min, (2013), regular physical activity increases serotonin, dopamine, and reduces noradrenaline, which increases brain neuroplasticity; a fundamental mechanism for learning, memory, and general cognition. Furthermore, Animal studies have also shown that exercise inhibits the death of dopamine producing cells, thereby increasing synaptic activity (Smith and Zigmond, 2003), and as the levels of dopamine increase, so does learning and memory. Further research has found that long-term exercise facilitates an increase in the production of brain derived neurotrophic factor (BDNF), which contributes to learning and recognition (Gligoroska, & Manchevska, 2012). Studies on memory have emphasised on the concreteness and abstractness of material; emphasising the idea that concrete words are easier to remember than abstract words (Coady, and Huckin, 1997).

Concrete and Abstract Words

Concrete words are concepts that can be pictured, while abstract words cannot be pictured (Clark, & Paivio, 1991). There is a concern for the development of abstract and concrete conceptual knowledge (Caramelli, Setti, Maurizzi, 2004). Different studies have established a concreteness effect (Clark, & Paivio, 1991; Schwanenflugel and Akin, 1994).

In one study, Caramelli, et al., (2004), obtained a sample of 120 Italian native speakers who were subdivided into 3 different groups according to ages 8, 10, and 12, each group had 40 participants. In their study, they had 80 words; 40 concrete and 40 abstract. Caramelli et al., (2004) assumed the children's familiarity of words because they occurred very often in tales and stories that children at the selected age were acquainted with. The nouns were presented by the school teachers, and when the words were presented, children

were required to write the first thing that came to mind when they saw the word presented e.g, 'rose,=>St. Valentine's day. The children were also required to rate the words on a scale of 1 to 7; 1 being unknown and 7, very familiar. From analysing the results, Caramelli et al., (2004), found that children rated concrete words as more familiar, while the rating of abstract words was judged as less familiar with ratings increasing from age 10 -12 years.

Similar research by Schwanenflugel & Akin, (1994), aimed to compare children's understanding of abstract and concrete words with that of adults. In the study, there were 15 adults and 15 children with a mean age of 7years, 11months. Words were presented on the screen with uppercase letters. They found that the image-ability pattern was higher in children than in adults, in addition, they also found that decision making time increased in adults as image-ability decreased.

Using an FMRI study, Mestres-Misse, & Rodriguez-Fornells, (2008) established a qualitative difference in learning, storing, and processing of concrete and abstract words as they activated different regions in the brain. New concrete words selectively activated the ventral anterior fusiform gyrus; a region boosted by image-ability which had previously been associated with the processing of concrete words (Mestres-Misse, & Rodriguez-Fornells, 2008). Further research established that concrete concepts were learned rapidly than abstract concepts, which were also learned more rapidly than number concepts, following the idea of Gestalt frame of reference where the dominance of mediating responses associated with a name was determined by the natural tendency to perceive concrete objects as familiar and easier to remember because their physical presence (Di-Viesta, Peters, Sanders, Schultz, & Weener, 1970).

According to Clark, & Paivio, (1991), concrete words are more likely to be remembered because they have imagery codes, as opposed to abstract concepts which have

none. Paivio's dual coding theory supported the idea that concreteness and imagery values primarily reflect the idea of accessibility to verbal and nonverbal representations; he also emphasised that concrete words are learned faster than abstract words. Additionally, concrete words have been shown to have an advantage over abstract words in recall and recognition; the concreteness effect Marschark & Paivio, (1977). An FMRI study found that different regions of the brain were activated when participants read sentences with abstract and concrete concepts and the sentences linked to concrete concepts yielded more activation in the bilateral posterior network; which indicates a difference in the neural substrates for semantic processing (Wallentin, Østergaard, Østergaard, & Roepstorff, 2005).

Children's Developmental Stage

Different exercise interventions may affect aspects of executive functioning depending on age as a result of differences in the maturation of the pre-frontal cortex (Tomporowski, Davis, Miller, & Naglieri, 2008). Besides, the effects of an exercise intervention may be mediated by social factors as Tomporowski, et al.,(2008) highlights. For instance, the co-ordination required for a group game like basketball may influence planning, while a simpler game such as skipping may not influence cognitive processes. To facilitate an understanding of a multifactorial behaviour like PA, there is a need to understand the role of the surrounding environment and children's cognitive development stage.

Children between middle childhood (6-11) and adolescence (12 years) are in their concrete operational period of learning and formal operational learning respectively (Piaget, 1952, as cited in Crain, 2005). During middle childhood (6-11), children's working memory is devoted to comprehension, and words are recognized effortlessly (Kail, & Cavanaugh, 2013). In addition, they acquire more general knowledge of their social, psychological and

physiological worlds which allows them to understand and with experience; they become more advanced in their thinking (Crain, 2005). Piaget (1952), as cited in in Crain, (2005) highlighted that the most important cognitive structure is attained during the concrete operational thought, characterised by concepts that enable a child to reason, where they begin to organise things into groups to form one logical crucial concept of classification**.**

Piaget (1952) emphasised on a constructivist approach that put emphasis on the role of environment on cognitive development (Cook, & Cook, 2005). In the theory, Piaget (1952) highlighted that an individual interacts with the environment where they organize their action to deal with the immediate environment, by organising their knowledge in different aspects. Adding to the constructivist approach, Bronfenbrenner (1994) proposed the ecological theory, which maintains that environment plays a role in a person's development, and among children, the most part in their lives is spent in a school, and during school years, people adapt different behaviours, and surrounding may contribute to a person's level of physical activity (Knuth, & Hallal, 2012). Environments may resist a range of physical activity behaviours, due to factors such as safety, accessibility of recreation facilities and transit options (Popkin, Duffey, & Gordon-Larsen, 2005).

