Relationship Between

Physical Exercise, Sleep

Attention and Re-call Memory

Olga Brych 1570730

Course Code HBAPSY3F

Submitted in partial fulfilment of the requirements of the Bachelor of Arts degree (Psychological Specialization) at DBS School of Arts, Dublin

Supervisor: Dr. J. Murphy

Head of Department: Dr. S. Eccles

March 2013-04-01

Department of Psychology

DBS School of Arts
Content Page

Acknowledgement 3

Abstract 4

Introduction 5-17

Methodology

Participants 18

Design 18-19

Measures 19-20

Pilot Study 20

Procedure 20-21

Results 22-29

Discussion 30-39

References 40-55

Appendix 56-73
Acknowledgement

I am grateful to my supervisor Dr. J. Murphy for allowing me to run the experiment in his class, the support and insight throughout the project. Many thanks to the participants that volunteered to take part in the research, without whom the study would not have been completed. I would also like to thank Dr. S. Eccles for any additional help throughout the process. I am in debt to Susan Honnon and Fiach Caffrey-Treacy for help and support throughout the project.
Abstract

The current research looked at relationship between physical exercise, sleep, attention and recall of pictures memory performance. Sample representative of 80 undergraduate psychology students were split in to two groups: no distraction during picture presentation and white noise distraction. Auditory distraction was hypothesised to impair phonological loop technique participants may use. Results did not support the hypotheses. Further analysis revealed a significant relationship between physical exercise and attention; attention and memory in females; attention and memory in group that received white noise distraction.
Introduction

In 1968, Gorbunov demonstrated that physical exercise can have an effect on cognitive performance such as problem solving. Since then there has been number of studies suggesting relationship between exercise and many cognitive functions such as reaction time, working memory, reasoning (Clarkson-Smith & Hartley, 1990), speed of cognition (McMorris & Graydon, 2000) and executive-control processes (Colcombe & Kramer, 2003). Weuve and colleagues (2004) using a longitudinal study found an association between higher level of exercise and cognitive functions in women. One of the cognitive functions that have been associated with physical exercise is memory.

“Memory is defined as processes that maintain information over time” (Matlin, 2009, p.21) and these processes are encoding, storage and retrieval. According Atkinson and Shiffrin’s (1968) influential Multi-Store Model (MSM) which includes features of many memory models proposed in the 1960’s, there are three memory stores or structures: sensory memory, short-term (STM) and long-term memory (LTM). When stimulus is perceived it moves to sensory register, influenced by attention the stimulus or information is rehearsed in short-term memory after which it is then stored in long-term memory and can be retrieved via short-term memory when needed. Each structure differs in capacity, duration and mechanisms of forgetting. Even though the model was proposed in the 1960’s it has been widely influential and has been supported by neuropsychological research (Nee & Jonides, 2011).
Despite the influence the Multi-Store Model appears to ignore implicit memory, treats all information as equivalent and has over simplistic view of short-term memory. Baddeley and Hitch (1974) suggested that short-term memory is more complex than what Multi-Store Model suggests and redefined it as working memory (WM).

Baddeley have also contributed to the research of phonological loop in relation to working memory. Phonological loop consists of two components: the phonological store and articulatory rehearsal processes. Phonological store has a limited capacity thus allows the retention of verbal phonetic information for a limited time. Articulatery rehearsal processes able to keep items in the phonological store from decaying. Phonological loop allows for a better remembrance of items by repeating the information, similarity to an audiotape. According to early studies of Baddeley et al. (1984) the length of words affects the memory, short words recalled better than long words. However Lovatt et al.’s (2000) research contradicts Badelley et al. as results demonstrate no difference between long and short (disyllable) words in spoken recall and picture-pointing recall tasks.

Noise may act as an auditory distraction during the re-call task as the irreverent noise may impair phonological loop technique. For instance Banbury et al (2001) demonstrated that background sound had an effect on efficiency in performing cognitive tasks. It is also reported by Hygge et al. (2003) that road traffic noise and meaningful irrelevant speech impairs re-call text and retrieval from semantic memory. Marsh et al. (2008) also demonstrate that irrelevant background sound disrupts the free re-call of semantic information. It is evident that noise may play as a distracter in short-term memory tasks. However according to Berti and Schrōger (2003) working memory is able to coordinate the maintenance of auditory distractibility and manage to focus on the task demand.
Working memory and short-term memory may share similar cognitive functions, for instance perceiving information and using retrieved information from long-term memory. Some researchers argue there is a difference. As emphasised by Kail and Hall (2001), short-term memory and working memory tests measure different processes, for instance working memory uses decoding whereas short-term memory does not. Engle and colleagues (1999) using multiple tests argue that although short-term memory and working memory are distinct, they use the same memory system and often rely on each other. Short-term memory is a system that is involved in storing small amounts of information for a brief period of time (Baddeley et al., 2009). There are different ways that short-term memory can be coded or represented; these are auditory coding (involves sound), visual coding (involves items represented visually) or semantic coding (items represented in terms of their meaning).

**Physical Exercise and Memory**

Number of studies suggests a positive relationship between memory and physical exercise. Many studies focus on how physical exercise can improve memory in older adults (Hill et al., 1993; Stones & Dawe, 1993). Colcombe and colleagues (2006) present a study of fifty-nine older adults (age 60-79) performing aerobic fitness exercise in space of 6 months. After the training significant increase in brain volume was observed, particularly in white and gray matter regions that are associated with various cognitive functions. Erickson and colleagues’ (2011) research suggests that spatial memory improves in older adults due to increased size of the anterior hippocampus that is led by aerobic exercise. The study suggests that exercise protects against volume loss, which may consequently influence memory function. The hippocampus shrinks in late adulthood and according to Erickson et al.’s (2011) study exercise offers improvement of spatial memory due to reversing hippocampal volume loss.
What about adolescence and young adults? Normally young people do not suffer from hippocampal loss, therefore should it be assumed that physical exercise will not have any effect of memory in young people?