At the onset of adolescence, changes in the body could result to reduced self-esteem according to Tremblay, Inman, & Willms, (2000), which affects the level of PA. Kail, & Cavanaugh, (2013), highlighted that during adolescence, females were the most affected, as they reported low levels of PA. Further research by Ortega, et al., (2013) identified a decrease in the amount of vigorous to moderate physical activity, and an increase in sedentary behaviour from childhood to adolescence. In addition, (Yungblut, Schinke, & McGannon, (2012), highlighted that early adolescence is a period where transition from PA occurs at its highest point among adolescents, highlighting issues such as self-efficacy, self-esteem, social,

and environmental factors. Hinson (2001), identified 5 essential motivating components for children to participate in PA; control, challenge, curiosity, creativity, and constant feedback.

Gender Differences in Recall

Gender differences on short-term memory processing have been examined explicitly (Zarei & Khazaie, 2011). In one study, male and female participants watched 60 pictures of objects; 15 in each quadrant for one minute, and had 3 minutes allocated to recall the objects and their locations, it was done on 3 successive trials (Hite, 2003). Women outperformed men in object recall, and performance increased with trials (Hite, 2003). On a verbal recall task, Mcgivern et al., (1998) aimed, to examine whether women's superiority in recall of words was due to their compliance to take instructions or as a result of greater verbal ability. Findings from the experiment established that females recognized significantly more abstract shapes and nameable objects than males; indicating that the greater recall was not due to their greater verbal ability.

Previous studies have shown the superiority of women to perform better in the recall of visual than audio words. May and Hutt, (1974) presented 20, 6 letter words, to 9 year olds. Thirty participants were allocated to each group and there was an equivalent number of males and females, in either of the groups; audio or visual. In the visual group, each word appeared for 5 seconds with a one minute delay before the other word was presented and they found that girls performed better than boys in the recall of visual words than audio words.

In an attempt to explain the major differences in the hemispheric organisation between males and females, McGowan and Duka, (2000) provided a manual task that involved finger tapping, and a verbal task that involved reciting words; the words were either presented visually or orally. The results showed a greater interference in right finger tapping (RH) than left finger tapping when the verbal task was presented in the visual mode; and

this was similar across both genders, and females showed a greater interference in finger tapping when the verbal task was presented orally than when presented visually. This led McGowan and Duka (2000) to conclude that males are better in mental rotation tasks as opposed to females.

Using a continuous memory and visual test to measure non-verbal visual recognition memory, Ullman et al., (1997) found no significant difference in the recall of objects across genders. In the study, Ullman et al., (1997), had 61females and 71 males from grade 1 to 5; each child was tested in one, 45 minute session. The acquisition phase of the continuous visual memory test (CVMT) was administered, following a 15 minute delay condition where children performed an unrelated drawing task, after which the delayed recognition and visual discrimination tasks from the CVMT were administered. Recall for objects in the CMVT was only present in older participants, with no significant gender difference in recall.

Rationale for Current Research

The emergence of programs specialising in exercise psychology has led to a renewed interest in evaluating the effects of exercise on cognition (Tomporowski, Davis, Miller & Naglieri, 2008). A growing amount of research has established that exercise may not only help to improve physical health, but may also contribute to improved academic performance (Tomporowski, 2003; Erickson et al., 2008; Pesce et al., 2009; Erickson et al., 2011) . Researchers highlight that there is limited research assessing the effects of exercise on children's development, thus recommending that more research should be conducted (Erickson et al., 2008; and Tomporowski et al., 2008).

In addition, previous studies have examined word ratings Caramelli et al, (2004), in children, and have also studied the processing of concrete and abstract words between adults and children (Schwanenflugel & Akin, 1994). Earlier studies have examined the effect of

exercise on short term memory, and have found conflicting results based on gender differences in recall; they have also studied the differences in the recall of concrete and abstract words. However, none of the studies have examined the immediate benefit of exercise in the recall of both concrete and abstract words.

Hypothesis

Present research hypothesises that;

- There will be a significant difference in the recall of concrete and abstract words before and after exercise.
- There will be a significant difference in the recall of concrete and abstract words after exercise between males and females.
- There will be no significant difference in the recall of concrete and abstract words before and after the sedentary condition.
- There will be no relationship between the amount of PA engaged in a week and the change score in the recall of concrete and abstract words on day 1.

METHODS

Participants

Convenience sampling was used to obtain 35, 5th and 6th class children between the ages of 10-12 from a local urban Dublin school. There were 14 females and 21 males in the study, and both had an equal chance of participating. The principal gave the guardian consent, as the study was considered non-invasive and insensitive. This was a voluntary participation, with no incentives being offered; it was made clear to the participants that they could withdraw from the study at any point. While analysing the results, outcomes from the children above the age of 12 were excluded and so were the results of the children who were not present at any point during the study.

Design

This was a mixed method study, comprising both qualitative data and quantitative data obtained from the PAQ-C (Kowalski et al., 1997); qualitative analysis involved answering 3 open-ended questions from the questionnaire, while quantitative data was the score obtained from the questions that required participants to rate on a likert scale the amount of PA they engaged in, over a week's period. PAQ-C, Kowalski et al., (1997), was used to establish whether the amount of PA that participants engaged over a week's period predicted the number of words recalled .The predictor variable was physical activity engaged in the past one week, while the criterion variable was recall of words.

In addition, a mixed design was also used; the within groups criteria, was where all participants studied and recalled both concrete and abstract words, males and females alike. While the between groups design involved comparing recall of concrete and abstract words pre-, and post-, exercise and sedentary conditions, and also comparing the recall of these

words across genders. The dependent variable was recall of both abstract and concrete words. The independent variable was physical activity, and the control, sedentary activity Small, (2000), which involved a puzzle game that required the participants to spot the differences between two different pictures. The sedentary activity Small, (2000) was structured in a way that the children worked in pairs or in trios and no more than 3 people were allowed in a group; the children were allowed to select their group members. The activity gave the children a chance for creativity and competition.

Materials and Apparatus

Materials

An original list of concrete and abstract words was obtained from Whelan et al., (2007). This was done to ensure that the words used were standard for the age of participants, based on their level of education. There were 80 words in the overall study; 40 concrete and 40 abstract words. A coin was tossed to establish the position of each category of words. The length of words varied from long to short letter words for instance, cat, love, chair, hate and knowledge. The words were prepared in advance of the presentation, and they were prepared on 20 PowerPoint slides and copied to an overhead projector for presentation to the participants.

The Physical Exercise Questionnaire for Children (PAQ-C), Kowalski et al., (1997) designed for classroom administration, was handed on the last day of the research; right after the sedentary activity. The questionnaire requires PAQ-C, Kowalski et al., (1997), was based in the United States, and to make it culturally relevant, the replacement of sports was agreed. Aerobics and floor hockey was substituted by Wii sports and hockey respectively, whereas street hockey and ice hockey were replaced by hurling and Gaelic respectively. The original questionnaire had ten items. In the first question, children were required to state the number

of times they engaged in physical activity during their spare time, and also to specify the kind of sport they engaged in. While the list had a limited choice of sports, children had an option to add any other sport they engaged in, and to rate the number of times their chosen sport was played in a week. Children were required to rate their chosen sport on a 5-point likert scale, with the categories grouped as; none, 1-2, 3-4, 5-6, and 6-7, the highest score was 5, and the lowest score was 1. The children were instructed to tick one box per row for the first question.

Question 2-8 required participants to rate how often they engaged in sports in their free time at home, during break time in school, lunchtime, after school, on weekends, in the evenings, during physical exercise classes and to rate how they would describe their level of physical activity over the past 7 days. These items were on a 5 point Likert scale, with 'very little' being the lowest and 'quite often' being the highest. The last question required the children to rate the amount of physical activity they engaged in everyday, Monday to Sunday, on a 5-point scale, with 'none' being the lowest and 'very often' being the highest. Question 2-9, had straightforward instructions that the children were instructed to tick one box per question. Questions 10, 11, and 12 had 3 open-ended questions that required children to state their general feeling about physical exercise, whether they thought exercise helped with their school performance and finally, to check whether there was anything that prevented the children from participating in physical activity, and if there was, the children were required to state the reason.

Only 9 items (1-9) were used when computing the scores. Each question was based on a 5-point scale; 1 being low activity and 5 being high activity. For item 1, a mean of all 23 activities was computed; this involved adding all the scores from every single activity and then dividing by 23, to get a composite score. In items 2-8, every question had a single answer, and all the scores were summed up. For question 9, a mean was obtained from 7 days

to form a composite score. While analysing the scores, the researcher added the 3 scores from question 1, 2-8 and 9, and divided by 9. A score of 1 indicated low physical activity, whereas a score of 5 indicated high physical activity.

Reliability and Validity of PAQ-C

The evidence for the reliability and validity of the PAQ-C was done on three studies Kowalski et al., (1997). In the first study, the item and property scale scores were examined. The study involved 215 children; 90 girls and 125 boys, the item correlation was above 0.3, and the scale reliability was acceptable for both males ($\alpha = 0.80$) and females ($\alpha = 0.83$). Recess and lunch had the lowest correlation with other items for males ($r = 0.33$ and 0.30 respectively) and females ($r = 0.42$ and 0.55 respectively). It was agreed to have acceptable measurement properties (Kowalski et al., 1997).

In the second study, PAQ-C's test-retest consistency and sensitivity to genders was examined using 43 boys and 41 girls between 9-14 years. The children were assessed at two time points during school hours. The internal consistency for the first assessment was ($\alpha = 0.79$) and ($\alpha = 0.89$) in the second assessment. This was as a result of weather conditions, however, the questionnaire showed sensitivity to gender differences in PA levels, as boys appeared to be more physically active than girls (Crocker et al., 1997).