Coles and Tomporowski (2008) conducted a study with young adults performing recall memory tasks before and after 40 minutes of moderate aerobic exercise on a cycle ergometer. Results in this study suggest no relationship between exercise and short-term memory in young adults. However Coles and Tomporowski (2008) were measuring how short-term memory is influenced by exercise-induced arousal, therefore measuring re-call memory immediately after the exercise. This may not have a sufficient influence on participants as the physical exercise performed at the experiment may not be adequate to have any impact on the physical state that may have influenced short-term memory. For instance in the study performed by Erickson and colleagues (2011) participants performed exercise over six months before participating in a memory test, not 40 minutes before.

Perhaps more acute exercise is necessary to facilitate short-term memory. According to Pesce and colleagues (2009) this may be the case. Participants in their study were the school preadolescence age (11-12) and similarly to Coles and Tomporowski (2008) study performed a free-recall memory task with physical exercise, in this case aerobic circuit training, team games or no physical exercise. Pesce et al. (2009) using between participants design found that an acute bout of submaximal exercise may facilitate memory storage. Researchers also propose that memory storage may be facilitated by cognitive activation induced by cognitive exercise demands, not only by exercise-induced increases in physiological arousal.

More compelling evidence is offered by Lambourne (2006). Her research examined relationship between physical activity and reading span as working memory capacity in
young adults (aged 19-30). Results of the study demonstrate a relationship between the two variables. As working memory is a part of cognitive functioning that requires effortful processing, Lambourne (2006) suggests that exercise may have an effect on these processes even before they declines due to aging.

In addition to structural changes in hippocampus various neurological studies suggest that prolonged exercise may also have a positive impact on memory. Many involve animals such as rats. In 1979 Olton, Beckera and Handelmann used lesioned rats to demonstrate that hippocampus is responsible for working memory. Since then there has been a various studies in relation to the hippocampus and memory]. For instance daily treadmill exercise during adolescence increases hippocampal expression and improves spatial learning and memory in Wistar rats (Gomes da Silva et al., 2012). Memory improvement and an increase number of maturing granule neurons in the hippocampus in rats due to exercise were also observed by Van der Borght et al. (2007). Hippocampus volume and memory performance have also been associated with Alzheimer’s disease (Laakso et al., 1995; Collie & Maruff, 2000; Eichenbaum, 2000).

Sleep and Memory

Although there are a considerable number of studies demonstrating relationship between physical exercise and memory, there may also be other variables that may be responsible for memory performance. For instance studies highlight how sleep plays a crucial role in memory in procedural (Cohen et al., 2005) and motor memory (Walker et al., 2003). One of the purported functions of sleep is to allow consolidation of the material learned while wakening period. The phenomenon is known as sleep-dependent consolidation (Stickgold, 2005; Marshall & Born, 2007). As shown above studies on physical exercise and memory suggest that the improvement in memory may be associated with hippocampus. Hippocampus
may also be associated with sleep and memory (Borm et al., 2007; Daoyun & Wilson, 2007; Marshall & Born, 2007). Peigneux and colleagues (2004) demonstrated using virtual town navigation learning that hippocampal activity during slow-wave sleep is significantly correlated with spatial memory performance the next day.

Different stages of sleep tend to influence consolidation of many memory functions. For instance episodic memory and visual discrimination tasks are better remembered after slow-wave sleep (Gais et al., 2000; Scullin, 2012) where as declarative memory is improved more so after REM sleep (Fogel et al., 2007).

Studies also emphasize that the quality of sleep is crucial for memory consolidation (Stickgold & Walker, 2007), working memory (Steenari et al., 2003) and recall memory (Henderson et al., 2012) in children. Schabus and et al. (2004) demonstrate that spindle activity during second stage of sleep is highly correlated with amount of recalled words. The study highlights the importance of sleep in information reprocessing and declarative memory consolidation.

Studies also highlight importance of sleep in academic performance. Elkin and Murray (1974) studied how sleep affects students using short-term memory. An undergraduate group of students that had been deprived of sleep made significantly more errors in a short-term memory recognition task than those who were not deprived of sleep. Elkin and Murray (1974) suggest that sleep loss causes a deficit in attention, which may be responsible for the poor performance. A corresponding study and results was reported by Chee and Chuah (2007) who looked at reduced storage capacity and process contributed to appropriate information encoding in short-term memory after a good night sleep and sleep deprivation. Results indicate that sleep deprivation impaired short-term memory. Chee and
Chuah (2007) suggest that this could be due to deficits in visual processing and visual attention that is caused by sleep deprivation and result in short-term memory impairment.

According to Curcio, Ferrara and Gennaro (2006) study many students who posses a poor sleep quality have a poor performance in academic performance and learning capacity. Dewald et al (2010) and Taras with Potts-Datema (2005) looked at relationship between sleep and academic performance in children and adolescence. Results suggest that factors such as sleep quality, sleep duration and sleepiness influence academic performance amongst school students. Gais et al. (2006) demonstrated a research independent of fatigue, time of day, and the amount of interference during retention intervals. Study consisted of a group of students learning list of English-German words and going to sleep after three hours and a group of students going to sleep after ten hours. The results indicate a significant difference between the two groups, where those who got three hours sleep recalled more words.

Evidently sleep promotes better academic performance and memory. Most researches focus on memory and academic performance in students after periods of deprived sleep. Yet does the quality of sleep over long period promote short-term memory? According to Li Deming’s (1985) research sleep habits may also influence short-term memory. In the study college students that described as good sleepers performed better at short-term memory digit span task than those that reported to be poor sleepers. There is also evidence of a relationship between sleep quality and memory in older adults with subclinical depression (Sutter et al., 2012) and between poor sleep quality and patients with memory complains (Hancock & Larner, 2009).