In order to validate the questionnaire, Kowalski, Crocker, & Faulkner,(1997) examined the construct, divergent and convergent validity. Thirty eight boys and 51 girls completed a behavioural conduct scale, an athletic competence scale and the PAQ-C on activity rating. The PAQ-C's moderate correlation with perceptions of athletic competence ($r = 0.48$) provided support for the construct validity of the PAQ-C. Divergent validity of the PAQ-C was supported by no relationship between the behavioural conduct scale and the PAQ-C. Gender differences were found on the PAQ-C and teacher's rating of physical

activity (Kowalski et al., 1997). Current study established reliability score of ($\alpha = 0.908$).

Apparatus

A list of 80 English concrete and abstract words was prepared for presentation in an overhead projector, and a recall sheet was used at the end. The words were installed in Microsoft PowerPoint of an ASUS laptop. A HTC phone timer was used to time the participants. The researcher made sure before commencing the study that every participant had a pen or pencil, to write the words in the recall sheet.

Procedure

The research proposal was subject to authorization from Dublin Business School Psychology ethics committee, and in order to pass ethics, a signed statutory declaration form, and a letter of access from the school principal were required. On presentation of both, permission to conduct research was granted by the ethics committee. When the dates were confirmed from the primary school principal, the research commenced. Research was voluntary, with no incentives being offered. It was also made clear to the participants that they could choose to drop out from the study at any point. It was important that the research was conducted at the same time and day, as it was done for two days on a weekly basis.

Before commencing the research, participants were given a brief verbal outline of the study (Appendix), and what was expected of them. The researcher also made it clear that the research was not an exam or spelling test, they were made to feel at ease before commencing the research, and they were allowed to ask questions before the study, to ensure that they were clear on what was supposed to be done. Participants were urged to remain quiet, even after the list of words was exhausted, as talking would affect their recall ability. They were

also not allowed to confide in their friends. There were 80 words in the overall study; 20 words appeared at each time; 10 abstract and 10 concrete. The words were presented at different time points; before and after sedentary and exercise conditions. The study was carried out on a weekly basis; day 1, 20 words before and 20 words after exercise, and on day 2, 20 words before and 20 words after sedentary activity (Small, 2000).

On day 1, a list of 20 (10 concrete and 10 abstract) power point slides were projected on the screen. Each word appeared on the screen for 6 seconds. The words appeared in the screen for 2 minutes, after which, the researcher handed the recall sheets to the participants, which took an extra minute. When everybody had the recall sheet, participants were asked to start writing as many words as they could remember and to stop writing when the researcher asked them to. The participants were asked to write their age and gender after the 3 minutes of recall.

After recall of words, participants engaged in a physical activity (exercise) in the school gym, which lasted for 15 minutes. The form of exercise involved vigorous dancing, which was directed by the teacher. Children were given room for creativity; they could select a dance move that everyone had to imitate. After 15 minutes, the children returned to the classroom and on settling, a different list of 20 words was projected on the screen. After the 2 minutes of watching the list of words, the same procedure was repeated. They were handed recall sheets, and they were required to write as many words as they could remember, and to only write their age and gender after the 3 minutes of recall. The two classes were tested separately; the researcher started with 5^{th} class children, followed by 6^{th} class. The rules of the study applied to both classes. The researcher made sure that the two classes engaged in a vigorous dance activity, and they danced to the same music which the teacher provided. The two classes were presented with a similar list of words.

The researcher returned to the school after a week, and commenced research with the 5th class students. Participants were reminded of the procedure, and when they clear of the process, a different list of 20 words, 10 abstract and 10 concrete was presented. Just like day 1, they are to write as many words as they could remember in the recall sheet in a span of 3 minutes. Instead of physical exercise, the participants engaged in a sedentary activity Small, (2000) that required them to spot the differences between two pictures. Participants were allowed to work either in pairs or in trios. The children were allowed to select the people in their group. This allowed for room for creativity and competition. After 15 minutes, the participants were motioned to return to their original positions, and they were presented with a different list of 20 words; 10 abstract and 10 concrete and recall in a 3 minutes span. After the recall, a 10-item physical activity questionnaire for children (PAQ-C) Kowalski et al., (1997), was handed to the participants to find out how often they engaged in physical activity during the week. The researcher and the teacher were present throughout the period. The researcher asked the children to raise their hands if they required any sort of help in filling in the questionnaire. After the children handed the questionnaire, they were fully debriefed. This procedure was also applied for 6th class children, who participated in the study after the 5th class children.

RESULTS

Qualitative analysis of data

Participants were required to state whether anything stopped them from engaging in physical activity. Half of the female participants highlighted to have been sick for the past one week, listing problems such as stomach bugs, stomach pain as the main reason why they could not engage in PA. Nonetheless, all participants highlighted that they enjoyed physical exercise, describing how they felt about exercise in words such as; “it is fun”, “I feel better at things I couldn’t do”, “I feel free, happy and active”. The importance of peers did not go undetected as some participants felt that they could only enjoy activity with friends. For instance, one of the male participants described exercise as; “fun with friends”, while a female participant highlighted that she liked going walking/running with friends. Despite the enjoyable characteristics, most of the participants felt that exercise did not contribute to their academic achievement.

Quantitative Analysis of Data

Descriptive Statistics

On computing the scores from the PAQ-C, Kowalski et al., (1997), the mean was 2.77, which meant that the children engaged in low to moderate physical activity over a week’s time.

From table 1, it is clear that the means for concrete and abstract words differed, before and after exercise, and before and after sedentary. The maximum and minimum number of concrete words recalled before exercise was 8, and 1 respectively, while after exercise, the maximum was 10, and minimum, 2. In abstract words, the maximum and minimum number of words recalled before exercise was 8, and 2 respectively, whereas after

exercise, the maximum and minimum number of abstract words recalled was 8, and 2. In the sedentary condition, the maximum and minimum number of concrete words recalled before sedentary was 8 and 1 respectively, while after exercise the maximum was 8, and minimum, 2, in the correct concrete words recalled. In the recall of abstract words before sedentary, the maximum number of correct words was 9, and a minimum was 1. After sedentary, the maximum number of correct words recalled was 10, while the minimum number of words recalled was1.

Table 1 Descriptive statistics for words pre-and post-, sedentary and exercise conditions.

	Before exercise	After exercise	Before sedentary	After sedentary
Concrete words				
Mean	5.37	6.77	5.14	5.03
SD	1.8	2.12	1.65	1.58
Abstract words				
Mean	5.09	5.40	5.40	4.60
SD	1.62	1.78	2.2	2.09

Inferential Statistics

Data was analysed using SPSS version 21. A histogram was run to check for normality in distribution. The data was normally distributed therefore parametric tests were used.

Relationship between concrete change score and PAQ-C

The concrete change score was correlated with the amount of PA every participant engaged in a week. The mean score was 1.4 (SD= 1.65). A Pearson's correlation coefficient found that there was no significant relationship between the amount of PA engaged in over a week's time and the number of words recalled ($r(35)= 0.056$, $p= 0.751$). Therefore the null was rejected.

Relationship between abstract change score and PAQ-C

To establish whether there was a relationship between the amount of PA engaged in over a week's time and the recall of abstract words, the mean score for abstract change score was 0.31 (SD = 2.37). A Pearson's correlation found that there was no relationship between PA and the number of abstract words recalled, ($r(35) = 0.085$, $p = 0.625$). Therefore the null hypothesis was rejected.

Recall of concrete words, pre-, and post exercise

The descriptive statistics for the recall of concrete words pre, and post exercise shows that the mean score for concrete words pre-exercise was 5.37 (SD=1.8), however, the mean for recall of concrete words post-exercise was slightly higher at 6.77, SD=2.12. The 95% confidence limits shows that the mean difference lies somewhere between -1.966 and -0.834. A paired sample t-test found that there was a significant difference between the number of correct concrete words recalled after exercise than before exercise, ($t(34) = -5.024$, $p<.001$). Therefore, the null hypothesis was rejected.

Recall of abstract words pre-, and post-, exercise

The descriptive statistics for the recall of abstract words pre-, and post-,exercise show that the mean score for the recall of abstract words pre-exercise was 5.09 (SD=1.62), however, the mean for recall of concrete words post-exercise was slightly higher at 5.40, (SD= 1.78). The 95% confidence limits shows that the mean difference lies somewhere between 0.501 and -0.783. A paired sample t-test found that there was no significant difference between the number of correct abstract words recalled before or after exercise, ($t(34) = -0.783$, $p = 0.439$). Therefore, the null hypothesis was retained.

Recall of concrete words pre- and post-, sedentary activity

The descriptive statistics for the recall of concrete words pre-, and post-sedentary activity show that the mean score for the recall of concrete words pre-sedentary was 5.14 (SD=1.65), however, the mean for recall of concrete words post-sedentary was slightly lower at 5.03, (SD= 1.58). The 95% confidence limits shows that the mean difference lies somewhere between -0.491and 0.720. A paired sample t-test found that there was no significant difference between the number of correct concrete words recalled after sedentary activity, ($t(34) = 0.384$, $p = 0.704$). Therefore, the null hypothesis was retained.

Recall of abstract words pre- and post-, sedentary activity

The descriptive statistics for the recall of abstract words before and after sedentary activity show that the mean score for the recall of abstract words pre-sedentary was 5.4 (SD=2.2), however, the mean for recall of abstract words after sedentary activity was slightly lower at 4.6 (SD= 2.09). The 95% confidence limits shows that the mean difference lies somewhere between -0.189 and 1.789 A paired sample t-test found that there was no significant difference between the number of correct concrete words recalled after sedentary activity, ($t(34) = 1.645$, $p = 0.109$). Therefore, the null hypothesis was retained.

Gender differences in recall of concrete words after exercise

Females (mean= 7.36, SD= 1.86) were found to have recalled more concrete words after exercise than males (mean= 6.38, SD= 2.22). The 95% confidence limits found that the means lie between -2.243 and 0.491. An independent samples t-test found that there was no significant difference in the recall of concrete words after exercise ($t(33) = -1.354$, $p= 0.531$. Therefore the null hypothesis was retained.

Gender differences in recall of abstract words after exercise

In the recall of abstract words after exercise, females had a mean of 5.93, SD= 1.68, slightly higher than males; mean= 5.05, SD=1.80. The 95% confidence limits found that these means lie between -2.114 and 0.352. An independent samples t-test found that there was no significant difference in the recall of abstract words after exercise (t (33) = -1.453, p= 0.156. The null hypothesis was retained.