Number of studies suggest that young adults experience poor quality of sleep in students in Palestine (Sweileh, 2011), the USA (Buboltz, et al., 2009), poor sleep was also studied in Japan in relation to behavioural problems (Takeru ey al., 2010). According to
Lèger and co-workers (2008) 56% of US, 31% of Western Europe and 23% of Japanese general population suffer from sleep problems. As highlighted above sleep quality may play an important role in memory processing. It may be beneficial to promote sleep as according to the previous research many students do not obtain a healthy sleep pattern. Currently there is a lack of research about quality of sleep amongst individuals who study in Ireland and the effects of quality of sleep on short-term memory. Researching sleep quality amongst students in Ireland and short-term memory performance may reveal interesting results and perhaps the information may benefit academic performance.

Physical Exercise and Sleep

There is also some evidence promoting that there may be a relationship between sleep quality and physical exercise. Zhanhg and Diao (2006) using PSQI test which measures quality of sleep demonstrated that quality of sleep may influence physical exercise habits amongst college students. PSQI was also used by Lund and colleagues (2010) who propose a relationship between poor-quality sleepers and reported physical and psychological problems amongst student population. Montgomery and Dennis (2009) grant evidence that regular physical exercise is able to promote a good quality of sleep in older adults as exercise provides relaxation and raising core temperature that is beneficial for initiating and maintaining sleep. According to Wallace (2012) students who sleep short amounts have a poorer sleep quality, which may influence their physical and mental health. Research evidence persuade the importance of physical exercise and good quality of sleep, however there is limited evidence about sleep quality and the amount of physical activity on a typical day of students.
Gender and Memory

Research suggests difference in gender in relation to cognitive functions (Weiss et al., 2003; Jorm, 2004; Maylor et al., 2007). Memory is one of the cognitive functions that women appear to perform better than men. For instance Maitland and colleagues (2000) implemented a longitudinal research during which they observed gender differences in cognitive performance over seven years. Results of the study suggest that females performed better than males in verbal recall task, independent of age influence. Similarly Lowe et al.’s (2003) research results demonstrate female outperformance in verbal task memory, whereas higher performance in spatial task memory was apparent in males, amongst children and adolescence. Corresponding within-group and between-group design study Kaushanskaya et al.’s (2011) demonstrated that women outperformed men in phonologically-familiar novel words but not in phonologically-unfamiliar words. According to Evolutionary Neuroandrogenic Theory (Ellis, 2011) women may over perform men in verbal-recall task because they posses more superior abilities that involve language than man because of women’s leftward shifted brains. Males on the other hand have greater interest in academic subjects that involve spatial reasoning, for instance advanced mathematics or engineering, because of men’s rightward shifted brains.

Attention and Memory

Attention is another variable that may be associated with memory performance. Attention allows selection and processing a portion of the perceptual information that is received and involves concentration of mental activities (Matlin, 2009). It also allows focusing on certain aspects of environment and ignores other aspects. If it was not for attention regulating perceptions overload of sensations may occur. Attention requires mental effort, therefore has a limited capacity. For instance early Filter Theories of attention,
Broadbent’s (1958) bottleneck for example, suggest that attended information is allowed through the filter and other information is blocked out. However Treisman (1964) found that there can be a breakthrough in the bottleneck as some information that is unattended is still processed semantically. Treisman (1964) proposed Attenuation Model of attention in which she argues that filter simply reduces analysis of unattended stimuli. Recent studies by Lacher and colleagues (2004) confirmed Broadbent’s theory and demonstrated that people cannot identify a visual stimulus unless they pay attention to it. Appling Lacher and colleagues’ (2004) findings it can be argued that attention should be considered when measuring memory as if the stimulus is not played attention to, the stimulus more likely not be remembered. Role of attention in short-memory performance can also be argued as an important one when considering Late Selection Models. According to this model filtering occurs later as stimuli moves to short-term memory first where it is analysed for meaning (Mackay, 1973).

Although filter theories propose a valid argument and research of the processes involved in the attention, they are mostly focused on single processers and do not explain divided attention and limited to auditory attention. A recent Perceptual Load Theory proposes that the amount of attentional capacity dedicated to task depends on perceptual (cognitive) load (Lavie, 2005). Attention is necessary so that limited capacity of short-term memory does not become overloaded. Lavie (2005) demonstrated that varying cognitive load influences whether people will be affected by distracters using a flank-compatibility task.

In 1960 Sperling’s studies on visual sensory memory (iconic memory) demonstrated the role attention plays in short-term memory. The average number letters that participants remembered in his study was four out of nine. Sperling performed number of experiments, including flashing lines of words then signalling a tone, with each line having its particular tone. After seeing nine letters on the screen, participants heard a high, middle or low tone, which indicated to focus their attention on a specific line of words in their iconic memory,
they were then asked to select the correct line from their mental imagery and recall them. After a brief delay participants had no problem recalling the correct line of words with accuracy. These findings indicate that people are able to recall visual images with better accuracy if they focus their attention.

Since then various studies have been performed focusing on the role of attention in memory. For instance Awh and Jonides (2001) provide evidence of a relationship between spatial attention and spatial memory. Awh with Vogel (2006) also highlight different approaches and theories about the role of attention in memory performance. One of them attention is described as a “gatekeeper” for working memory. Because only three or four objects are able to be maintained simultaneously within the capacity of working memory (Vogel et al., 2001), attention is able to bias encoding information to the items that are most relevant to the current goal. Awh and Vogel (2006) provide evidence of the “gatekeeper” theory applying the intentional blink paradigm, as after two sequenced visual targets are presented observers report the second target several hundred milliseconds after the first one. Awh and Vogel (2006) give numerous other processes, theories and approaches that highlight the relationship between working memory and attention.