DISCUSSION

The purpose of this study was to examine the immediate effect of physical exercise on the recall of concrete and abstract words, to explore whether the recall of words could differ across genders, and finally, to establish whether the concreteness effect is present among pre-adolescents.

After analysing the data, the results found that significantly more concrete words were recalled after exercise, these findings were in line with (Caramelli et al.,2004; Keeling and Porter, 2005; Erickson et al., 2011; Kamijo et al., 2013). The study revealed that there were no significant gender differences in recall of concrete words, which was contrary to previous studies that found that gender differences existed in recall, (May & Hutt, 1974; Hite, 2003; and McGowan & Duka, 2000). In addition, there was no significant difference in the recall of concrete and abstract words before and after the sedentary condition. The results from the study also found that there was no relationship between the amount of PA engaged over a week's time and the ability to recall either of the categories of words. This showed that exercise has an immediate benefit on memory.

Concrete and abstract words

Research on the concreteness and abstractness of material has been examined explicitly. In a study, Caramelli et al., (2004), examined word familiarity task in Italian children between the ages of 8 and 12. The children were required to rate the familiarity of 40 concrete and 40 abstract words on a scale of 1 to 7, where 7 was 'very familiar'. They found that the children rated concrete words as more familiar than abstract words. In addition, Schwanenflugel and Akin (1994) also found that word meaning had a decided influence in lexical processing in children; and that children took longer in processing abstract concepts as opposed to concrete concepts.

Among the earliest studies on concreteness and abstractness of material by Clark and Paivio,(1991), they highlighted that concrete words were more likely to be remembered than abstract words because of their imagery codes. In the dual coding theory, Clark & Paivio (1991) highlighted that cognition involves the activity of two subsystems; a verbal system set aside for dealing specifically with language, and a non-verbal system (imagery), specialised for dealing with non-linguistic objects and events. Clark & Paivio (1991) assumed that the systems were composed of internal representation units called logogens and imagens that were activated when an individual thought of a word or things. They highlighted that the representations was connected to a sensory input and output to function cooperatively or independently to mediate non-verbal or verbal behaviour.

Furthermore, Di-viesta et al., (1970), emphasised the idea of gestalt frame of reference which highlighted that there was a dominant mediating response determined by people's natural tendency to perceive concrete objects without abstracting smaller features and therefore, the concepts on objects were easiest to learn, and recall. According to Di-Viesta et al., (1970), sensory perception of concreteness appears to be more rapid than that of abstractness and numbers, which may be as a result of dominance, preference, or complexity associated with the stimulus. To support the findings of Clark and Paivio, (1991), studies using an FMRI by Mestres-Misse & Roudrigues-Fornells, (2008), established that concrete and abstract words activated different regions in the brain; concrete words were found to activate the ventral fusiform gyrus; a region boosted by image-ability. Previous research show that the concreteness effect exists, and in processing, that there is a difference in activation occurring in the brain. The current study is in collaboration with previous studies in that it found that concreteness effect is present in children.

Effect of exercise

The results of this study found that significantly more concrete but not abstract words were recalled after exercise. Although previous studies did not focus on the effect PE has on the recall of concrete and abstract words, the increase in short-term memory processing could be used to explain these findings.

Previous studies found that short term memory increased after participants engaged in PE. These results were in line with those of Pesce et al., (2009), who had 52 participants between the ages of 11-12. In their study, the pre-adolescents were required to recall 20 items in a word list at 3 different time points; two of the sessions followed PE, while the third session was not followed by any exercise, they found that recall of words increased after participants engaged in a team game as opposed to when participants did not engage in any form of exercise. Further research by Mead et al., (2013), found that there was an increased in the comprehension of a reading passage after 10- 13 year olds engaged in physical exercise.

While analysing the qualitative research data, it was noted that most pre-adolescents enjoyed PE, which could be considered as a possible motivator for engaging in PA. Among the characteristics related to motivation include fun, in a way that the children do not realise that they are exercising; a characteristic highlighted during the study. Hinson (2001), identified 5 essential components for children to participate in PA; control, challenge, curiosity, creativity, and constant feedback, while the children in this study were allowed by their teachers to be creative in terms of innovating dance moves, they seemed to be enjoying their level of control among fellow students and the all seemed to be enjoying the activity, and the obtained a flow, which is the achievement of the optimal state of intrinsic motivation and the willingness to participate in PA (Csikszentmihalyi, 1990). Flow theory, posits that the state of flow occurs when individuals are engrossed in their activity and they discover an internal

feeling of accomplishment and enjoyment, and when children are engaged in a flow experience, there is equilibrium between their ability and the challenge Csikszentmihalyi (1990).

Gender differences in memory

The results of this study are in conflict with May & Hutt (1974), whose research indicated a significant gender difference in the recall of words, presented visually. In their study, May & Hutt (1974), presented a list of 20, 6 letter words, to 9 year olds, in audio and visual conditions, they had an even distribution of genders in both categories, and 30 participants in each group; 15 males and 15 females. In the visual condition, girls outperformed boys, while there was no significant gender difference in the recall of audio words presented. To account for the results, May & Hutt (1974) highlighted that it was important to consider a tendency for an earlier maturation in girls, and emphasised that their findings could only offer a partial support, and stressed a need for further research in this area. In addition, the findings of the current study were inconsistent with those of Hite, (2003), who had female and male participants watching 60 objects, and had 3 minutes allocated to recall of the 15 objects in each quadrant, where females recalled more objects than men in increased trials.

The results of current study are similar those of Ullman et al., (1997) who found no significant difference in the recall of objects across genders. In their study, Ullman et al., (1997), had 61 females and 71 males from grade 1 to 5, where participants were tested on a continuous memory and visual test to measure non-verbal visual recognition memory. Researchers found that older children performed better than younger children, and there were no significant gender difference observed in the recall. However, current research failed to examine the difference in the recall between younger participants and older participants. Furthermore, current study had a limited number of female participants, which could have contributed to these findings.

Limitations and Implications for Future Research

Current research was conducted in one urban school, which had a considerably low number of female participants and researcher had not controlled for environmental factors which have long been shown to affect people's level of physical activity (Popkin, Duffey, & Gordon-Larsen, 2005). Furthermore, socio-economic status and parents' level of education was also not accounted for as it could have also contributed to children's PA levels.

The duration of exercise was relatively short (15 minutes) contrary to previous studies which had an extensive exposure to PA for up to 60 minutes (Tomporowski et al., 2003). The 15 minute duration was due to time constraints, as Irish primary school program runs for less than 6 hours. The school curriculum allocated 60 minutes of physical education per week (Department of Health and Skills, 1999), and since the study was carried out on a Friday, children had already had their 60 minutes exhausted, by the time the research commenced.

Besides, the PAQ-C may not be a satisfactory measure for PA as is relies on self-report, which could be an inaccurate measure for PA due to recall bias. Furthermore, the questionnaire does not provide specific caloric expenditure, or frequency, and intensity of exercise; it simply provides a general score of the activity level (Kowalski et al., 1997). Moreover, children had difficulty responding to the amount of PA they engaged in during lunch time as the school has strict rules on standing up while eating, they are strictly supposed to remain seated. The PAQ-C, does not account for different school programs, bearing in mind the little time in schools per day. This study was carried out during the winter season, where winter bugs are inevitable; as a result, most girls reported a change of PA routine. In addition, the researcher did not compare the level of PA between young adolescent males and females; a composite score for the overall level of physical activity in females was accounted for, due to the frequency of their report in reduced PA over a week's time.

Previous studies highlighted that PA is highly affected during the onset of adolescence with females reporting reduced PA (Tremblay et al., 2000; Ortega, et al., 2013; Yungblut et al., 2012).

Future research in this area should incorporate a measure of self -esteem, as it could affect motivation, and an individual's level of physical activity (Popkin, Duffey, & Gordon-Larsen, 2005). Furthermore, researchers should consider the children's social economic status by carrying out different sets of research, comprising urban and rural schools; to compare their level of activity and recall of concrete and abstract words. A larger sample is also recommended, with an even distribution of genders. Future research should be conducted during warmer seasons where the likelihood to miss sports is slight. In addition, the researchers should also measure the level of physical activity in both early adolescent males and females as current research reported reduced physical activity in adolescent females.

Conclusion and implication of findings

This research project may contribute to the enlightenment of the importance of physical activity in the development of children. It also supplements the limited body of research that has focused on how physical activity affects the recall of concrete and abstract words. It further offers an understanding of the immediate benefits of physical activity. Current research hopes to create awareness to school children, by showing the immediate benefits of short-term physical activity. While PA may contribute to cognitive development, children should be careful not to exercise to exhaustion, as dehydration may result to damaging effects in information processing (Tomporowski, 2003). Moreover, children should be encouraged to consistently engage in physical activity as a physically active regime during childhood has been linked to brain and cognitive health (Erickson et al., 2011).

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APPENDIX

Questionnaire

Physical Activity Questionnaire (Elementary School)

What age are you? _____

Boy_____ girl_____ Class: _____

We are trying to find out about your level of physical activity from ***the last 7 days*** (in the last week). This includes; sports or dance that make you sweat or make your legs feel tired, or games that make you breathe hard, like tag, skipping, running, climbing, and others.

Remember:

1. There are no right and wrong answers — **this is not a test**.

2. Please answer all the questions as honestly and accurately as you can

1. Physical activity in your spare time: Have you done any of the following activities in the past 7 days (last week)? If yes, how many times? (<u>Mark only one per row</u>)

	No	1-2	3-4	5-6	7 times or more
Skipping	□	□	□	□	□
Rowing/canoeing	□	□	□	□	□
In-line skating	□	□	□	□	□
Tag	□	□	□	□	□
Walking for exercise	□	□	□	□	□
Bicycling	□	□	□	□	□
Jogging or running	□	□	□	□	□
Wii Sports	□	□	□	□	□
Swimming	□	□	□	□	□
Baseball, softball	□	□	□	□	□
Dance	□	□	□	□	□
Football/ soccer	□	□	□	□	□
Badminton	□	□	□	□	□
Skateboarding	□	□	□	□	□
Hockey	□	□	□	□	□
Hurling	□	□	□	□	□
Volleyball	□	□	□	□	□
Gaelic	□	□	□	□	□
Basketball	□	□	□	□	□
Ice skating	□	□	□	□	□
Cross-country skiing	□	□	□	□	□
Handball	□	□	□	□	□
Other_____	□	□	□	□	□

2. In the last 7 days, during your physical education (PE) classes, how often were you very active (playing hard, running, jumping, throwing)? (Check one only.)