**Current Study**

Compelling research evidence suggests the important part that attention may have on memory performance. Previous research concerning influence of physical exercise on short-term memory did not consider the role of attention or sleep (e.g. Lambourne, 2006; Coles & Tomporowski, 2008; Pesce et al., 2009) in their research. The purpose of the current study is to investigate the relationship between short-term memory performance and a typical daily physical exercise as well as to measure sleep quality and attention amongst college students. A convenience sample of approximately 80 participants will be administered a Godin
Leisure-Time Exercise Questionnaire in order to measure physical activity, Pittsburgh Sleep quality Index to measure sleep quality and a attention task will be implemented as those variables may have influence on memory. In addition two groups will be formed, approximately 40 in each group. Group one will presented with 16 pictures and asked to recall them; Group two in addition will have white noise present during presentation of pictures. It is assumed that white noise will act as attentional mask or auditory distraction to impair phonological loop strategy that individuals may apply during the presentation. It is hypothesized that:

- High Godin Leisure-Time Exercise Questionnaire scores will significantly correlate with high scores on short-term recall task in both groups
- Quality sleep score will positively correlate with memory performance score in both group
- There will be a positive relationship between sleep quality and physical exercise amongst college students.
- Attention performance will positively correlate with memory performance
- Female students will perform higher on memory task in Group one and Group two than male students.
- There will be a difference between Group one and Group two memory performance

The results of the study will contribute to a better understanding of the influence of physical exercise and short-term memory in young adults; collaborate to the previous literature within the relevant research by examining influential variables such as sleep quality and physical exercise to memory performance. Study will also contribute toward a growing research of influence of physical exercise on sleep quality. Research will also benefit to a
better understanding of physical habits and sleep quality amongst Irish college students’ sample. The present study will contribute to a better understanding of variables that may influence memory, and benefit student in their academic performance.
Methodology

Participants

Participants were 80 undergraduate psychology students at Dublin Business School. Group 1 (no noise) had 36 participants and Group 2 (white noise) had 44 participants. The sample consisted of 25 male and 55 female students, with 10 males and 26 females in Group 1 and 15 males and 29 females in Group 2. Students ranged in age from 18 to 48, with a mean age of twenty-seven. Mean age in Group 1 was thirty-two years and in Group 2 was twenty-two years. No students under age on 18 were considered in the study, for legal reasons.

Participants were recruited during their psychology class to volunteer in a study. Administration of questionnaires, memory and attention tasks occurred in two different psychology classes. Class one was assigned to no white noise during memory task (Group 1), in the second class participants received white noise during memory task (Group 2). No deception was used in the study and participants were informed that the study is anonymous and participation is voluntary.

Design

Independent variables/predictor variables included sleep quality, physical activity, attention, gender, age and white noise. Dependent variable/criterion variable was memory performance. Between participants design was used to measure the difference in memory performance with white noise and no noise during picture presentations in two groups. There was no particular method of assigning participants to groups. Part time psychology student
were assigned to Group 1 and full time psychology students were assigned to Group 2. The study was partly correlational, looking in correlations in sample population as a whole (both groups) in physical exercise, sleep quality, attention and gender. The study was also partly experimental by applying white noise condition to Group 2 and no noise to Group 1.

*Measures*

Participant’s attention was measured using awareness video task retrieved from You Tube website (Playwithvideo, 2010). The video consisted of counting the words in red that appeared on the screen with pictures in the background, participants were asked to write down did they notice objects in the background and what were the objects. Memory re-call task consisted of 16 pictures of objects (such as cat, train, watch) that were taken from Pezdek et al.’s (1986) study. The pictures of the objects were assessed from Microsoft Clip Art and were put together using Microsoft Power Point. Pictures were displayed one after another using projector, with 4 seconds between the pictures.

Godin Leisure-Time Exercise (Godin & Shephard, 1997) questionnaire was used to measure physical activity. Participants were asked a self-explanatory, brief four item questions of their usual leisure-time exercise habits (strenuous, moderate and mild exercise). Godin Leisure-Time Exercise questionnaire have been reported to have over 2 retest reliability coefficients (Cronbach’s $a$) of 0.48 for mild, 0.46 for moderate, and 0.94 for strenuous exercise, indicating a high degree of internal consistency (Ekkekakis et al., 2008).

To measure participants sleep quality, Pittsburg Sleep Quality Index (PSQI) self-rated questionnaire was used. PSQI asserted participants’ sleep quality and disturbances over a one month interval and contained 19 questions. The resulting scores ranged 0 to 21, with 0 indicating no difficulty and 21 indicating severe difficulties in sleeping. PSQI have been
reported to have reliability coefficient (Cronbach’s $a$) of .83, indicating a high degree of internal consistency (Buysse et al., 1989).

Regardless of a group participants were offered sweets at the end of the study as appreciation for participation in the research.

*Pilot study*

Pilot study was executed in concern with pictures that were chosen from Microsoft Clip Art. For the purpose of validity and reliability the objects were taken from Pedzdek et al.’s (1986) research. Because Pedzdek and colleagues had used real object for their study it was impossible to obtain pictures of those objects for the present study. For the pilot study three participants were presented with pictures of the objects form Pedzdek et al.’s (1986) study that were obtained from Microsoft Clip Art and were asked to write down objects that they perceived from the pictures. Results indicated 95.83% accuracy and resemblance to Pedzdek et al.’s (1986) study. The aim of the pilot study was to make sure that there was no ambiguity about the pictures and that they represented objects that they were meant to represent.

*Procedure*

Participants, regardless of the group were presented with two parts. First they were asked to participate in attention task, which was followed by a memory task. Students were asked to recall using pen and pencil the objects they have seen on the projection screen (pictures available appendix 1). Participants in Group 2 were presented with white noise during presentation of the pictures; Group 1 did not have any noise.

The second part consisted of answering questionnaires (complete questionnaire available appendix 2). Demographics questionnaire consisted of age and gender. Godin
Leisure-Time exercise questionnaire was assessed to measure participants’ amount of physical exercise and Pittsburgh Sleep quality Index (PSQI) was assessed to measure participants’ quality of sleep.

In addition to the attention task, memory task and questionnaires, participants were asked to write down any concerns, questions or any inconvenience they felt they had with the study. This provided any limitations information that participants felt about the study may have and could be improved on.
**Results**

*Descriptive Statistics*

Participant ages ranged from 18 to 48 years, with mean of 27 years. Overall, the sample out of 80 participants included 69 % females and 31 % male students. There was no difference between ration of male and female participants in noise and no noise groups. However mean age for Group 1 (no noise) was 32 (SD = 6.51) and Group 2 (noise) had a mean age of 22 years (SD = 3.17). Age and gender variables are also displayed in histogram format, Group 1: Figure 1; Group 2: Figure 2.

![Histogram](image)

*Figure 1 Histogram representing gender and age of participants in Group 1*
Figure 2 *Histogram representing gender and age of participants in Group 2*

Psychological measures are provided in Table 1. Mean scores for memory performance (maximum 16) in Group 1 was 9.67 (SD = 1.94) and in Group 2 mean was 9.07 (SD = 1.21). Other variable were analysed as a whole, regardless of groups. Attention performance (maximum of 4) had a mean of 2.28 (SD = 1.15); sleep quality (0 no difficulty, 21 difficulty in sleeping) had a mean of 6.49 (SD = 3.23), also represented in Figure 3; physical exercise had a mean of 53.16 (SD = 63.20).

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Memory Group 1</td>
<td>9.67</td>
<td>1.94</td>
</tr>
<tr>
<td>Memory Group 2</td>
<td>9.07</td>
<td>2.49</td>
</tr>
<tr>
<td>Attention</td>
<td>2.28</td>
<td>1.15</td>
</tr>
<tr>
<td>Physical Exercise</td>
<td>53.16</td>
<td>63.20</td>
</tr>
<tr>
<td>Sleep Quality</td>
<td>6.49</td>
<td>3.23</td>
</tr>
</tbody>
</table>
Figure 3 Simple line representing Sleep quality scores; 0=no difficulty; 18=difficulty

Inferential Statistics

An Independent sample t-test found that there was no statistically difference between memory performance in group that received noise and the group that did not (t (77) = 1.039, p = .302). Therefore the null is accepted. Similarly Independent sample t-test did not find significant difference between male and female memory performance (t (78) = -1.221, p = .226), attention (t (.221) = 1.510, p = 1.35), sleep (t (.165) = .523, p = .603) and physical exercise (t (27.083) = 1.676, p = .105).

By using Pearson correlation coefficient it was found that there was no significant relationship between sleep quality and memory performance in group one (r (36) = .075, p = .663) or group two (r (44) = -.094, p = .545). Therefore the null hypothesis is accepted.
Pearson correlation coefficient also found that there was no significant relationship between physical exercise and sleep (r (80) = -.03, p = .781). Therefore hypothesis is rejected.

Using simple regression it was found that physical exercise did not predict memory performance in group one (F (1, 34) = .097, p = .758, R² = .03) or in group two (F = (1, 42) = .038, p = .847, R² = .01). Therefore hypothesis is rejected.

Further Analysis

An Independent sample t-test found that there was a statistically significant difference between age in Group 1 and Group 2 (t (49) = 9.058, p = .000). Group 1 (mean = 32.44, SD = 6.509) was found to have older age than Group 2 (mean = 21.70, SD = .478). The Confidence limits shows that the population mean difference of the variables lie somewhere between 8.356 and 13.123. These findings may have implications when discussing research limitations and difference between groups.

Pearson correlation coefficient found that there was a weak positive significant relationship between physical exercise and attention (r (80) = 0.23, p = .04). The mean scores for physical exercise was 53.16 (SD = 63.20) and attention was 2.28 (SD = 1.45).

Further data analysis using simple regression revealed that physical exercise significantly predicted attention (F (1, 78) = 4.37, p = .040, R² = .23). Confidence limits were slightly narrow, showing that the population slope is between .000 and .008 (physical exercise, beta = .230, p < .001); Further details refer to Table 2 and Figure 4.
Table 2 Simple Regression significant results

<table>
<thead>
<tr>
<th>Variables</th>
<th>Correlation</th>
<th>p</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical exercise &amp; attention</td>
<td>.230</td>
<td>.040</td>
<td>80</td>
</tr>
<tr>
<td>Attention &amp; memory group one only</td>
<td>.355</td>
<td>.018</td>
<td>44</td>
</tr>
<tr>
<td>Attention &amp; memory females only</td>
<td>.493</td>
<td>.000</td>
<td>55</td>
</tr>
</tbody>
</table>

*p significant at .05 level

Figure 4 Simple Scatter plot representing causal relationship between Physical Exercise and Attention

Interestingly there was also a relationship between attention and memory only in a group that received noise. The mean score for attention was 2.30 (SD = 1.21) and for memory performance was 9.07 (SD = 2.49). A Pearson correlation coefficient found that there was a
moderate significant relationship between attention and memory (r (44) = 0.36, p = .018) in group 2 only.

Further analysis revealed that attention significantly predicted memory performance in Group 2 only (F (1, 42) = 6.066, p = 0.18, R² = .13). Confidence limits were slightly narrow, showing 95% confidence that the population slope is between .13 and 1.33 (attention, beta = .355, p = .018). Further details refer to Table 2. Casual relationship is demonstrated in Figure 5.

![Figure 5 Simple Scatter plot representing causal relationship between Attention Performance and Memory Performance in Group 2 only](image)

Relationship between attention and memory was also observed in gender differences. The mean score for attention was 2.15 (SD = 1.08) and for memory performance was 9.55
(SD = 2.28). Pearson coefficient found that there was a moderate significant relationship between attention and memory ($r (55) = 0.49$, $p = .000$) in females only.

Using simple regression it was found that attention significantly predicted memory performance in females ($F (1, 53) = 17.05$, $p = .000$, $R^2 = .24$). Confidence limits were narrow between .537 and 1.552 (attention, beta =.493, $p = .000$). Causal relationship is demonstrated in Figure 6.