I don't do PE ..... □

Hardly ever..... □

Sometimes ..... □

Quite often ..... □

Always ..... □

3. In the last 7 days, what did you do most during *break time*? (Check one only)

Sat down (talking, reading, doing schoolwork)…… □

Stood around or walked around ..... □

Ran or played a little bit ..... □

Ran around and played quite a bit ..... □

Ran and played hard most of the time ..... □

4. In the last 7 days, what did you normally do *at lunch* (besides eating lunch)? (Check one only)

Sat down (talking, reading, doing schoolwork)… □

Stood around or walked around ..... □

Ran or played a little bit ..... □

Ran around and played quite a bit ..... □

Ran and played hard most of the time ..... □

5. In the last 7 days, on how many days *right after school*, did you do sport, dance, or play games in which you were very active? (Check one only)

None ..... □

1 time last week ..... □

2 or 3 times last week ..... □

4 times last week ..... □

5 times last week ..... □

6. In the last 7 days, on how many *evenings* did you do sports, dance, or play games in which you were very active? (Check one only)

None ..... □

1 time last week ..... □

2 or 3 times last week ..... □

4 or 5 last week..... □

6 or 7 times last week ..... □

7. *On the last weekend*, how many times did you do sports, dance, or play games in which you were very active? (Check one only)

None ..... □

1 time..... □

2 — 3 times ..... □

4 — 5 times ..... □

6 or more times..... □

8. Which *one* of the following describes you best for the last 7 days? Read *all five* statements before deciding on the *one* answer that describes you.

A. All or most of my free time was spent doing things that involve little

Physical effort .....…… □

B. I sometimes (1 — 2 times last week) did physical things in my free time

(E.g. played sports, went running, swimming, bike riding, did aerobics) .....…… □

C. I often (3 — 4 times last week) did physical things in my free time .....…….. □

D. I quite often (5 — 6 times last week) did physical things in my free time ……... □

E. I very often (7 or more times last week) did physical things in my free time …….. □

9. Mark how often you did physical activity (like playing sports, games, doing dance, or any other physical activity) for each day last week.

	None	Little bit	Medium	Very Often	Often
Monday	□	□	□	□	□
Tuesday	□	□	□	□	□
Wednesday	□	□	□	□	□
Thursday	□	□	□	□	□
Friday	□	□	□	□	□
Saturday	□	□	□	□	□
Sunday	□	□	□	□	□

10. Were you sick last week, or did anything prevent you from doing your normal physical activities? (Check one)

Yes .....……□

No ..... □

If **yes**, what prevented you? _____

11. How do you feel about exercise? _____

12. Do you think exercise helps you with your school work?

_____

Sedentary Activity

Find The Differences!

Verbal Instructions

- I am carrying out a study to see whether the exercise you engage in school, may you with your school work. I am going to show you a list of 20 words; the list is very long, so wait until the last word has been exhausted.
- This study requires you to pay attention to a list of words on the screen. After the list

  I will hand you a recall sheet.
- After 3 minutes of recalling, you will hand in your recall sheet, and then we are going to engage in a 15 minutes exercise.
- Do not speak to your neighbour as you might forget the words you watched.
- You are not allowed to note the words elsewhere, during the process
- After the list of words, I will hand you a recall sheet, where you are going to write as many words as you can remember.
- The order of the words does not matter.
- It is not an exam! You are not being penalised on spelling mistakes.
- You may choose to withdraw from the study at any point

Recall Sheet

a. What age are you?

b. Please circle whether you are: Boy or Girl

Write as many words as you can remember. Please stop writing when I ask you to stop.

1.
2.
3.
4.
5.
6.
7.
8.
9.
10.
11.
12.
13.
14.
15.
16.
17.
18.
19.
20.

Abstract/concrete words Day 1

DAY 1: ***Pre-exercise***	Day 1: ***Post-exercise***
Key	Chair
Banana	Coin
Understand	Behaviour
Apple	Listen
Scissors	Dislike
Flavour	Shirt
Joy	Helmet
Nose	Jealous
Love	Bag
Arm	Water
Remember	Trouser
Pigeon	Advice
Beans	Table
Umbrella	Anger
Ability	Book
Honour	Television
Hate	Believe
Cat	Pencil
Calm	Sad
Smell	Faith

Abstract/concrete words, Day 2

DAY 2: ***Pre-sedentary***	*DAY 2:* ***Post-sedentary***
Headache	Peace
Fear	Tomato
Bicycle	Permission
Ticket	Trouble
Courage	Screen
Train	Happy
Wisdom	Teddy
Rain	Pencil
Knowledge	Kindness
Scooter	Shoes
Woman	Mercy
Nervous	Computer
Anger	Hope
Neighbour	Glass
Noise	Joy
Mood	Horse
Neck	Patience
Flower	School
Bulb	Fruits
Pain	Freedom