![Figure 6](image_url)

Figure 6 Simple Scatter plot representing causal relationship between Attention Performance and Memory Performance in Females only

Due to significant findings in relationship between attention and memory in females and Group 2 participants, additional analysis using an Independent sample t-test was carried out to investigate the differences in male and female attention and memory performance in two groups. An Independent sample t-test found that there was no statistically significant
difference between attention performance (t (42) = 1.205, p = .24) and memory performance (t (42) = -1.424, p = .16) between male and female participants in Group 2.
Discussion

The purpose of the present study was to examine a relationship between physical exercise, sleep quality, attention and short-term memory in sample of college students. It was hypothesized that physical activity would significantly influence short-term memory; furthermore relationship would exist between attention, sleep quality and short-term memory performance; there would be a positive relationship between physical activity and sleep quality; it was also hypothesised that there would be a difference between Group 1 and Group 2 short-term memory performance and there would also be a difference between male and female performance in short-term memory in both groups. Present data did not support any of the hypotheses and contradict previous research.

Nevertheless further analysis of results of the current data revealed a number of appealing findings. It was found that physical activity questionnaire significantly predicted attention performance; attention positively affected memory performance in female students only and also attention positively affected memory performance in a group that received white noise.

Physical Exercise and Memory

Current study did not support the hypotheses or previous research. The inconsistencies with previous research results may be due to the discrepancies between method’s design, materials and sample representative. For instance in relation to relationship between physical exercise and memory, Lambourne (2006) administrated a specifically designed by Cooper Institute for Aerobics Research instrument to measure physical activity.
The instrument included questionnaires, BMI measure and metabolic equivalent task value. Physical activity measure in the current research was assessed using Godin Leisure-Time Exercise short questionnaire. Short questionnaire may not be equivalent or sufficient enough to measure physical activity. Participants may also have biases towards the questionnaire and not answer truthfully or answer desirably. Perhaps by directly controlling physical exercise similarly to Colcombe et al. (2006) and Pesce et al. (2009), rather than asking about physical activity habits results may indicate a causal relationship between physical activity and memory performance.

Contradiction to previous finding may also lie in means of measuring memory performance. In the current study picture re-call task was assessed to measure short-time memory performance. Lambourne (2006) applied reading span task adapted from Daneman and Carpenter (1980) which required recall of the last word of each sentence, measuring working memory performance. As highlighted by Kail and Hall (2001) short-term memory and working memory tests measure different processes. Working memory tests require participants to maintain target items while performing concurrent cognitive processing. They differ to traditional short-term memory tasks by imposing dual-task demands thus require more than passive storage of target memory items (Miyake, 2001). Perhaps the differences in processes and requirements in short-term memory and working memory are affected differently by physical activity. Perhaps working memory task would have been more appropriate than short-term recall task.

Sleep and Memory

Although there is a rich amount of research demonstrating effect of sleep on memory performance, the current study does not contribute to the previous research. Pittsburgh Sleep Quality Index scores did not correlate with short-term memory performance in undergraduate
students. By reviewing previous studies that had found a relationship between sleep and memory it is evident that most of the past research was implemented over period of time. Perhaps additional measure and questionnaires over phase of time would give a bigger picture and summery of sleep quality. Also majority of research report positive affect of sleep on long-term memory, rather than short-term memory. For instance it is evident that sleep benefits memory consolidation (Stickgold & Walker, 2007). Henderson (2012) reported that children’s ability to recognize and recall the nonwords improved only after sleep (approximately 12 hours). Steenari et al. (2003) measured participants’ actigraphy and sleep performance over 72 consecutive hours. Elking and Murray (1974) and Chee and Chuah (2007) have found that deprivation of sleep significantly reduces short-term recognition task. Gaise et al. (2006) demonstrated that students who went to sleep after three hours of learning English-German words have re-called significantly more words than those students who went to sleep after ten hours. Perhaps sleep affects long-term memory performance rather than short-term memory as sleep influences a better consolidation of memory learned during the day over night.

Physical Exercise and Sleep

Previous studies (Zhanhg & Diao, 2006; Lund et al., 2010) investigating a relationship between physical exercise and sleep have used the same sleep quality measure as the current research. However unlike previous research the current study did not find a relationship between those variables. Current study contributes to previous research that fails to find a relationship between physical activities and sleep quality (Youngstedt et al., 2003; Oudegeest-Sander et al., 2013). Perhaps there are other variables that may have an effect on the relationship between physical exercise and sleep. For instance general health, frequent mental distress, activity limitations, depressive symptoms, anxiety (Strine & Chapman, 2005), environmental noise (Muzet, 2007) and food habits (Imaki et al., 2002).
Gender and Memory

Owing to previous research it was hypothesised that female participants will perform better in memory task than male participants, hypothesis was not supported in the current study. However majority of previous research focused on the verbal re-call memory performance (Maitland et al., 2000; Lowe et al., 2003; Kaushanskaya et al., 2011), rather than picture re-call memory. There are limited recent studies that suggest that females outperform male participants in visual re-call task. McGuinness and McLaughlin (1982) found that even though females did not outperformed males in visual recognition memory, females did outperform male participants in visual-recall task. However sample representative in the study was relatively small (20 males and 20 females) and the research was carried out 31 years ago. Poulne et al. (2004) demonstrated that estrogen hormone in fetal development influences visual recall abilities in females. Yet more research is required in this area.

Attention and Memory in Females

Although current research did not demonstrate that females outperform male participants in memory re-call task, it was found that attention significantly predicted memory performance in female participants only. Previous research suggests that perceptual encoding in visual cortex is greater when people view pleasant pictures (Schupp et al., 2003) as sensory encoding of affective stimuli is promoted by natural selective attention. In other words a pleasant stimulus promotes approach towards that stimulus and an unpleasant stimulus promotes avoidance. Talmi et al. (2007) demonstrate that emotionally enhanced memory for positive pictures is mediated by attention. It has also been demonstrated that pictures displaying fear-inducing images facilitate greater hemodynamic response in males than females (Schienle et al., 2005). Perhaps because objects were displayed in animated
manner they were perceived joyous and positively, thus perceived more by female than male participants.

Nevertheless female participants did not merely outperform male participants in memory re-call task. Those female participants that performed well in attention task also performed well in memory re-call task. These findings may support previous research by suggesting a relationship between attention and memory (Awh & Jonides, 2001; Awh & Vogel, 2006), providing perceived positive picture stimuli affect (Schupp et al., 2003) by female participants.

Attention and Memory in Groups

It was hypothesised that attention will significantly affect memory performance in both noise and no noise groups. Interestingly attention exclusively affected participants that received noise during memory task. Previous theories suggest that attention allows focusing on certain relevant aspects in the environment and ignore or reduce focus on the irrelevant aspects (Broadbent, 1958; Treisman, 1964; Awh & Vogel, 2006). In the current study participants that performed well in attention task also performed well in memory task exclusively when the white noise was present during memory task. The purpose of the white noise during memory task was to eliminate phonological loop strategy that individuals may apply during images presentation.

Previous studies suggest that distracting sounds reduces concentration, impairs attention and cognitive performance. For instance Gumenyuk et al. (2004) demonstrated that distracting novel sounds increased reaction time and impaired performance accuracy in forced-choice visual task in children (8-13 years). Evidence also demonstrates that auditory distraction during memory tasks impairs memory performance (Hygge et al., 2003; Marsh et al., 2008). However Sørvqvist et al. (2013) review multiple studies that have failed to find a
relationship between working memory capacity and effects of auditory distraction on visual-verbal cognitive performance. Consequently, Sörlqvist et al. (2013) conclude that individual differences in working memory capacity may be related for magnitude of distraction.

The study was carried out using sample representative of Dublin Business School students. The college is located in the middle of the Dublin city. It is possible that because the college location, students became habituated by the irrelevant sound (...street noises, traffic noises) and white noise did not serve as a distracter. For instance Elliot and Nelson (2001) demonstrated that habituation to auditory distracters reduced interference in color-naming task.

During attention task participants were asked to count the words in red that appeared in the video. However their attention was measured by how many (if any at all) images participants noticed in the background. It is possible that this slight defraud of what was expected from the attention task that guided participants to thinking that there was more expected from memory task also. It is possible that the white noise that was not warned about may have indicated participants to pay additional attention to the images.

Although there was a causal relationship between attention and memory in Group 2 and attention and memory causal relationship in females, there was no relationship between those variables in Group 2 female participants. The relationship seems to appear over all female performance in two groups. Thus it may be concluded that female participants outperform male participants despite of white noise distraction.

Age and Memory

In addition, Group 1 consisted of second year part-time students (mean age 32 years) and Group 2 consisted of second year full-time students (mean age 22). It is possible that
memory performance was influence by the mean age of the two groups. There is evidence that suggest that age may have influence on memory performance. For instance Fernandes and Grady (2008) demonstrated that younger adults (mean age 19) outperformed older adults (mean age 72) in retrieval of categorizable words. However the age difference was more significant than in the current study. There is limited research looking at memory difference between twenty year olds and thirty year olds, as they are commonly allocated in the similar age group (Grady & Craik, 2000; Mitchell & Bruss, 2003). Additional research must be considered regarding sample representative with a broader age difference.

**Physical Exercise and Attention**

Current research found a causal relationship between physical exercise and attention. Fewer researches also suggest a relationship between physical exercise and attention performance in older adults (Hawkins, et al., 1992; Roth et al., 2003). However there is very limited research investigating a relationship between physical exercise and attention. Current research findings contribute to the growing research in this area.

**Limitations, Recommendations and Further Research**

Current research has a number of limitations that future research is suggested to take in to account. The current research applied questionnaires to measure physical exercise habits and sleep quality. Because questionnaire may have their biases, it would be beneficial to control those variables, for instance deprivation of sleep. It would also be beneficial to control for the amount of physical exercise.

Current research has used a video to measure attention performance. Perhaps more in depth examination would be beneficial for the study. For instance measurement of blood pressure, heart beat etc.
The two groups in the current research were studied at the different times of the day: part time student (Group 1) evening and full time students (Group 2) afternoon. The time of the day effect should also be controlled for, as it may affect attention and memory performance.

The current research may exclusively be applied to college students. College students may differ in their memory performance because of continues demand for recollection of college material. Current study have looked at psychology students, it is possible that students involved in different college courses for instance art degree may outperform psychology students, as their demands in learning is associated with visual representations.

It is also possible that the time of the study may influence the results. Because the research was carried out during economic downturn many students may also work part-time, this may have an effect on sleep quality and decreased physical exercise. Part-time job may also increase stress amongst students, which may also have an effect on sleep quality and attention. Stress and coping styles should be considered in regards to the current research.

It is also worth acknowledging that participants were private college students. It may be assumed that private college students are more financially stable, because of the financial demand in private colleges. Financial stability, especially during current economical circumstances may reduce stress. It would be beneficial to compare the scores of current students and government college students.

Population frequency sample had considerably more female than male participants. This may have an effect on research results. Population sample was also limited in amount of participants. It is possible that a bigger sample size may reveal more significant results.

*Strengths*
The current study has revealed a number of compelling results. For instance the research found that physical exercise may affect attention performance. There is very limited research regarding effect of physical exercise on attention performance. The current study contributes to the scarce research in this area. Research findings may also be applied in sport psychology, where physical exercise may affect attention during certain sport performance (e.g. football).

Attention and memory performance in female participants may be applied to strengthen memory performance in females and perhaps promote further research in regards to attention and memory.

The research has also revealed no relationships between physical exercise, sleep quality and re-call memory. Further research may consider examining more variables that may affect memory (e.g. stress).

Current study also contributes to the body of research about college students in Ireland. Because majority of research is implemented outside Ireland, many may not be applicable to Irish residents. Supplementary research is acquired about Irish residents in order to acknowledge, understand and benefit Irish society.

Implications and Applications of Results

Although research hypotheses were rejected, several findings were acknowledged. Research found that physical exercise may affect attention performance. Considering there is very limited research regarding those variables, current study contributes to the growing research. Implications may include performance in sports, attention performance in education, job occupations that may acquire attention for instance transportation, fire-fighters and law enforcements.
Casual relationship between attention and memory in female participants and in Group 2 may be applied to academic concept. Further research may be acquired in order to explore the difference between attention and memory performance in male and female participants. In regards to attention and memory causal performance in Group 2, it may be assumed that requiring attention during memory task may result in improved memory re-call performance.

Though hypotheses were not accepted, research findings provide compelling findings that may have beneficial applications and promote future research.
References


Journal of the Human Factors and Ergonomics Society, 43, 12-29. DOI: 10.1518/001872001775992462


Clarkson-Smith, L., & Hartley, A. A. (1990). Structural equation models or relationship between exercise and cognitive abilities. Psychology and Aging, 5, 437-446. DOI: 10.1037/0882-7974.5.3.437


Retrieved January 9th 2013, from:


Appendix:

APPENDIX 1. *Pictures used for re-call task; refer to Procedure section of the Method*
BUTTONS

PIN
RING

COWBOY
CAR

SWEETS/CANDY
WATCH

BALL
FLAG

THREAD/NEEDLE
APPENDIX 2 *Complete questionnaire; refer to Procedure section of Method*

Dear Participant:

I am an undergraduate Psychology student at Dublin Business School conducting a research about the relationship between physical exercise, quality of sleep, attention and short term memory in students. I would like to enlist your help by participating in the research.

The questionnaire consists of two parts. In the first part you will be asked to participate in attention and a short term memory task. The second part will include general demographics information, questions about physical activities habits and quality of sleep.

The study will take approximately 15 minutes. Your answers are anonymous and all answers will be kept confidential. If you have questions, concerns or would like to be notified about the results of the study, you may contact me via email.

Thank you for your time and consideration.

Please turn the page when indicated so
**PART ONE**

Attention task

Please indicate have you noticed any objects that appeared in the background and what were they:

Please turn the page when indicated so
Memory task

Please write down objects that you have remembered below:

________________________________________

________________________________________

________________________________________

________________________________________

________________________________________
PART TWO

Demographics

Please answer the following questions:

Age: ____________

Gender: ____________
Godin Leisure-Time Exercise Questionnaire

1. During a typical 7-Day period (a week), how many times on the average do you do the following kinds of exercise for more than 15 minutes during your free time (write on each line the appropriate number, for instance if the activity took approximately 15 minutes write down 1, if 30 minutes write down 2 etc).

TIMES PER WEEK

a. STRENUOUS EXERCISE
   (HEART BEAT RAPIDLY)
   (e.g., running, jogging, hockey, football, 
soccer, squash, basketball, cross country skiing, 
judo, roller skating, vigorous swimming, 
vigorous long distance bicycling)

b. MODERATE EXERCISE
   (NOT EXHAUSTING)
   (e.g., fast walking, baseball, tennis, 
easy bicycling, volleyball, badminton, 
easy swimming, alpine skiing, popular and 
folk dancing)

c. MILD EXERCISE
   (MINIMAL EFFORT)
   (e.g., yoga, archery, fishing from river bank, 
bowling, horseshoes, golf, snow-mobiling, 
easy walking)

2. During a typical 7-Day period (a week), in your leisure time, how often do you engage in any regular activity long enough to work up a sweat (heart beats rapidly)?

   OFTEN □   SOMETIMES □   NEVER/RARELY □
Pittsburgh Sleep Quality Index (PSQI)

The following questions relate to your usual sleep habits during the past month only. Your answers should indicate the most accurate reply for the majority of days and nights in the past month.

Please answer these questions:

1. During the past month, when have you usually gone to bed at night?
   USUAL BED TIME__________

2. During the past month, how long (in minutes) has it usually take you to fall asleep each night?
   NUMBER OF MINUTES__________

3. During the past month, when have you usually gotten up n the morning?
   USUAL GETTING UP TIME__________

4. During the past month, how many hours of actual sleep did you get at night? (This may be different that the number of hours you spend in bed)
   HOURS OF SLEEP AT NIGHT__________

For each of the remaining questions, check the one best score. Please answer all questions.

5. During the past month, how often have you had trouble sleeping because you….

   a. Cannot get to sleep with 30 minutes
      
      Not during the past month □ Less than once a week □
      Once or twice a week □ Three or more times a week □

   b. Wake up in the middle of the night or early morning
      
      Not during the past month □ Less than once a week □
      Once or twice a week □ Three or more times a week □
c. Have to get up to use the bathroom

Not during the past month [ ] Less than once a week [ ]
Once or twice a week [ ] Three or more times a week [ ]
d. Cannot breath comfortably

Not during the past month [ ] Less than once a week [ ]
Once or twice a week [ ] Three or more times a week [ ]
e. Cough or snore loudly

Not during the past month [ ] Less than once a week [ ]
Once or twice a week [ ] Three or more times a week [ ]
f. Feel too cold

Not during the past month [ ] Less than once a week [ ]
Once or twice a week [ ] Three or more times a week [ ]
g. Feel too hot

Not during the past month [ ] Less than once a week [ ]
Once or twice a week [ ] Three or more times a week [ ]
h. Had bad dreams

Not during the past month [ ] Less than once a week [ ]
Once or twice a week [ ] Three or more times a week [ ]
i. Have pain

Not during the past month [ ] Less than once a week [ ]
Once or twice a week [ ] Three or more times a week [ ]
j. Other reason(s), please describe __________________________________________

How often during the past month have you had trouble sleeping because of this?

Not during the past month □  Less than once a week □
Once or twice a week □  Three or more times a week □

6. During the past month, how would you rate your sleep quality overall?

Very good □
Fairly good □
Fairly bad □
Very bad □

7. During the past month, how often have you taken medicine (prescribed or over the counter) to help you sleep?

Not during the past month □  Less than once a week □
Once or twice a week □  Three or more times a week □

8. During the past month, how often have you had trouble staying awake while driving, eating meals or engaging in social activity?

Not during the past month □  Less than once a week □
Once or twice a week □  Three or more times a week □

9. During the past month, how much of a problem has it been for you to keep up enough enthusiasm to get things done?

Not during the past month □  Less than once a week □
Once or twice a week □  Three or more times a week □
If you have any concerns, questions or inconvenience that you have felt about the study or questionnaires please indicate so, your response is anonymous and very helpful